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EFFECTS OF 2,4,5-T ON MAN AND THE ENVIRONMENT ^{Human}

HEARINGS
BEFORE THE
SUBCOMMITTEE ON ENERGY, NATURAL
RESOURCES, AND THE ENVIRONMENT,
^{U.S. Congress, Senate,} OF THE
COMMITTEE ON COMMERCE
UNITED STATES SENATE
NINETY-FIRST CONGRESS
SECOND SESSION
ON
EFFECTS OF 2,4,5-T ON MAN AND THE ENVIRONMENT

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Windham College

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AFTERNOON SESSION

Senator HART. The committee will be in order.

Resuming this afternoon, our first witness is Dr. Arthur H. Westing. Dr. Westing is chairman of the Biology Department of Windham College in Putney, Vt.

STATEMENT OF DR. ARTHUR H. WESTING, CHAIRMAN, BIOLOGY DEPARTMENT, WINDHAM COLLEGE, PUTNEY, VT.

Dr. WESTING. Senator Hart, I consider it a privilege to be able to testify before your committee. Actually, I am very pleasantly surprised that you and your staff show such tolerance toward me despite a fairly questionable record with respect to your state.

First of all, most of the year I lived in Michigan, I devoted to spraying your forests with 2,4,5-T, and perhaps even worse, when I left Michigan I took with me one of your most desirable natives as my wife.

Senator HART. I don't know whether that makes an even trade or not.

Dr. WESTING. All the time I was listening to this morning's testimony and realizing how muddled the situation was with respect to the medical and public health aspects and the legal and administrative aspects. I kept thinking that those aspects were crystal-clear in relation to the aspects that I am going to try to talk about, and that is the impact of 2,4,5-T on the environment.

It is such a difficult field to cope with because ecology is still really in its infancy, particularly when it comes to the study of the full impact of a toxic introduction to the environment.

To judge from the popular press, our nation is on the brink of environmental disaster. Ecology has achieved some sort of a mystical significance to many people, and a whole new vocabulary has emerged overnight utilizing that wonderful avant-garde prefix "eco."

Over and over again we are being reminded of our collision course with "ecocatastrophe" leading to "ecodeath." We are told that we have to really use drastic "ecotactics;" a Senator like you should be using aggressive "ecopolitics." The whole world is being challenged to accept a protocol on "ecocide." And I suspect that psychiatrists are very soon going to be diagnosing "econeuroses."

Actually, the unhappy truth of the matter is that there may well be good cause for concern over the future of man's environment. It is being assaulted from all quarters with a gusto that is hard to grasp. Man has habitually ignored the impact that he has had on the environment, the environment that all of us depend upon for our well-being and survival. Western man has always considered himself master of his surroundings. Until the present, with far smaller numbers and very ineffectual technology, this self-delusion made very little difference.

But today we are introducing a great diversity of chemicals into our environment in vast, continuing, and exponentially increasing quantities. Among these chemicals, pesticides are worthy of particu-

lar scrutiny because of their potential ability to decimate certain classes of living organisms, and thereby to upset the balance of nature—to disrupt what the ecologist refers to as the "ecosystem."

I shall here limit my remarks to the potential dangers to the environment that might be expected from the excessive or otherwise incorrect use of one such substance: 2,4,5-T.

As we have heard this morning, this compound has recently gained a degree of notoriety owing to its massive military use in Vietnam despite the suspected ability of it, or an associated impurity, to cause birth defects.

I need not refer you to Thomas Whiteside's article on this subject which really is a beautiful expose of the current legal, administrative, and other associated problems. (*New Yorker*, 7 February and 14 March 1970). Now, to speak briefly on the current use of 2,4,5-T, it is one of a class of potent herbicides or plant killers, the one preferred by utility employees, foresters, range managers, and farmers, and by our armed forces in Vietnam for the destruction of unwanted woody vegetation. It is one of a class of growth-hormone-mimicking herbicides whose close chemical relatives include 2,4-D, MCPA, and Silvex. 2,4,5-T was developed during the early 1940's (as a possible chemical warfare agent) and came into widespread domestic use during the mid-1950's. In 1964, some 13 million pounds of 2,4,5-T were manufactured in the United States. About a million of these pounds were applied to about 3 million acres of U.S. croplands, another million pounds were sprayed on perhaps 80,000 acres of forest lands in Vietnam, and most of the remaining 11 million pounds were presumably used domestically on an undetermined number of acres of noncroplands. This morning we were vividly reminded that a small portion of this is also used by home gardeners.

Now, these are the 1964 figures. Although I am not sure of the current ones, I understand that the domestic use of herbicides in general has been increasing at a compounded growth rate of 10 percent per annum.

2,4,5-T is commercially available in a number of formulations of which the most important are the oil-soluble esters and the slightly less effective water-soluble amines. Whereas the amine formulations are very low in volatility, some of the ester formulations are relatively high and others are relatively low. The low volatility esters are actually somewhat more effective than the high volatility ones, but they are also slightly more expensive. 2,4,5-T is also available in combination with 2,4-D, a mixture which is known domestically as "brush killer" and by the military as "agent orange."

The 2,4,5-T is effectively applied either to the foliage of unwanted woody vegetation from ground- or aircraft-mounted spray rigs, or to their stems by a variety of techniques.

Domestically, it is very often applied highly diluted by oil or water, although some domestic techniques of individual application call for strong concentrations.

In Vietnam, it is aeri ally applied in totally undiluted form.

Recommended broadcast dosages—these are domestic recommendations—range from one-half to three pounds of active ingredient per

acre. At these levels of one-half to three pounds per acre, the 2,4,5-T is quite selective, killing many species of broad-leaved woody plants and sparing most grasses and conifers. At the high rates the military use in Vietnam—which is about 13 pounds per acre, together with as much again of 2,4-D—it becomes far less selective and kills a high proportion of the vegetation.

In their silvicultural applications, foresters do some aerial spraying, but often resort to individual application to unwanted trees. However, in range improvement and in the control of vegetation on rights-of-way, and in Vietnam, application is mainly or entirely from the air.

Overall, the domestic applications average out to about one-third to one-half pound per acre treated.

That is a very brief summary of the use of 2,4,5-T.

Now I would like to spend a few minutes on the potential dangers from the use of 2,4,5-T. I am limiting my remarks, by and large, to the dangers to the environment since the medical and public health aspects were covered previously, and I understand will be covered by subsequent speakers.

Senator HART. Doctor, as you leave the use section and before you get into these potential dangers, can you describe for the record—I think it has not yet been stated in layman's language for the record—what the bush or tree or grass or area of earth surface looks like when this is applied to it, you say 1 to 3 pounds an acre.

Dr. WESTING. That is right.

Senator HART. If you can in language describe for the reader and me what it looks like, I frankly have not seen it.

Dr. WESTING. Stretching my memory back to the Upper Peninsula.

Senator HART. The beautiful Upper Peninsula.

Dr. WESTING. I might interject here that a lot of pioneering work in aerial forest spraying was actually done in Michigan. The leaves on unwanted oaks or maples very rapidly turn brown, within a matter of 3 or 4 days. In 5 days they start showing signs of shriveling up. They usually hang on that way for 6 to 8 weeks, and perhaps longer; so, one sees a lot of trees that have brown, shriveled up leaves. If conifers are intermingled, they show no damage so they stand out like green thumbs, and a good bit of the forest floor stays green; grasses and so on stay green, ferns and so on will turn brown; some plants stay green and others do not, depending upon the type. What it looks like really in this country is as if fall had just decided to come a few months early.

Senator HART. How would you describe the same scene if there was applied to it the 13 pounds per acre which you say is the current application on the average in Vietnam?

Dr. WESTING. It is actually about 25 or 26 pounds. It is 13 of 2,4,5-T plus another 13 of 2,4-D.

Senator HART. The picture you described—

Dr. WESTING. Was for one to two pounds.

Senator HART. Of 2,4,5-T only?

Dr. WESTING. Right.

I have not seen an area myself that has been hit this heavily, but I have seen pictures. Within a very short period of time, all the

leaves look brown and shriveled up and within a matter of perhaps two to three weeks most of the leaves drop off the trees, vines, and shrubs.

This, of course, is the reason why the military spray these herbicides and sprays them in such heavy dosages, in order to get as rapid a leaf defoliation as possible. But in the process of getting rapid defoliation, there is a high degree of kill, which is an unhappy corollary. I am not sure if this is really intended: it happens, particularly in certain types of vegetation.

Subsequently, grasses, bamboos, and a variety of other weeds grow back fairly rapidly. So, after several months you see lots of large dead trees and then a very heavy new undergrowth.

Senator HART. You say the tree does die?

Dr. WESTING. Well, it depends upon the species, Senator Hart. Mangroves would be killed by one application in Vietnam whereas some other trees might not be killed unless they were sprayed a second time. A single spraying seems to kill about 10 percent of the trees. There is a great diversity of tree species there.

I have flown over areas in southeast Asia that have been sprayed once and it seems that roughly one tree in eight or 10 is dead. If these were sprayed a second time 6 months later, perhaps two out of three trees would be dead, or maybe even more.

Senator HART. Thank you.

Dr. WESTING. I wish now to touch upon some of the potential dangers to the environment from the use of 2,4,5-T, and I am speaking again primarily domestically. The dangers can arise not only from the 2,4,5-T itself, but also from its contaminants, (such as were discussed at great length this morning), from its additives, (and there are endless kinds of additives: wetting agents, emulsifiers, stickers, penetrants, thickeners, humectants, spreaders, etc.), from its carriers or diluents, (such as fuel oil, kerosene, seal oil), and from its degradation products (or perhaps degradation products arising from subsequent burning). All of these various possibilities I shall lump together for purposes of my comments here, just calling them 2,4,5-T.

The dangers from the use of 2,4,5-T need not be confined to the site of application, but can be carried elsewhere by wind, either as liquid or as vapor, or carried elsewhere by water, either surface water or ground water. Moreover, the potential dangers are not confined to the time of application, but last, of course, until the 2,4,5-T degrades to the level of insignificance. Under wet and warm field conditions, one of the advantages of 2,4,5-T is that it breaks down within a matter of several weeks, 6 or 8 weeks perhaps. But under dry and cool conditions, this may take well over a year. Furthermore, the rate of degradation in the groundwater may also be very slow.

The dangers from the use of 2,4,5-T can result from damage to plants, damage to animals, both higher and lower, possibly from damage to microorganisms, and from direct and indirect combinations of these effects.

I shall elaborate very briefly on some of these possibilities.

The most spectacular effect of 2,4,5-T—when used as recommended domestically—is, of course, on certain classes of plants, particularly

but not exclusively the broadleaved woody vegetation. In selectively destroying such plants and sparing others, the species composition of the treated area is altered, the overall diversity of species is reduced, and the total mass of living things is probably diminished. And such changes are considered by ecologists to be an unstabilizing and therefore detrimental influence on an ecosystem. In other words, they make the balance of nature more precarious.

A properly functioning, relatively undisturbed ecosystem owes its stability—indeed, its very integrity—to a highly complex set of interactions amongst all of its many living and nonliving components. Nutrients cycle and recycle from the soil up through the interlocking food chains and back again to the soil. Population levels of the many component plants, animals, and microorganisms are kept in balance by a staggering multitude of predator/prey, host/parasite, and other long-established interactions of mutual dependency.

As soon as a toxic factor such as 2,4,5-T intrudes upon this highly complex, totally interacting system, a certain amount of the so-called ecological buffering action (of the many inherent checks and balances) is lost, and things start going wrong. Erosion may be accelerated, particularly in hilly terrain and even more particularly when streamside vegetation is killed. This effect, together with a reduction in the total mass of the living component of an ecosystem inevitably leads to a loss to the area of vital nutrient materials. Especially following heavy or repeated applications, the result is a steady decline in the productivity of the treated ecosystem—something that may take it centuries from which to recover.

On top of this there are all sorts of subtle things that can go wrong. For example, a continuing supply of available nitrogen—one of the elements essential to all life, and often in short supply—depends to a large extent on the presence of certain 2,4,5-T sensitive plants, whose roots play host to various microorganisms crucial to this process.

Actually, there has been some evidence of this occurring in the Pacific Northwest, where ponderosa pines are the crop tree and alders are being removed by 2,4,5-T as weeds, with a resulting loss to the area of available nitrogen.

Additionally, the birds and other animals that depend upon the 2,4,5-T decimated plants for food or cover are placed at a great disadvantage and may be partially or even completely eliminated from a treated area.

The direct toxicity of 2,4,5-T to most higher animals is known not to be very severe, particularly at the recommended rates of application. However, that there is also potential danger in this regard is suggested by its known effects on humans. The U.S. Department of Agriculture categorize 2,4,5-T as "mildly" irritating to the skin in a standard dermal response rating, and as "moderately" toxic when ingested. In fact, one can quote the following precaution from the product label: "Do not contaminate irrigation ditches or water used for domestic purposes;" and also the following warning: "Causes irritation of skin and eyes."

Moreover, in aquatic habitats, the death of trout and some other fish has been reported when 2,4,5-T is applied at recommended rates

for weed killing. Certain crabs, shrimps, and mollusks are also harmed by low concentrations of 2,4,5-T.

The adverse effects on wildlife are not limited to the ones already alluded to. Some plants exposed to sublethal doses of 2,4,5-T (or 2,4-D) start producing abnormally high levels of nitrates (and in some cases there has been a suggestion of even cyanide). It has been noted with livestock that when such plants are ingested, the excess nitrates are converted to nitrites, toxic or even lethal to the animals.

Another occasional result of 2,4,5-T application is that naturally poisonous, and usually avoided, plants are made attractive to animals as a result of 2,4,5-T spraying; and then the animals feed on these newly attractive plants and are poisoned.

The known ability of 2,4,5-T to cause chromosomal damage in some plants and the fact that in some animals it, or an associated impurity, results in deformed offspring when ingested during pregnancy, suggest that the plant and animal populations thus affected will be less able to cope with their environment.

All of these debilitations that I have been cataloging, and additional ones that I have not, do harm not only to the affected species, but, of course, thereby also to the ecosystems of which they are a part.

Since man is also a part of nature, I can bring out here once again for emphasis that there is strong reason to suspect that 2,4,5-T or an unavoidably associated impurity, the dioxin we have been hearing about this morning, 2,3,7,8-tetrachlorodibenzo-p-dioxin (or, by the way, a dozen or so closely related compounds all coming under the name of dioxin), are now known to be highly teratogenic. In other words, they result in malformed offspring when ingested during pregnancy. Until this issue is clarified, I think it should go without saying that the use of 2,4,5-T both domestically and in Vietnam be restricted to locations and amounts that would preclude its possible human ingestion.

Well, let me now make a few concluding remarks.

Senator HART. Doctor, I think it would be wise if we interrupt briefly for a recess. That was a signal that sounded for a vote. I think this is the time to suspend.

(Short recess.)

Senator HART. Doctor, with luck we will finish before there is another vote.

You were just about to begin with your conclusions.

Dr. WESTING. It is possible that I have been painting somewhat too grim a picture of the domestic use of 2,4,5-T. But I have no particular fears that detailed exposition of its safety and benefits can be left to the herbicide manufacturers and others. So, I figure that what I am describing here from the environmental standpoint is one side of the picture, and let the manufacturers tell us the other side.

Senator HART. Let me react to that, but very briefly. It is not inappropriate or a matter of surprise, nor in my book, should it be the basis of criticism, if the manufacturer of the product describes it in glowing terms if society and its government permits him to market it. If those responsible for the protection of the health of the society conclude that he can market the product with those claims, then why get mad at him? Why don't we get mad at the society's institutions?

Dr. WESTING. I agree.

Senator HART. You can't have it both ways, if I make myself clear.

Dr. WESTING. Yes. I certainly am in full sympathy with this. I think the burden falls upon our regulatory agencies.

Senator HART. Clearly.

Dr. WESTING. I don't think Dow is the culprit here at all. It is FDA and USDA, and so on.

Senator HART. This goes beyond the immediate product line we are talking about. This goes to the marketplace and the role of society in protecting itself, establishing regulations where needed, and enforcing them as established.

Dr. WESTING. I would certainly have to admit that the vast successes of productivity upon which our nation's current affluence hinges, depend to a large extent upon the use of pesticides such as 2,4,5-T. And it seems clear that the use of pesticides will continue, perhaps even unabated, without a highly unlikely downward trend in our population, and, even more particularly, in our collective desires and demands.

However, the time seems to be fast arriving when certain precautions must be taken so as not to overload our environment with such potent pollutants. A number of suggestions are thus in order to forestall the need for a basic change in our way of life.

First of all, research efforts should be expanded on several fronts. Effective cultural and biological controls of pest species should be sought and developed with renewed vigor. With respect to the pesticides themselves, highly selective and rapidly degrading ones should be aimed for.

In the light of the current 2,4,5-T affair, I must add here that all pesticides, existing and potential, must be rigorously tested prior to their general release for possible toxicity, carcinogenicity, teratogenicity, and mutagenicity to humans; and additionally, for possible adverse effects on livestock, on wildlife, on game, on fish, and on other components of the ecosystem.

With respect to 2,4,5-T, its use—in my considered opinion—must be limited to areas remote from human habitation. Control of vegetation on rights-of-way must be regulated with particular care since utility, transportation, and other rights-of-way are by their very nature frequently close to civilization. I want to emphasize here, Senator Hart, that one of the major uses of 2,4,5-T—one of its preferred uses—is in woody vegetation control along rights-of-way. This is a major place where 2,4,5-T is likely to impinge upon human habitation, to come in contact with civilization.

Broadcast applications, where safely remote from human habitation, should not exceed 3 pounds per acre; and where spraying covers extensive areas, unsprayed zones should be left as oases for wildlife, and so forth.

Repeat applications should be controlled, perhaps to intervals of 3 years or more. Aerial broadcast spraying should be avoided where possible, and always avoided near bodies of water, in favor of spot applications, or individual applications.

In those areas where aerial spraying is permissible, the highly volatile (though cheaper) formulations should be banned completely.

The low volatile formulations are not only more effective as herbicides, but they are also much safer with respect to the problem of drift and volatilization.

Aerial spraying should be confined to relatively windless periods (wind speeds of less than 5 mph) and to air temperatures of less than 85 degrees. Only nozzles equipped with coarse sprays should be used. The cleaning of spray equipment or the dumping of excesses near lakes or streams must be avoided; and getting rid of the empty cans and so on should be limited to sanitary land-fill dumps or similarly safe locations.

To insure all of the above, State and Federal regulations should be tightened both for manufacturers and users, and educational efforts increased with the aim of minimizing unnecessary or excess application. Our flagrant misuse in Vietnam should be halted immediately (see, e.g., my article in the Friends Journal of 1 April 1970).

Finally, I wish to stress once again the complex and as yet little understood nature of our environment. The study of ecosystems as such is still in its infancy. And since hormonal herbicides have been in general use now for only two decades or less, we simply are not yet able to predict the full range of potential disasters that their unrestricted use may inflict upon us and all other living creatures with which we share this small world.

Senator HARR. Doctor, for all its brevity, this is a very helpful statement.

I have a couple of questions that I would like for you to react to.

You tell us in dry and cool conditions it may take well over a year for 2,4,5-T to degrade. I think you were here this morning. The Department of Agriculture is not in agreement with that statement.

Can you give us some evidence for your statement, or refer us to sources that are in agreement with your statement?

Dr. WESTING. To my knowledge, there has been precious little research done on the life of 2,4,5-T in the environment. I am aware of one study that was done in a forest environment in which it was shown that 2,4,5-T degraded to insignificance in a matter of several months, as I recall.

On the other hand, it has been well established, and it is clearly known, that 2,4-D—a compound similar to 2,4,5-T—degrades much more rapidly than 2,4,5-T. It has been demonstrated a number of times that under dry conditions, 2,4-D can persist in the environment and have detrimental effects for as long as a year or a year and a half after application. From this I infer that 2,4,5-T, which is more persistent than 2,4,5-D, would have at least a similar life under dry conditions.

Senator HARR. Then, adopting your reasoning, it would mean that under those conditions, 2,4,5-T might be found on food that is served months after the spraying of the crop; is that correct?

Dr. WESTING. I have no direct information, but one could surmise that this could happen. This is a possibility.

Senator HARR. What would you think the possibility of 2,4,5-T's capacity is to persist within the organism, plant or animal, which had ingested it, including the human?

Dr. WESTING. I have no first-hand knowledge on this whatsoever; so I prefer not to try to answer it.

Senator HARR. You would agree that it is impossible to say it is not possible?

Dr. WESTING. The likelihood is there. As far as I know, it may persist, or even build up in the human body. Some other chemicals that are fat soluble (as are the ester formulations of 2,4,5-T) are known to deposit and be stored in the fatty tissue of humans; so, it is highly possible that 2,4,5-T does this, but I simply do not know whether it does or not.

Senator HARR. You suggest that use of 2,4,5-T be limited to areas remote from human habitation, and that it should be restricted in other respects. Does that mean that you would feel that Dr. DuBridge's suggestion that pesticides be deregistered for food use, assuming there can be no tolerance level set by FDA doesn't go far enough?

Dr. WESTING. 2,4,5-T as it is commercially available with its impurities, is a substance that should not have any food tolerance at all. It should have zero tolerance, at least given the current state of knowledge.

Certainly, the suggestion made this morning by—I think it was Mr. Wellford—that its use should be curtailed severely, or suspended until we clarify this whole issue is one that I fully support. I think that 2,4,5-T is probably a safe chemical to use at the low, recommended doses in areas remote from human habitation. I don't think it need be banned under such conditions in the forest environment, or on range lands.

On the other hand, along power line rights-of-way, railroad rights-of-way, and so on, that get near houses, I think there should be severe restrictions.

Senator HARR. What about proximity to crops?

Dr. WESTING. Food crops?

Senator HARR. Yes.

Dr. WESTING. I think that certainly for the time being, it should not be registered for use on food crops and not be used near them.

Senator HARR. In these areas that you have described where 2,4,5-T has been applied you have said that some of the birds and animals that depend on the plants that have been destroyed may be eliminated. Which birds and which animals are likely to be affected?

One way to answer that I suppose is any that are in that area, but I am trying to find out if some are and others are not affected.

Dr. WESTING. I wish I could give you some spectacular answer about bird X or Y having become extinct as a result of the use of 2,4,5-T, but I cannot. I can quote a recent statement made by a British authority on pesticides, Dr. N. W. Moore, director of the Monks Wood Experimental Station in England:

The use of 2,4-D and 2,4,5-T to control scrub by roads and in woods reduces the essential habitat of almost all British land birds, which, because they are survivors of the original forest fauna, are still dependent on trees and bushes. (Advances in Ecological Research 4:108; 1967)

To judge from this statement Dr. Moore is concerned over the fate of the native British birds as a result of the routine use of these herbicides.

In this country there is an extensive program over many tens of thousands of acres in the West of sagebrush control in which herbi-

cides of this nature are used, primarily 2,4-D. There is some evidence that the sage grouse population has been depleted; at least the hunters are not as happy as they used to be.

I have to warn you, Senator Hart, this is one area where the herbicide proponents will jump up and say that there are a number of clear cases where the use of herbicides has actually benefitted wildlife populations.

Senator HART. I made an interjection earlier to say that if we are going to get mad at somebody let's get mad at ourselves first of all as a people for not recognizing dangers and setting down the laws that will prohibit the marketing of certain things, but equally true, of course, is that the producer is obligated, absent any explicit regulation, to make truthful representation about its product—again, I am thinking not of chemicals alone but anything—and report factually the experience that has come to his attention to whatever public agency there is that is expected to make the judgment for all of us as to whether that product in fact should be marketed. So, if they jump up and explain it is good for us, I hope, they will not do so unless they can explain why.

You noted, among other things, in your conclusion that we should expand research, attempting to develop other controls of pests. What development do you imagine would be fruitful?

Dr. WESTING. Well, the main thrust of alternatives to the use of insecticides has been to introduce predators or diseases of the insect pests. This same approach can also be used with herbicides such as 2,4,5-T. Plant pests are a little less amenable to this sort of an approach, but one could push ahead on research on possible virus diseases or fungus diseases or insect enemies of weed species.

I am familiar with one success story in this regard. A serious weed in the Northwest is St. Johnswort, and a beetle (*chrysolina*) has been introduced from Australia that feeds on the St. Johnswort, in a highly successful alternative to chemical herbicides. This general type of approach should be exploited to the greatest extent possible.

There are all kinds of other possibilities. Just in forestry, for example, closer spacing of crop trees shades out certain weeds. You can go back to a greater emphasis on some of the mechanical methods that are now avoided because of the high cost of labor: mowing, weeding (pulling out the weeds or cutting them down), burning. Flamethrowers are used in certain instances and even controlled fires. These methods have a much more selective effect on the actual weed and a minimum of lasting untoward side effects.

If chemicals are to be used, the forester's approach of individual application is far preferable to the utility and range manager's approach of broadcast spraying from the air.

So, there are a variety of alternatives available. With just the slightest amount of urging, the slightest realization that there is a necessity to worry, these alternatives would at least be explored. In the past it had never even been realized that there were possible ill side effects to the use of herbicides.

Senator HART. Now, you have lectured us quite thoroughly on the dangers inherent in changing the ecological pattern. Yet every one

of these alternatives that you talk about suggests similar dangers and some additional ones.

The Australian beetle is not native to the Northwest, I take it, but you are going to bring Australian beetles in. The flamethrower is not really an altogether acceptable—

Dr. WESTING. There is a history of introducing something to combat a pest and thereby introducing a worse pest, so there has to be some very careful preliminary testing and evaluating before this approach is used. With this in mind, it is safer to use something like a virus than it is to use something like an insect or a fungus because the virus one will be far more host-specific and therefore will not switch to an alternate host after it does its job and then become a pest in its own right. This is a danger that has to be kept in mind.

With regard to the pesticides, I suggested that we keep searching for much more highly selective ones. The problem with 2,4,5-T is that although selective in a certain sense it still is relatively unselective and kills lots of things that you do not want it to kill. This is the sort of thing that has to be watched out for.

Senator HARR. I must admit that I got the impression clearly this morning that the existence of a realistic alternative to some of these things might help to convince the Department of Agriculture to take action; that is if they knew they had a realistic alternative, maybe the evidence which the Department now says is not sufficient to alarm them might have higher credibility.

I don't know whether I make myself clear.

Dr. WESTING. Yes; that is why it is important to mention that there are possible alternatives or at least that a goodly research effort should be aimed in that direction, to provide possible alternatives. We have come to depend upon the chemicals to such an extent that I think other possible control methods have become less interesting.

Senator HARR. I think it should be said, and not necessarily as a direct criticism of anybody, but humans are humans and if there is some acceptable alternative for what would otherwise be a decision that would put a lot of heat on the fellow making the decision, it would be much easier to make and somewhat unconsciously perhaps the existence of an alternative might change the attitude of some of these individuals.

Mr. Bickwit.

Mr. BICKWIT. Part of your evidence for the persistence of 2,4,5-T under certain conditions for over a year stems from experiments establishing the persistence of 2,4-D. I think for the record we ought to have some reason why you can jump from evidence of the persistence of 2,4-D to conclusions about the persistence of 2,4,5-T. Can you meet the argument that the 2,4-D evidence might show that 2,4-D is just more persistent than 2,4,5-T?

Dr. WESTING. No, I think one could be on completely safe ground in saying that 2,4-D is considerably less persistent than 2,4,5-T. 2,4-D will degrade under normal, moist environmental conditions in a matter of weeks. 2,4,5-T is perhaps twice as persistent. There are a lot of studies to show that 2,4-D degrades more readily than 2,4,5-T; lots of short-term experiments have shown this. I am not familiar

with any definitive long-term 2,4,5-T studies. It is very reasonable to assume that as long as 2,4-D will, under dry conditions such as you find in Idaho, have harmful effects on crops a year or more after use that 2,4,5-T would also.

Senator HART. Doctor, thank you very much. It was a helpful paper.

The signal a few moments ago indicated another roll being called in the Senate. I apologize to Dr. Kotin, but we will have to take another recess, and I will be back just as soon as I can get on the roll.

(Recess.)

Senator HARR. The Committee will be in order.

Our concluding witness on this first day of hearing is the Director of the National Institute of Environmental Health Sciences, Dr. Paul Kotin.

STATEMENT OF DR. PAUL KOTIN, DIRECTOR, NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES

Dr. KOTIN. Mr. Chairman, I am privileged to be here today engaging in the practice of one of my most pleasant responsibilities—that of discussing the programs and plans of the National Institute of Environmental Health Sciences of which I am Director.

Our Institute is a newcomer in the executive branch; we have been in existence since 1966, achieving the status of National Institute of Environmental Health Sciences only in January 1969.

This activity started as a small segment of the Department of Health, Education, and Welfare's effort in environmental health in response to recommendations made by several public advisory committees during the late 1950's and early 1960's. These committees—starting with one chaired in 1958 by Dr. Stanhope Bayne-Jones and concluding with one headed in 1965 by Dr. Detlev W. Bronk—repeatedly emphasized the necessity of establishing within the Public Health Service an organization dedicated to performing fundamental research into the real and potential effects of human health wrought by a rapidly changing environment.

The decision of the Surgeon General in 1966 that this research program be located within the National Institutes of Health—that Federal agency responsible for building the Nation's base of fundamental biomedical, health-related research—made clear the mission envisioned for our program. That mission was and is:

First, to determine the magnitude and significance of the hazard to man's health from long-term exposures to low-level concentrations of chemical, physical, and biological agents in the environment; and second, to elucidate the underlying mechanisms of adverse response with the hope that principles and generalizations would be identified to provide a scientific base for criteria upon which control agencies could set standards for protective and preventive measures.

During the present (1970) fiscal year, Congress and the President have authorized \$17,730,000 to be expended in the conduct of this program.

Since you may be familiar with other programs of the National Institutes of Health, I would like to take just a moment to point out

to you some ways in which we are similar to other parts of NIH and some ways in which we differ. I might preface this by saying that we are similar to other NIH research components in more ways than we are different.

Like the other research institutes of NIH, our mission reflects two very important principles of operation: (1) We are in business primarily to add to the fundamental knowledge and understanding of environmental agents which as biomedical hazards immediately or ultimately affect human health.

In other words, we are concerned about the what and how of health effects first and foremost in human beings. That we must also understand that what and how of the complex constituents of our environment in order to perform the primary task is obvious.

Nevertheless, it is the results in humans which is of overriding concern to us. (2) The responsibility for taking direct action to control or eliminate the hazards which we must identify resides in other components of HEW.

I hasten to emphasize that we do not consider our job done until our findings are made available to the appropriate components of Government. To accomplish this, we maintain effective, close, and continuing relationships with the Environmental Health Service, the Food and Drug Administration, the Department of Interior, the Department of Agriculture, the Federal Trade Commission, and other agencies with control responsibilities.

The reasons for the distinction between fundamental research and control powers are, I think, important. First, the urgency in the need for control measures requires research directed to answering today's questions with today's techniques.

There is, however, an equally, or perhaps more, important need for research directed to questions having long-range implications extending for decades and perhaps even generations into the future. It is in response to this need that our Institute's program is designed.

While techniques frequently used in attacking these two sets of questions are similar, the orientation and end points stand in sharp contrast.

Second, freedom from control activities permits us to devote our total effort to research.

Third, control activities are performed by experts in an environment in which the guidelines for operation are completely dedicated to this responsibility.

Fourth, our relationship with industries, communities, and individuals is one based exclusively on scientific grounds rather than one of regulation, monitoring, and enforcing.

Finally, our inputs to control agencies are objective and provide an impartial basis for the very real practical considerations which must be faced in formulating and inaugurating control measures.

As noted, the fruits of our work are promptly forwarded to appropriate Government agencies for use in the pursuit of their mission with virtual simultaneous publication in professional journals rather than in the popular press.

This practice assures that our findings are subject to the scrutiny

and critical review of other researchers who have an opportunity to question our methods and conclusions by usual stringent standards.

I hope that the preceding discussion has placed the National Institute of Environmental Health Sciences in perspective for you.

I would now like briefly to tell you in somewhat greater detail some of the things we are doing, why we are doing them, and how we come to be involved in the resolution of the problem which is the subject of these hearings.

Speaking quite broadly, the NIEHS program attempts to employ a wide spectrum of scientific disciplines and bring them to bear on real and potential human health problems resulting from:

1. Changes in the makeup of the environment in consequence of technological progress and industrialization;
2. Changes in the size and characteristics of the population; and
3. Changes in the character of interactions between these two.

In order to best understand the significance of changes in the makeup of the environment, we employ the disciplines of analytical and synthetic chemistry, pharmacology, and of biophysics.

In order to better understand our changing population and the subtle interactions of new and changing environments on people, we employ the sciences of epidemiology, biometry, pathology, and toxicology.

In order to establish the mode and mechanisms of interactions, we employ all categorical divisions of scientific inquiry with special emphasis on comparative biology to assure maximum relevance of research data to man.

These varied resources and methods have so far been brought to bear in programs studying the potential health hazards of:

Natural products including fungal contaminants of food; fibers and polymer dusts, asbestos and fiberglass; alpha radiation; trace metals (such as lead) and their compounds; hydrocarbons and their reaction products; tobacco smoke; and pesticides and pesticide synergists (including herbicides).

In all of these studies we are concerned with the effects of long-term exposures to low levels of concentration because these are the usual characteristics of exposure during life in the environment we have created for ourselves.

Effects are likely to be gradual in appearance, and most commonly the result of interactions of numerous agents combining in additive, synergistic, or antagonistic manners.

To dissect these complexities we must identify interactions at all levels from the intracellular organelle to the whole organism.

Our goals include determinations of threshold for response, effects of repetitive exposures, effects of storage of the agents in living organisms, and the roles of such host factors as age, sex, antecedent or concurrent illness, nutrition, behavioral characteristics, and genetic make-up.

It may seem that our approach is somewhat complex, but it must be so in order to resolve the complex problems wrought by the changes in our environment intrinsic to technological progress.

We have attempted, in the process of establishing the program of the Institute during the past 3 years, to maintain a measure of flexibility amid this essential complexity to provide for response to

unanticipated problems. Our current efforts in response to concern over the widening use of herbicides is in a way a case in point.

You are aware, I am now certain, that the recently completed study which revealed information about the toxicity of the herbicide 2,4,5-T, in fact, was initiated by the National Cancer Institute in 1963.

As indicated earlier, our Institute was not in existence at that time. However, I was the scientific director for etiology in the Cancer Institute at that time, and along with members then and now on my staff played a leading role in the initiation of the research contract with Bionetics Research Laboratories, Inc., which yielded the information under discussion.

Very briefly, that study was undertaken primarily to identify any potential carcinogenic (cancer causing) or teratogenic (birth defect causing) agents in a wide variety of pesticides and allied compounds in commercial use.

We also anticipated that the study would provide data on which to develop improvements in our methods for identifying carcinogenic agents and hopefully identify any correlations that might exist between the carcinogenic and teratogenic capabilities of single specific compounds.

Pesticides were selected for inclusion in the study on either of two bases; First, a projection of the potential extent of their use in terms of their utility in the community; and; second, a judgment as to potential carcinogenicity by virtue of chemical structure or metabolic fate.

In consequence, some 86 pesticidal products—including insecticides, fungicides, and herbicides—were subjected to controlled, long-term studies on mice. As had been intended from the start, the study continued through the 1960's.

In the interim, the then Division of Environmental Health Sciences was established, and I was asked to become its first director. In agreeing, I was granted approval to take with me one or two key staffmembers—scientists, as it happened—who had also been associated with the Bionetics contract.

Since intensive programing and developmental responsibilities faced my staff and me during the first years of our Institute, we were quite satisfied to leave the management of the Bionetics pesticide study in the able hands of our successors in the Cancer Institute. Furthermore, it should be recalled that the one major basis for the study was quite clearly related to the mission of the Cancer Institute, the identification of cancer-causing agents in the environment.

Upon completion of the study in early 1969, the Cancer Institute released the results of the study. The results of the teratogenic studies were released to the Mraz Commission immediately as they became available. The popular press took intense interest in the findings reported, and pressures developed for more complete information on several of the pesticides included in the study.

The herbicide 2,4,5-T came under special scrutiny because its use is especially widespread, particularly in military operations in Vietnam. Word that the Bionetics study had shown this chemical com-

pound as "causing significantly more deformities than expected" was especially alarming in some quarters.

Dr. Endicott, then director of National Cancer Institute, requested that NIEHS staff familiar with the study in question, and also familiar with teratogenicity and pesticide chemistry generally, be assigned to data analysis and interpretation. NIEHS assumed sole responsibility for the statistical analysis of the very large volume of data.

During the early stages of the now public discussion, it was pointed out by the Dow Chemical Co., a major supplier of 2,4,5-T, that the materials used in the Bionetics study were significantly different than those which had been supplied by Dow since 1965.

It is certainly true that the 2,4,5-T used in the study contained significantly larger amounts of an impurity, dioxin. This impurity is highly toxic and its presence occurs incidental to minor alterations in the reaction conditions during the manufacture of 2,4,5-T.

Dow Chemical Co. scientists contended that it was the dioxin derivative rather than the 2,4,5-T which had caused the deformities in test animals. A sample of the original 2,4,5-T used in the Bionetics study was analyzed and was found to contain 30 parts per million of this dioxin compound.

In consequence, it became necessary to restudy the situation to see whether the virtually no-longer-existing impurity in 2,4,5-T could be held responsible for the adverse effects.

In order to verify the possible role of dioxin, NIEHS brought its available resources to bear and undertook an accelerated program of research.

Pure 2,4,5-T—and by pure, I mean that which is now in the marketplace with a dioxin concentration of less than one tenth of a part per million—has been made available to us and recently we received the dioxin in pure state so that experiments can be repeated with the pure material, as well as with a combination of the two ingredients.

These studies are now underway. As indicated in prior discussions with the subcommittee staff, the results of this research are not yet complete. At such time as they are, in the very near future, we will be pleased to supply them to this committee.

I would be happy at this time to answer any questions of the committee regarding the mission of NIEHS or the circumstances leading to our current study of 2,4,5-T.

Senator HARR. Thank you, Doctor. It was thoughtless of me—I should have suggested, since you commented on having a sore throat before, that you not read the statement, but merely put it into the record.

But I think as long as you were able to get through it, it helps all of us to hear it, rather than waiting for the printed record.

On this business of the study, do you know when the National Cancer Institute received its first data from Bionetics suggesting that 2,4,5-T was teratogenic?

Dr. KOTIN. I can't tell you offhand, but I would be very happy to put it for the record, sir.

The information was subsequently received for the record :)

"In June of 1966, we received the first data indicating that 2,4,5-T administered by injection at a dose of 113 mg/kg of body weight produced teratogenic effects. In May of 1968, data indicated teratogenic results from oral administration of 2,4,5-T at a dose of 113 mg/kg of body weight."

Senator HART. We would appreciate that, and it will be made a part of the record. I am under the impression that it was sometime in 1966. In a sense I guess that's about the time you departed the premises?

Dr. KOTIN. Exactly.

Senator HART. Let's assume that the date is June 1966, that being the time the first data was received from Bionetics by the Institute. Do you recall when the final report came out?

Dr. KOTIN. Yes, the final report, in 1969—late 1968 and early 1969, as I recall. A little over a year ago, as I recall.

Again, I can't be sure of that, but I would be pleased to get the exact date. I had left the Institute.

(The information was subsequently received for the record:)

"Bionetics supplied a draft "final" report in September of 1968. Questions raised by NIH required additional work by Bionetics and subsequent revisions of the report. Bionetics completed this work and submitted a truly "final" report in September of 1969."

Senator HART. The NIEHS report—when did that come out?

Dr. KOTIN. The final report was last fall, when we were providing the results of our statistical analysis, and the data on the teratogenicity to the Mraz Commission.

Senator HART. If it develops that the June 1966 date is the time that the National Cancer Institute got its first data from Bionetics, and the final report by NIEHS came out in the fall of 1969, why in the world did it take so long to come up with the information for that final report?

Dr. KOTIN. I really can't answer that, other than to say that at the time the National Institute of Environmental Health Sciences was asked by Dr. Endicott to provide the statistical and analytical competency for the review of the data, the work was done very promptly. In fact, we didn't even wait until the end of the report to make the information available to the Mraz Commission.

As each little increment of information that represented a part of the total became available, this was made immediately available to the Mraz Commission, and the Food and Drug Administration.

Senator HART. I am trying to get these dates clearly fixed, if I can. You state that NCI released the results of the study in early 1969. Was this the preliminary report of Bionetic's findings?

Dr. KOTIN. No, sir; this, I think, represented the first report in which conclusions were published, both in the scientific literature and in the Journal of the National Cancer Institute, as well as made available to the various responsible government agencies.

The really important aspects of the conclusions, the necessity for voluminous work—there were some 86 compounds—the National Cancer Institute justifiably felt that in-house staff should at least on a random basis review the data. There was much, much new information that heretofore had been unknown. And just the histological review of the slides from the autopsied animals, the statistical analy-

sis of data from a series of experiments in which multiple species were used, multiple doses were used, were terribly time-consuming.

So that all I can do is vouch for the commitment of resources it took from the National Institute of Environmental Health Sciences to do its little share, provide its little share of the total.

Senator HART. Doctor, I am going to ask Mr. Bickwit to continue with these questions. We have reviewed them prior to the hearing, and I will remain, using the time to read a memorandum that explains what this vote that was just signaled is all about. I hope by the time he finishes, and I finish this, we will have the answers.

Dr. KOTIN. I hope I don't disturb you.

Mr. BICKWIT. I'm frankly not clear on the major dates that are involved here, the dates that you received the Bionetics information, the date that you came out with your first report on it, and the date that you came out with your final report on it.

Now, if I'm right in thinking that those are relevant dates, could you tell me what those dates are?

Dr. KOTIN. Right. Well, the dates are relevant. I think it was, again, the date I offered for the record, which I don't remember offhand, is the date the Cancer Institute received the Bionetics report.

You will recall Dr. Falk and our associates instigated the Bionetics study, and it wasn't a personal contract with us. It was with the Cancer Institute.

So the report went to the Cancer Institute and I don't know when they received that.

Fundamentally, the only reason I suspect that we would have gotten involved at all in terms of the Bionetics report, as distinct from our own commitment by virtue of our mission in this, was the fact that Dr. Endicott did have a need for a tremendous amount of statistical and chemical analytical competency, and it was more than he had available in the Cancer Institute.

So I can give the date at which the material was forwarded to us. This was in 1968, and again, I will get the date for the record. But it was—actually, the material was forwarded to us coincidental with the request to get involved with some of the analyses.

Mr. BICKWIT. About when in 1968?

Dr. KOTIN. I will be happy to give you the exact date for the record, sir.

(The information was subsequently received for the record:)

NIEHS performed analyses of the raw data between January and June 1969.

Mr. BICKWIT. Then you released reports periodically?

Dr. KOTIN. To the Mark Commission only, and to the relevant Government agencies.

Mr. BICKWIT. About how many reports were there?

Dr. KOTIN. These were not formal reports, but they were presented quite informally—we finished the analysis of the White Swiss Mouse data, the C-57 black data, the DBA data.

We checked the statistical significance of the differences between test and controls, between the various dose levels, between the various modes of admission. So that, rather than adorn the data with

prose, we just gave them the statistical material with the listings of the conclusions.

Mr. BICKWIT. So, whenever you had anything of any importance, it went to Mrak.

Dr. KOTIX. Promptly.

Mr. BICKWIT. Your final report came out in the fall of 1969, is that right?

Dr. KOTIX. Yes, we have submitted a paper for publication in the journal *Science* which relates our analysis on the teratogenicity of 2,4,5-T, and it should be appearing shortly.

Again I would be happy to make a preprint copy of the manuscript available for the Committee if you desire.¹

Mr. BICKWIT. Thank you. That would be fine.

Now, if you got your information sometime in 1968, and we don't know when, let's assume it was late 1968, and it took until the fall of 1969 to come up with a final report, why did it take that length of time?

Dr. KOTIX. Just the difference between the magnitude of the job and the availability of professional resources within our institute. At that time, our Biometry branch consisted of two professional biometricians at the doctorate level. This staff was involved in a series of studies including one on the relationship of asbestos to lung cancer, and another on a quantification of the hazard to uranium miners. This limited staff had to be literally redeployed in order to perform the necessary analyses of the Bionetics data.

Mr. BICKWIT. On the carcinogenicity studies, when did you get the information from Bionetics?

Dr. KOTIX. We really didn't, other than as information. It came as part of the same report. But the analysis of the carcinogenicity study remained entirely within the Cancer Institute, since it was clearly relevant to their mission and responsibility as the National Cancer Institute.

Mr. BICKWIT. You were not responsible for analyzing that?

Dr. KOTIX. No, sir.

Mr. BICKWIT. You have stated the results of the teratogenicity studies were released to the Mrak Commission immediately when they became available. I am sure you are familiar with Mr. White-side's allegation that Dr. Samuel Epstein of the Mrak Commission had a great deal of difficulty acquiring information on the studies.

I wonder if you could reply to this allegation? If you are not familiar with it—

Dr. KOTIX. I am familiar with the allegation. I read it in the story in the *New Yorker*, of course.

No, I think that we are probably speaking of two different things. There was, at no time, the necessity for the requesting of any information from us. There was a mechanism for the forwarding of the information to the Mrak Commission; the best evidence that this allegation is not so in another sense is that the head of our Biometry Branch, Dr. David Gaylor, was on the Mrak Teratogenicity Committee, the very committee to which the data were being supplied.

¹ See p. 98.

So, essentially it would be denying his own data to his own committee if this were so.

Do you follow me.

Mr. BICKWIT. I am sorry, I don't.

Senator HART. I am going to have to interrupt again, I am sorry. I hoped we could avoid the necessity of holding you, but I will miss the vote.

I will not be able to return as promptly as I like, because I must remain on the floor to get something done, a matter that will be voted on tomorrow.

So, we will have to recess in the very unhappy condition of not knowing exactly when I will get back, but as quickly as I can.

(Recess.)

Senator HART. We will resume, and with better luck than we have been having in the last hour or so, maybe we can conclude before the next vote is signaled.

Mr. BICKWIT. I believe the last statement which you made I had some difficulty with.

Dr. KOTIN. What I was saying was that Dr. Epstein and Dr. Gaylor were on the same teratogenicity panel of the Mrak Commission, and each meeting they held Dr. Gaylor brought the data up.

So the only information Dr. Epstein might have asked for that he did not get were data that just were not complete. But certainly in relation to the teratogenicity, I cannot conceive of any available data that would not have been made available.

Mr. BICKWIT. Was the final Bionetics report made available to the Mrak Commission when they asked for it?

Dr. KOTIN. It is my impression that it was. And again they would not have come to us, because the final report was the property of the National Cancer Institute, as the contracting institution.

Mr. BICKWIT. If they did come to you, would you have had authority to give it to them?

Dr. KOTIN. Actually, I suspect I would have picked up the phone and asked Dr. Endicott who was responsible, and I would have gotten authority for it because the information contained in it was germane to the Mrak Commission. But again I would emphasize that the final report of any contractor would not include the interpretation and the analysis of the data. This was not part of the purchase.

Mr. BICKWIT. I realize that, but if Dr. Epstein of the Mrak Commission had asked you for the final Bionetics report, without an analysis from NIEHS, you would have furnished it to him immediately?

Dr. KOTIN. I would have furnished it to the Mrak Commission.

Mr. BICKWIT. Would you not have furnished it to Dr. Epstein?

Dr. KOTIN. The data itself?

Mr. BICKWIT. Yes.

Dr. KOTIN. Uninterpreted?

Mr. BICKWIT. Yes.

Dr. KOTIN. Oh, I probably would not have, no.

Mr. BICKWIT. Why not?

Dr. KOTIX. Essentially the data are crude data that require interpretation, and essentially the implications, the results of the report, are the conclusions, and the responsibility for those conclusions would have been ours,—that is, the responsibility of the NIH.

Mr. BICKWIR. These data, I understand, did raise doubts, about the teratogenicity of 2,4,5-f.

Dr. KOTIX. You mean, rather than raise doubts, established the experimental teratogenicity of this. After the data were analyzed, yes.

Mr. BICKWIR. You are saying that you do not believe that a member of the teratology panel of the Mraz Commission should have the right to examine those data analyzed?

Dr. KOTIX. Oh, not at all. All I am trying to say is the data themselves, short of total package, once the data were analyzed, and conclusions made, then by no stretch of the imagination would the data be withheld from anybody.

Mr. BICKWIR. But unanalyzed, he should not be entitled to look at them?

Dr. KOTIX. I do not think so, no, sir.

Mr. BICKWIR. Should anybody other than the organization entrusted with the analysis of the data be entitled to look at them?

Dr. KOTIX. Oh, surely, Mr. Hart's Committee, or there are a whole spectrum of responsible agencies.

Mr. BICKWIR. Could you list those agencies that would be entitled to look at this data?

Senator HART. You are inquiring about before analysis?

Mr. BICKWIR. Yes.

Dr. KOTIX. The hierarchy above me, as a lowly director of an institute, the director of NIH, The Surgeon General, the Secretary of HEW, all of the way up, any member of the legislature, any member of the executive branch, with the authority, surely.

Mr. BICKWIR. But you would not want to allow a nongovernmental scientist with some expertise in the field to look at this data?

Dr. KOTIX. Again, there is no flat yes and no. There are many instances when we call people in nongovernmentally to look.

Mr. BICKWIR. What I am asking you to do is draw the line. I know it is hard, but you have excluded one nongovernmental scientist. I would like to know how you formulate your opinion in deciding who should be excluded and who should be included.

Dr. KOTIX. That is a matter of judgment. How much help I think we can get from them, how much help we can provide them.

Mr. BICKWIR. Is that the only basis for your decision?

Dr. KOTIX. I would have to think. I suspect that is the major one. We have crude data and what we try to do is get the best expertise. We have everything from advisory committees to councils to study sections to consultants to the institutes, who are not Government employees, who are on call at all times and who are used rather consistently, particularly by a young institute like our own. (we are 3 years old; our \$17 million budget, when contrasted with the \$150-plus million budget of the larger well established institutes is probably as good an indication of our size as anything.)

I think a corollary of our small size is the great consistency with which we get outside help in terms of consultation. We just had a

task force that spent 3 weeks preparing a consultative guide, as it were, for the Institute. So there is no tendency on our part at all to treat anything that we get as either clandestine or in any way not open to scrutiny. In fact, as I said in my testimony, I made a special point that scientific scrutiny is something that we insist on in all of our data before we accept it as fact.

As our critical mass at NIEHS enlarges, we will probably be more certain. But we are a small outfit and we use outside consultants a lot. So in answer to your question specifically do I feel categorically that data should not be seen by outside scientists, not at all. There are instances where you call them in and they see it initially with us, as it were, around the table for the first time.

Mr. BICKWIT. On the pro side you are weighing the potential helpfulness of the scientist who would be asking to see the data.

Dr. KOTIX. Oh, no. Also what he can contribute to the maximum utilization of the data. In the years I have been in NIH when there are implications of the data that affect other executive branches, or have socioeconomic implications, the people who you try to get help from and provide help to are judged on an individual basis. This is really so.

Mr. BICKWIT. What is on the other side? In formulating your opinion what is it that would keep you from giving the information out?

Dr. KOTIX. Number one, concern over data where the interpretation would be such that we would want our interpretation to be on the record at the time the data were made available. That would be one example.

Another example, where there is some question we have about the data ourselves, so we want to go back and verify techniques, verify the workbooks from which the reports were made. And in fact this was done in this case. So there are lots of reasons. Not as many as on the other side, but you just have to do it on an individual basis, decide what is the best way to get maximum returns from the data.

Mr. BICKWIT. With respect to Dr. Epstein, a member of the teratology panel of the Mraz Commission, would you rule out the possibility of his being able to contribute to the utilization of this material?

Dr. KOTIX. Yes.

Mr. BICKWIT. Could you elaborate on that?

Dr. KOTIX. Fundamentally it is a matter of judgment. I felt at that time that the data themselves needed analysis for the reasons I mentioned, that the conclusions were integral to the data because again the mere fact that you had chi square indicated there that the significance was in large measure determined by statistical methods.

It wasn't a situation where, as the data amply attest, an all or none response occurred, where all of the controls did one thing, all of the test animals did the other. There were statistical differences. There were differences in degree and intensity and in time. These had to be determined by statistical techniques.

Senator HARR. Doctor, I will be brief in my thanks, since I am under the compulsion of another vote signal.

(The information referred to on p. 94 follows.)

TERATOGENIC EVALUATION OF 2,4,5-T

ABSTRACT

The herbicide 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) has been shown to be teratogenic and fetocidal in two strains of mice using either subcutaneous or oral routes of administration, and in one strain of rats by oral administration. The incidences of both cystic kidney and cleft palate were increased in the C57BL/6 mice as well as the incidence of cleft palate in the AKR mice. The incidence of cystic kidney was also increased in the rats. In addition, an increase in liver to body weight ratio in the mouse fetus and the occurrence of hemorrhagic gastrointestinal tract in the rat fetus suggest that this compound also has fetotoxic properties.

The chlorinated herbicide 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) is used extensively for weed control (1). However, there have been relatively few reports concerning its pharmacologic and toxicologic properties in animals (2,3). Indeed, there are no data available concerning the effects of this compound on the developing embryo and fetus. Therefore, this report evaluates the teratogenic and fetotoxic potential of 2,4,5-T in mice and rats (4).

Breeding colonies of C57BL/6 and AKR strains of mice were established at Bionetics Research Laboratories, Inc., to supply the mice. For the study, breeding was by random mating. Detection of a vaginal plug indicated day zero of pregnancy. Rats were procured from the Holtzman Co., with known insemination dates. Detection of sperm indicated day zero of pregnancy. All animals received chow and water *ad libitum*.

2,4,5-T (5) was administered by one of two routes, subcutaneously or orally. A solution of 2,4,5-T in 100% dimethylsulfoxide (DMSO) in a volume of 100 μ l/mouse was used for each subcutaneous administration. For oral administration by gastric intubation, 2,4,5-T was suspended in a honey solution (honey: water, 1:1) and volumes of 100 μ l/mouse and 200 μ l/rat were used.

In the studies with the C57BL/6 strain, 2,4,5-T was administered daily beginning on the sixth day of pregnancy and continuing through the 14th day or from the 9th through the 17th day. The mice were sacrificed on the 18th day of gestation for examination. In the studies with the AKR strain, 2,4,5-T was administered daily beginning on the 6th day of pregnancy and continuing through the 15th. These mice were sacrificed on the 19th day of gestation. The rats were treated on the 10th through the 15th and sacrificed on the 20th day of gestation.

Upon sacrifice both mothers and fetuses were examined carefully. In addition, about one-third of the mouse fetuses were stained with alizarin red S in order to detect skeletal anomalies.

Tables 1 through 3 contain data on fetal mortality, abnormal litters, abnormal fetuses per litter, fetuses with cleft palate, fetuses with cystic kidney, maternal weight gain, and maternal and fetal liver to body weight ratios. The following conventions were observed in compiling these data. If a fetus was either dead or resorbed, it was regarded as a dead fetus. A fetus was classified abnormal if it was alive and had at least one anomaly (regardless of type). Similarly, a litter was classified as abnormal if it contained one or more abnormal fetuses. A fetus was said to have a cystic kidney if at least one of its kidneys was affected. In calculating the maternal liver/body weight ratio, maternal body weight was defined as the difference between the weight of the animal on the day it was sacrificed and the gravid uterus weight. Finally, the maternal weight gain was defined as the difference in the corrected maternal body weight on the day it was sacrificed and its weight on day zero of pregnancy.

The percentages for fetal mortality, abnormal fetuses, fetuses with cleft palate and fetuses with cystic kidney were computed by first obtaining the percent for each litter and then calculating the average of these percentages.

The percentage of abnormal litters provides a measure of the prevalence of abnormal fetuses across litters, while the percentage of abnormal fetuses per litter gives an indication of the prevalence of abnormal fetuses within litters.

In this report, the control animals are those that were on a large study during the 3-year time period in which 2,4,5-T was evaluated. The data from the DMSO and honey treated control groups were compared with the data for the non-treated control group. Then the results from animals treated with 2,4,5-T in either DMSO or honey were compared to the appropriate control

data. Standard corrected 2x2 chi-square tests (6) were used to compare the results of 2,4,5-T treated animals with the appropriate control data for the proportion of litters containing abnormal fetuses.

The distribution of the percent of abnormal fetuses per litter for 2,4,5-T treated litters was compared with the appropriate control distribution by use of the non-parametric Mann-Whitney U-test (6). Also, this test was used for comparing the percent fetal mortality, cleft palate, cystic kidney, and enlarged renal pelvis per litter. This test requires that the proportion of dead or abnormal fetuses per litter is independent from litter to litter, but requires no assumption about the frequency distributions of these proportions.

Initial analyses of the data indicated that occurrences of anomalies among fetuses within litters were correlated. That is, anomalies were not randomly distributed across all litters but tended to cluster within litters. Many litters possessed no anomalies whereas all of the fetuses in some litters were abnormal. Since fetuses within the same litter tend to be more alike, pooling the data across litters before performing statistical tests is not appropriate. The experimental unit (7) is that entity to which treatments are applied, in this case the pregnant animal. Hence, all calculations of averages and all statistical tests were performed on the independent responses of the experimental units (litters).

The administration of DMSO or honey to mice or rats did not adversely affect the development of the fetuses. The incidence and type of naturally occurring anomalies observed in the DMSO and honey treated animals did not show an increase compared to the non-treated group. The alizarin stained fetuses of the control mice showed very few skeletal anomalies. No skeletal anomalies were detected by staining in the treated mice. For both mice and rats, there were no differences in the average number of implantations in the control and experimental litters. A few values for treated animals were less than those of their appropriate controls. None of these differences were statistically significant including the 3% fetal mortality observed in the C57BL/6 mice receiving a 21.5 mg/kg dose of 2,4,5-T reported in Table 1. This value of 3% reflects a period of low fetal mortality (9%) observed in the control mice during the initial few months of the study. This difference in mortality is not statistically significant. There were no other significant changes in these control data during the 3-year period.

As shown in Table 1, the administration of 2,4,5-T to C57BL/6 mice on days 6-14 at a dosage level of 113 mg/kg produced significant increases in percent of abnormal litters and percent of abnormal fetuses per litter. The anomalies produced by 2,4,5-T were almost exclusively cystic kidney and cleft palate. Similar results were obtained regardless of whether the compound was administered subcutaneously or orally. A dosage level of 46.4 mg/kg administered orally did not produce a significant increase in fetal mortality or an effect on palatal development, but did cause a significant increase in the percentages of fetuses with cystic kidney. Administration of 2,4,5-T subcutaneously at a dosage level of 21.5 mg/kg did not affect the visibility or development of the fetuses. Thus, a dose-response relationship for the fetocidal and teratogenic properties of 2,4,5-T in mice is suggested for both routes of administration.

It was also observed that in mice treated with 2,4,5-T on days 6 through 14, there was a significant decrease in the incidence of naturally occurring anomalies. These consist of microphthalmia followed by anophthalmia and are in accord with other C57BL/6 colonies (8). Although the fetuses from mice treated on the 6-14th days had fewer naturally occurring anomalies, the fetuses from mice treated on the 9th to 17th days did exhibit these anomalies. Thus, it appears that the interval of days 6 to 9 of gestation is one of the sensitive periods of development with respect to 2,4,5-T. Two other sensitive periods are during development of the palate and kidney since they are so highly affected. The occurrence of these two anomalies are statistically unrelated.

In the study where 2,4,5-T was administered on the 9th to the 17th day of gestation with the C57BL/6 mice, maternal and fetal liver weights were determined. As seen in Table 2, this treatment produced a significant increase in maternal and fetal liver to body weight ratios. The significant increase in fetal liver to body weight ratio reflects both an increase in fetal liver weight and a decrease in fetal body weight. The significant increase in the liver to body weight ratio suggests a change in activity of drug metabolizing enzymes of the

endoplasmic reticulum which has been studied (9). Again, the Mann-Whitney U-test was used to compare the animals administered 2,4,5-T with the appropriate DMSO control mice.

Thus, in the C57BL/6 mice, 2,4,5-T is fetocidal, teratogenic and capable of producing an increase in the liver to body weight ratios.

Treatment of mice of the AKR strain with 2,4,5-T in honey produced a significant increase in fetal mortality. The incidence of cleft palate was increased with both routes of administration. However, 2,4,5-T did not produce an increased incidence of cystic kidney in this strain. There was no effect of 2,4,5-T administration in this strain on the maternal weight gain with either route of administration. However, the maternal liver to body weight ratio was increased using either route of administration.

In addition, hybrid litters resulting from mating C57BL/6 females with AKR males were evaluated. The administration of 113 mg/kg in DMSO from days 6 through 14 of gestation produced a high incidence of both cystic kidney and cleft palate. There was no effect on maternal weight gain.

The oral administration to rats of 2,4,5-T at a dosage level of 10.0 or 46.4 mg/kg on the 10th through the 15th day of gestation produced a significant increase in fetal mortality (Table 3). The two lower dosage levels, 4.6 and 10.0 mg/kg produced a significant increase in the percentage of abnormal fetuses. These fetuses displayed a high incidence of cystic kidney. At the highest dose level, 46.4 mg/kg, the marked increase in fetal mortality reduced the population of live fetuses to a small sample. However, cystic kidneys were observed. In a limited study, the administration of 2,4,5-T at dosage levels of 21.5 or 46.4 mg/kg from the 6th through the 15th day of gestation was highly fetocidal.

At all dosage levels studied in the rat, hemorrhagic gastrointestinal tracts were observed in the fetuses. The percentages of fetuses per litter with hemorrhagic gastrointestinal tracts showed a dose-response relationship: i.e., 3%, 56%, and 83% at doses of 4.6, 10.0 and 46.4 mg/kg, respectively. None were observed in the fetuses from the control animals. Drill and Hiratzka (2) have reported that dogs which received 2,4,5-T in the diet showed some necrosis and inflammation of the intestinal mucosa. The hemorrhagic gastrointestinal tracts observed in the rat fetuses is probably a toxic effect of 2,4,5-T on the fetal organ as opposed to a developmental defect.

In conclusion, these studies show that 2,4,5-T adversely affects the development and viability of the mouse and rat fetus.

TABLE 1.—TERATOGENIC EVALUATION OF 2,4,5-T IN MICE

Compound	Vehicle	Dose (mg/kg)	Number of litters	Average number live fetuses/litter	Percent fetal mortality/litter	Percent abnormal fetuses/litters	Percent abnormal fetuses/litter	Percent of fetuses per litter with—	
								Cleft palate	Cystic kidney
C57BL/6 STRAIN TREATED DAYS 6-14									
Nontreated	None	None	72	5.8	26	38	11	<1	1
Control	DMSO	None	106	5.5	29	42	12	<1	2
Control	Honey	None	32	7.1	15	41	14	0	1
2,4,5-T	DMSO	21.5	6	7.7	3	50	12	0	0
2,4,5-T	DMSO	113.0	18	4.4	42	86	57	22	41
2,4,5-T	Honey	46.4	6	8.5	8	100	37	2	33
2,4,5-T	do.	113.0	12	4.8	47	100	70	23	48
C57BL/6 STRAIN TREATED DAYS 9-17									
Nontreated	None	None	8	5.1	36	71	31	0	7
Control	DMSO	None	10	6.1	23	30	8	0	0
2,4,5-T	DMSO	113.0	10	7.7	11	100	77	29	60
AKR STRAIN TREATED DAYS 6-15									
Nontreated	None	None	58	7.1	16	19	5	<1	<1
Control	DMSO	None	72	6.8	15	24	4	<1	<1
Control	Honey	None	12	8.8	9	0	0	0	0
2,4,5-T	DMSO	113.0	14	6.9	23	71	29	28	1
2,4,5-T	Honey	113.0	7	5.3	42	100	55	55	0

* Statistical Significance Level = 0.10; † Statistical Significance Level = 0.05; ‡ Statistical Significance Level = 0.01.

TABLE 2.—LIVER WEIGHT STUDY: 2,4,5-T ADMINISTERED DAILY AT 113 MG/KG SUBCUTANEOUSLY IN DMSO FROM THE 9TH THROUGH THE 17TH DAY OF GESTATION IN C57BL/6 MICE

Treatment	Fetal		Maternal		
	Liver wt. (gms)	Body wt. (gms)	Liver wt./ Body wt.	Wt. gain (gms)	Liver wt./ Body wt.
Nontreated.....	.047	.810	.058	6.00	.069
DMSO.....	.046	.818	.056	5.99	.068
2,4,5-T.....	.057	1.738	.076	4.65	.120

¹ Statistical significance level = 0.10. ² Statistical significance level = 0.05. ³ Statistical significance level = 0.01.

TABLE 3.—TERATOGENIC EVALUATION OF 2,4,5-T IN RATS

Compound	Vehicle	Dose (mg/kg)	Number of litters	Average number live fetuses/litter	Percent fetal mortality/litter	Percent abnormal litters	Percent abnormal fetuses/litter	Percent of fetuses per litter with—	
								Enlarged renal pelvis	Cystic kidney
Nontreated.....	None.....	None	7	9.9	11	43	9	9	0
Control.....	None.....	None	14	8.7	1	57	12	12	<1
2,4,5-T.....	do.....	4.6	8	8.2	12	88	236	18	21
2,4,5-T.....	do.....	10.0	7	7.1	28	86	246	17	30
2,4,5-T.....	do.....	46.4	6	2.7	59	67	60	27	33

¹ Statistical Significance Level = 0.10. ² Statistical Significance Level = 0.05. ³ Statistical Significance Level = 0.01.

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- (2) Drill, V. A. and Hirtzka, T., *Arch. Industrial Hygiene Occupational Med.* 7, 61, 1953.
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- (4) These results are from a large study designed to screen selected compounds for teratogenic effects in mice which was performed at the Bionetics Research Laboratories, Division of Litton Industries, under contract numbers PH 43-64-57 and PH 43-67-735 from the National Institutes of Health. During the performance of this study, Dr. Courtney was a staff member of the Bionetics Research Labs., Inc., and Dr. Falk was a member of the National Cancer Institute.
- (5) 2,4,5-T was produced by the Diamond Alkali Co., 98%, Tech., m.p. 149-151°.
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- (7) Kempthorne, O., *The Design and Analysis of Experiments*, Wiley, N.Y., 1952.
- (8) Kalter, H., *Teratology* 1, 193, 1968.
- (9) Courtney, K. D. (In preparation).

Note added in proof:

The sample of 2,4,5-T used in this study contained approximately 30 ppm of 2,3,7,8-tetrachlorodibenzo-p-dioxin (dioxin) (10). Dioxin as well as purified 2,4,5-T are currently being evaluated for their teratogenic and fetotoxic potential.

- (10) We thank Dow Chemical Co., for the analysis of 2,4,5-T.

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Senator HARR. Are there any additional questions?

Mr. BICKWIT. No, Mr. Chairman.

Senator HARR. If any arise we will submit them in writing and receive the replies in the record.

I appreciate the cooperation of everyone through the day, and apologize for the erratic scheduling this afternoon.

(The following was subsequently received for the record:)

Appendix 1

U.S. SHOWS SIGNS OF CONCERN OVER EFFECT IN VIETNAM OF 9-YEAR DEFOLIATION PROGRAM

(By Ralph Blumenthal, special to the New York Times)

SAIGON, South Vietnam, March 14—Many South Vietnamese who live adjacent to areas that are being defoliated by spray from United States planes are convinced that any ailments or misfortunes that they suffer are related to the sprayings.

There is no proof that they are right about the effect of the chemical sprays on the human body, but neither is there any assurance that they are wrong.

Although the defoliation program, organized and run by the United States, has been in operation for nearly nine years the full effect of the chemicals on animal and human life remains largely undetermined.

The United States military command says the program, which is designed to strip plant cover from areas occupied by the enemy and to destroy crops that might yield him food, has covered about 5,000 of South Vietnam's 66,350 square miles.

U.S. TERMS IT VALUABLE

The United States command says the program has proved its military worth. "It has contributed materially to the security of units operating in the field by increasing their visibility from the ground as well as the air," the command said.

About 13 per cent of the program has been directed against crops, presumably food grown by and for the enemy. Because of the drifting of defoliants and the difficulty of assessing the results on the ground, it is virtually impossible to say how much of the crop has been destroyed by the chemicals, but it would not appear to be a significant part of the country's capacity. It has brought hardships, however, to individual farmers.

After years of assuring the South Vietnamese that this extensive spraying was harmless to animals and humans, United States officials are showing signs of concern over recent reports the the chemical sprays may have some little-understood and alarming effects.

PANEL STUDYING EFFECTS

In the last several months, reportedly on instruction from Washington, the United States military command and the United States Embassy have formed a special committee to review the effects of the defoliation program, especially on humans.

The sensitivity of the issue has foreclosed official comment, but according to informed sources the science advisory office of the command is responsible for gathering data in interviews and tests that embassy officials will then evaluate.

The South Vietnamese Government regards the entire subject as taboo. Vietnamese newspapers have been suspended for publishing articles about birth defects allegedly attributed to the defoliants, and the public Health Ministry declines to provide any statistics on normal and abnormal births.

However, the concern felt among the Americans is shared by many South Vietnamese scientists, physicians, health officials and villagers interviewed in a three-week survey of the effects of the program.

Officers of the United States command are aware of the allegations of birth defects but they generally discount the reports.

Responsible South Vietnamese scientists and officials say they know virtually nothing about the effects of the chemical sprays.

Saligon's leading maternity hospital, Tudu, from which rumors of an increase of abnormal births emanate periodically, has not even compiled annual reports of statistics for the last three years. Recent monthly figures show an average of about 140 miscarriages and 150 premature births among approximately 2,800 pregnancies, but the hospital is not prepared to say whether this represents an increase and, if so, what the cause might be.

A high Agriculture Ministry official said: "I don't think the Americans would use the chemicals if they were harmful."

He conceded that his ministry had made no tests and asserted that his experts had been unable to get any information about the defoliants from the Defense Ministry, which considers such data secret. The main defoliant compounds and some information about them are available in the United States.

Last Oct. 29, President Nixon's science adviser, Dr. Lee A. Du Bridge, announced that as a result of a study showing that one of the defoliants used, 2,4,5-T, had caused an unexpectedly high incidence of fetal deformities in mice and rats, the compound would henceforth be restricted to areas remote from population.

That directive appears to be ambiguous in South Vietnam for military spokesmen assert that 2,4,5-T continues to be used only in "enemy staging areas"—by definition populated regions.

DEFOLIANTS WERE CONCEALED

Don That Trinh, Minister of Agriculture from November, 1967 to May, 1968, and for 10 years professor of agronomy at Saigon University, said that while he was minister, the Defense Ministry "would try to conceal the defoliant products from me."

"I did not believe in defoliation," he added.

According to one of the Vietnamese directors of a Government research laboratory in Saigon: "We didn't know anything before the United States started spraying. It was only when we received complaints from the livestock people that we started getting interested." But, he added, there are still no Vietnamese studies.

Even the village of Tanhiep, 20 miles north of Saigon, on which 1,000 gallons of defoliants were jettisoned on Dec. 1, 1968, has not been the object of attention or study.

An American C-123 flying out of Bienhoa air base, Northeast of Saigon, developed engine trouble shortly after takeoff. To lighten the craft, the pilot sprayed the full load of chemicals over Tanhiep and nearby Binhtri in 30 seconds instead of the usual 4 minutes 30 seconds, which spreads the defoliant at the rate of three gallons an acre in unpopulated areas.

The defoliant involved, according to the United States command, was a 50-50 mixture of 2,4-Dichlorophenoxyacetate, or 2,4-D, and 2,4,5-Trichlorophenoxyacetate, or 2,4,5-T, in an oil base. It is one of three compounds the military says it uses here, the others being a Dow chemical product called Tordon 101, a mixture of amine salts of 2,4-D and Picloram, and an arsenic compound of cacodylic acid.

No physicians visited Tanhiep to examine the people after their exposure, which, like eight similar emergency dumpings since 1968—some over unpopulated forests—was not made public by the United States command.

A United States Air Force medical team visited Binhtri shortly after the spraying and, according to American district officials, found the villagers had suffered no ill effects. There was no later inquiry.

Mrs. Tran Thi Tien of Tanhiep, who says she has four normal children, is convinced that the malfunction of her son, who still looks like a newborn at 14 months of age, "must be due to the chemicals I breathed."

Her neighbors, Mrs. Nguyen Thi Hai and Mrs. Tong Thi An, blame the spraying for the fact that their children, one year and 20 months old respectively, still crawl instead of walk.

Nguyen Van Nhap, a farmer, complains of suffering bouts of fever, sneezing and weakness.

"I was working in the field when the spray came down," Mrs. Tien said through an interpreter. "I felt dizzy, like vomiting and had to stay in bed three or four days."

Many other villagers reported feeling the same sensations as Mrs. Tien, but, except for the two children described as retarded in learning to walk, no other

Tran Van Dang, a farmer in neighboring Binhtri, recalled that three days after the spraying two villagers, Tam Ten and Mrs. Hai Mua, died after suffering respiratory difficulties and trembling. The next day, he said, a third villager, Mrs. Hai Nuc, died after showing similar symptoms. Mr. Ten was an old man and could have been expected to die soon anyway but the two others, Mr. Dang said, were middle-aged and seemed healthy.

Such complaints are not limited to Thanhiep and Binhtri, where villagers were admittedly exposed to concentrated doses of defoliant—though just how concentrated has not been established.

In Bienhoa city, 10 miles from Thanhiep, any defoliant in the air drifts down from the heavily sprayed battle areas to the north.

Dr. Nguyen Son Cao says he finds a clear correlation between the days when there is spraying and the number of patients who come in with respiratory ailments, mostly sneezing and coughing.

Dr. Cao, who has been practicing in Bienhoa for 21 years, said he had also noticed that in the last two to three years the number of miscarriages among his patients had doubled.

"These women are convinced they are the victims of the chemicals," he said. "I only suspect there could be a relationship. This suspicion is very well known. The increase in miscarriages is very obvious, very significant."

However, the manager of another clinic reported no increase in miscarriages over the last several years.

Any increase in miscarriages has many possible explanations; perhaps the deterioration of the daily diet, the cumulative effect of the hardships of war, population and economic movements that register statistics of only certain groups, or air pollution, of which the defoliant chemicals are a part.

Appendix 2

DEFOLIANTS, DEFORMITIES: WHAT RISK?

Dr. Jackie Verrett is fascinated and horrified by what has now become an everyday sight at her FDA toxicology lab in Washington, D.C.: several white leghorn chicks struggling to get to their feet and then finally walking—on their knees. Besides slipped tendons in their legs, some of the chicks have cleft palates and beak deformities. All this has been wrought by injecting fertilized eggs with an ethanol solution containing just 2.5 micromicrograms (or 50 parts per trillion) of 2,3,6,7-tetrachlorodibenzo-*p*-dioxin, a contaminant in 2,4,5-trichlorophenoxyacetic acid (2,4,5-T).

Over the past nine years, 40 million pounds of this defoliating herbicide have been sprayed in very heavy concentrations across at least five million acres of Vietnam to destroy crops and expose the enemy. By MWR's reckoning, some 30 million pounds have been spewed out in lesser concentrations during just the past five years across perhaps 30 million acres of range, forest, and farmland (not to mention home gardens) in the U.S.—an area three times the size of Texas.

Thus, Dr. Verrett's preliminary findings are not just of interest to poultrymen. The 11 crippled chicks in her study were among 15 survivors of a clutch of 25 eggs. In the unhatched chicks, Dr. Verrett found pronounced evidence of chick edema—swollen tissues, cysts on the back, necrotic livers, and the same deformities the live birds have. The FDA researcher is diluting the dioxin content to try to find a "no effects" level. In another brood, she has produced a similar pattern of birth defects with just 2½ parts per trillion of dioxin, 1/400,000 the 1 ppm found in currently marketed products. Now she's experimenting with .25 parts per trillion. (The work is so politically sensitive that she doesn't even know the origin of the 2,4,5-T involved and feels "like I'm in the CIA.")

When told that HEW Secretary Robert Finch is doubtful about the applicability of the chick embryo work to human risk, Dr. Verrett snapped, "I know, I know, but the only time Bob Finch sees eggs is when he eats them for breakfast."

While Dr. Verrett labored in the lab early this month, Dr. Samuel Epstein, chief of toxicology at Children's Hospital Medical Center in Boston, was out in Globe, a foothill town in southeastern Arizona, to evaluate reports of toxic and

teratogenic effects attending the spraying of 2,4,5-T and its chemical cousin, 2-(2,4,5-Trichlorophenoxy) propionic Acid (*Silvex*) in adjacent Tonto National Forest. These reports have disturbed the nation and drawn experts to the scene.

ODD EFFECTS AROUND GLOBE

In Globe, Dr. Epstein saw two goats and a duck with leg deformities similar to those in Dr. Verrett's chickens, and studied the histories of sick people. "It's impossible to say for certain whether the claimed symptoms and effects are attributable to the spray," he said. But at the same time he lashed out at the U.S. Forest Service for risking the contamination of water sources against its own policy, for contributing to drift by using water as a 2,4,5-T solvent, and for failing to post the area before spraying.

MWX found that the Department of Agriculture keeps such casual tabs of 2,4,5-T spraying that it would take officials a week just to find which of the 33 national forests besides Tonto have been bombed with the two million pounds Forest Service has jettied out over the past six years. "But Interior uses more than we do," said one official. Replies an Interior spokesman, "We used only 41,232 pounds last year."

In the Globe area, the Forest Service has sprayed 2,4,5-T and *Silvex* four of the past five years to promote growth of grass in a burned-over section and to eliminate chaparral. But most 2,4,5-T use is unmonitored. The defoliant is bought by ranchers and private foresters and it's pretty much up to them what happens to it.

Human teratogenicity is the chief worry; it is fairly well known by now that Dr. Verrett's work is not the first study to dramatize the risk. Yet MWX learned that the U.S. doesn't keep nationwide birth-defect figures.

Dr. Edward Burger of the government's Office of Science and Technology does not seem worried by this absence of monitoring and supervision, nor, indeed, about the risk of 2,4,5-T teratogenicity. Dr. Burger, technical assistant to Presidential science advisor Lee A. DuBridge, acknowledges that a study done by Bionetics Research Laboratories for the National Cancer Institute showed last March (it was suppressed for six months) that nearly all offspring of mice and rats given 2,4,5-T early in gestation at the relatively high levels of 21.5 mg/kg or 46.4 mg/kg were born dead or deformed—in some cases with no eyes, with cleft palates, and cystic kidneys and enlarged livers. Even at 4.6 mg/kg dosage, 39% of the animals were born malformed.

The OST expert is more familiar than most with the high-level decision-making that went into Dr. DuBridge's declaration October 29 that on the basis of the Bionetics study, the use of 2,4,5-T in populated areas would be restricted. Dr. DuBridge said Agriculture would, by Jan. 1, 1970, withdraw licenses for its use on crops (corn, blueberries, peaches, pears, and several leafy vegetables) unless the FDA found that the residue was negligible and humans were tolerant of it.

Dr. Burger explains that the FDA missed this deadline for a number of reasons. First, Dow Chemical Co., a major maker of 2,4,5-T, discovered last December that the sample used by Bionetics contained 27 ppm of the tetrachloro dioxin instead of the "less than 1 ppm" Dow says is in its product. So the study is now being re-run with a Dow sample at Dow labs in Zionsville, Ind., and Midland, Mich., and at the National Institute Environmental Health Sciences.

Next, says Dr. Burger, even after the teratogenic potential is re-evaluated in a rodent model, the disappearance rate of the contaminant in the animal blood stream must be determined and calibrated with that in human volunteers. He concludes: "The possibility of exposure to 2,4,5-T, vis-a-vis the small teratogenic risk, is certainly not sufficient at this time to justify wiping the chemical off the market."

Comments Associate FDA Commissioner for Science Dale Lindsay: "Dr. DuBridge had no damned business setting a tolerance deadline. Our market-basket surveys for 1968 and 1969—thousands of samples of 120 foods and vegetables are constantly being assessed—show only five recoveries of 2,4,5-T—three from leafy vegetables at negligible levels, plus one from milk, and one from meat at the .01-mg level.

"Yet if we had to set a tolerance today it would be zero. The trouble with this very active dioxin contaminant is that while it may be a known quantity in a product, you can't extract it in the same quantity."

Harvard microbiologist Matthew Meselson is worried for the same reason—and many others. Dr. Meselson—appointed last year by the American Association for the Advancement of Science to head a 2,4,5-T evaluation project—says: "The tetrachloro dioxin represents just one of 12 or 13 ways the chlorine atoms can arrange themselves on a benzene ring to form dioxin molecules. How do we know about the hexa, hepta, and octychlors, or about how persistent the tetrachlor itself is? Moreover, I'm very concerned about the dioxins that might be formed by unreacted trichlorophenol [2,4,5-T precursor] when the product is exposed to heat. If it were taken up by plants or wood and these were burned, you'd get more dioxin. Finally, I'm bothered by the bizarre mental effects suffered by German workers making 2,4,5-T. I say when in doubt, stop it."

Dr. Julius Johnson, vice president and director of research for Dow, regards these concerns as speculative. "If we thought 2,4,5-T was harming anybody we'd take it off the market tomorrow," he says. "We've been dedicated to cleaning it up ever since 1964 [when the contaminant was linked to an outbreak of chlor-acne in Dow workers at Midland]." Dr. Johnson says it would take a 200-degree jolt to produce reaction of dioxin, and the contaminant disappears within hours under ultraviolet light. So far, he adds, Dow tests show that its 2,4,5-T has no teratogenic effect on rats at a dosage of 24 mg/kg and on rabbits at 40 mg/kg. But how about Dr. Verrett's new findings in the chick embryo test? The Dow executive confesses surprise. "But I'm confident," he says, "that we'll be safe when we propose a new specification for all 2,4,5-T products of .1 ppm of dioxin."

Safety also assumes gauges of teratogenicity in the population, however. FDA's Dr. Lindsay spoke with certitude when he told MWN that "the National Institute of Neurological Diseases and Stroke has recorded birth defects for some 15 years and would be telling us if they were on the rise." He's wrong. Dr. Heinz Berendes, chief of NINDS' perinatal research branch, admits dolefully that "no nationwide data are available on frequency or incidence of malformation."

Adds Yale biologist Arthur Galston: "It's shocking, but absolutely no studies have been made in Vietnam either. There have been reports of birth defects in Saigon papers since last June but hospital records haven't been made available."

State Department officials say they know of no policy whereby such data would be classified or withheld. Significantly, however, Dr. Malcolm Phelps, chief of the Vietnam medical section of the Agency for International Development, says he is acting on a recent White House request to collect figures on teratological occurrences in Vietnam civilian hospitals.

As for all the toxic effects reported by Globe residents after the June 8-11 spraying—a helicopter released 935 gallons of *Silver*, 30 of 2,4,5-T, and 20 gallons of a combination called "Orange" over 1,900 acres of forest—an MWN reporter inquired into the histories of 18 patients with four of the five doctors who treated them, and checked on the two crippled goats, the crippled duck, a bleeding bull terrier, and two other dogs with pneumonia. Net result: two strongly suspected herbicide poisoning cases linked to the spraying, and one "definite." There's one-year-old Paul McCray, who lives on the edge of Tonto National Forest and whose father drove the family right up to the 'copter landing spot during spraying. The boy has had respiratory attacks and convulsions. Phoenix pediatrician W. Scott Chisholm finds Paul has lymphositis, with a white cell count twice normal.

The second suspected case, a smeltery worker named James Andrews who has complained of a number of symptoms associated with herbicide poisoning—nausea, muscle weakness, vertigo, numbness, and stabbing pain—is vouchsafed by Dr. Granville Knight of Santa Monica, Calif. In the third case, that of Mrs. Billee Shoecraft, Dr. Knight says he has found 2,4-D in tissue.

Dr. Bernard Collopy would not label the muscle spasms and stabbing pain suffered by potter Robert McKusick, owner of the defective goats and ducks, as herbicide-related. Dr. William Bishop would not credit the chest pains of Bob McCray, father of little Paul, or his wife's tingling fingers and toes, as 2,4,5-T or *Silver* poisoning. And veterinarian F. I. Skinner hadn't seen any of the animal cases.

Sums up Dr. Bishop: "There's a good possibility some of the human cases are related to spraying, but symptomatic connections aren't connections and

I'm no toxicologist. People here are emotional and each morning wake up with new nails pounded into their palms. What's needed is solid scientific investigation. All I hope is they don't leave us hanging in the air for the next 20 years."

Appendix 3

[From the New Yorker, Feb. 7, 1970]

A REPORTER AT LARGE: DEFOLIATION

By Thomas Whiteside

Late in 1961, the United States Military Advisory Group in Vietnam began, as a minor test operation, the defoliation, by aerial spraying, of trees along the sides of roads and canals east of Saigon. The purpose of the operation was to increase visibility and thus safeguard against ambushes of allied troops and make more vulnerable any Vietcong who might be concealed under cover of the dense foliage. The number of acres sprayed does not appear to have been publicly recorded, but the test was adjudged a success militarily. In January, 1962 following a formal announcement by South Vietnamese and American officials that a program of such spraying was to be put into effect, and that it was intended "to improve the country's economy by permitting freer communication as well as to facilitate the Vietnamese Army's task of keeping these avenues free of Vietcong harassments," military defoliation operations really got under way. According to an article that month in the New York Times, "a high South Vietnamese official" announced that a seventy-mile stretch of road between Saigon and the coast was sprayed "to remove foliage hiding Communist guerrillas." The South Vietnamese spokesman also announced that defoliant chemicals would be sprayed on Vietcong plantations of manioc and sweet potatoes in the Highlands. The program was gathering momentum. It was doing so in spite of certain private misgivings among American officials, particularly in the State Department, who feared, first, that the operations might open the United States to charges of engaging in chemical and biological warfare, and second, that they were not all that militarily effective. Roger Hilsman, now a professor of government at Columbia University, and then Director of Intelligence and Research for the State Department, reported, after a trip to Vietnam, that defoliation operations "had political disadvantages" and, furthermore, that they were of questionable military value, particularly in accomplishing their supposed purpose of reducing cover for ambushes. Hilsman later recalled in his book, "To Move a Nation," his visit to Vietnam, in March, 1962: "I had flown down a stretch of road that had been used for a test and found that the results were not very impressive. . . . Later, the senior Australian military representative in Saigon, Colonel Serong, also pointed out that defoliation actually aided the ambushers—if the vegetation was close to the road those who were ambushed could take cover quickly; when it was removed the guerrillas had a better field of fire." According to Hilsman, "The National Security Council spent tense sessions debating the matter."

Nonetheless, the Joint Chiefs of Staff and their Chairman, General Maxwell Taylor, agreed that chemical defoliation was a useful military weapon. In 1962, the American military "treated" 4,940 acres of the Vietnamese countryside with herbicides. In 1963, the area sprayed increased five-fold to a total of 24,700 acres. In 1964, the defoliated area was more than tripled. In 1965, the 1964 figure was doubled, increasing to 155,610 acres. In 1966, the sprayed area was again increased fivefold, to 741,247 acres, and in 1967 it was doubled once again over the previous year, to 1,486,446 acres. Thus, the areas defoliated in Vietnam had increased approximately three hundredfold in five years, but now adverse opinion among scientists and other people who were concerned about the effects of defoliation on the Vietnamese ecology at last began to have a braking effect on the program. In 1968, 1,267,110 acres were sprayed, and in 1969 perhaps a million acres. Since 1962, the defoliation operations have covered almost five million acres, an area equivalent to about twelve per cent of the entire territory of South Vietnam, and about the size of the state of Massachusetts. Between 1962 and 1967, the deliberate destruction of plots of rice, manioc, beans, and other foodstuffs through herbicidal spraying—the word "deliberate" is used here to exclude the many reported instances of accidental

spraying of Vietnamese plots—increased three hundredfold, from an estimated 741 acres to 221,312 acres, and by the end of 1969 the Vietnamese cropgrowing area that since 1962 had been sprayed with herbicides totalled at least half a million acres. By then, in many areas the original purpose of the defoliation had been all but forgotten. The military had discovered that a more effective way of keeping roadsides clear was to bulldoze them. But by the time of that discovery defoliation had settled in as a general policy and taken on a life of its own—mainly justified on the ground that it made enemy infiltration from the North much more difficult by removing vegetation that concealed jungle roads and trails.

During all the time since the program began in 1961, no American military or civilian official has ever publicly characterized it as an operation of either chemical or biological warfare, although there can be no doubt that it is an operation of chemical warfare in that it involves the aerial spraying of chemical substances with the aim of gaining a military advantage, and that it is an operation of biological warfare in that it is aimed at a deliberate disruption of the biological conditions prevailing in a given area. Such distinctions simply do not appear in official United States statements or documents; they were long ago shrouded under heavy verbal cover. Thus, a State Department report, made public in March, 1966, saying that about twenty thousand acres of crops in South Vietnam had been destroyed by defoliation to deny food to guerrillas, described the areas involved as "remote and thinly populated," and gave a firm assurance that the materials sprayed on the crops were of a mild and transient potency: "The herbicides used are nontoxic and not dangerous to man or animal life. The land is not affected for future use."

However comforting the statements issued by our government during seven years of herbicidal operations in Vietnam, the fact is that the major development of defoliant chemicals (whose existence had been known in the thirties) and other herbicidal agents came about in military programs for biological warfare. The direction of this work was set during the Second World War, when Professor E. J. Kraus, who then headed the Botany Department of the University of Chicago, brought certain scientific possibilities to the attention of a committee that had been set up by Henry L. Stimson, the Secretary of War, under the National Research Council, to provide the military with advice on various aspects of biological warfare. Kraus, referring to the existence of hormone-like substances that experimentation had shown would kill certain plants or disrupt their growth, suggested to the committee in 1941 that it might be interested in "the toxic properties of growth-regulating substances for the destruction of crops or the limitation of crop production." Military research on herbicides thereupon got under way, principally at Camp (later Fort) Detrick, Maryland, the Army center for biological-warfare research. According to George Merck, a chemist, who headed Stimson's biological-warfare advisory committee, "Only the rapid ending of the war prevented field trials in an active theatre of synthetic agents that would, without injury to human or animal life, affect the growing crops and make them useless."

After the war, many of the herbicidal materials that had been developed and tested for biological-warfare use were marketed for civilian purposes and used by farmers and homeowners for killing weeds and controlling brush. The most powerful of the herbicides were the two chemicals 2,4-dichlorophenoxyacetic acid, generally known as 2,4-D, and 2,4,5-trichlorophenoxyacetic acid, known as 2,4,5-T. The direct toxicity levels of these chemicals as they affected experimental animals, and, by scientific estimates, men, appeared then to be low (although these estimates have later been challenged), and the United States Department of Agriculture, the Food and Drug Administration, and the Fish and Wildlife Service all sanctioned the widespread sale and use of both. The chemicals were also reported to be shortlived in soil after their application. 2,4-D was the bigger seller of the two, partly because it was cheaper, and suburbanites commonly used mixtures containing 2,4-D on their lawns to control dandelions and other weeds. Commercially, 2,4-D and 2,4,5-T were used to clear railroad rights-of-way and power-line routes, and, in cattle country, to get rid of woody brush, 2,4,5-T being favored for the last, because it was considered to have a more effective herbicidal action on woody plants. Very often, however, the two chemicals were used in combination. Between 1945 and 1963, the production of herbicides jumped from nine hundred and seventeen thousand pounds to about a hundred and fifty million pounds in this country;

since 1963, their use had risen two hundred and seventy-one percent—more than double the rate of increase in the use of pesticides, though pesticides are still far more extensively used. By 1960, an area equivalent to more than three per cent of the entire United States was being sprayed each year with herbicides.

Considering the rapidly growing civilian use of these products, it is perhaps not surprising that the defoliation operations in Vietnam escaped any significant comment in the press, and that the American public remained unaware of the extent to which these uses had their origin in planning for chemical and biological warfare. Nevertheless, between 1941 and the present, testing and experimentation in the use of 2,4-D, 2,4,5-T, and other herbicides as military weapons were going forward very actively at Fort Detrick. While homeowners were using herbicidal mixtures to keep their lawns free of weeds, the military were screening some twelve hundred compounds for their usefulness in biological-warfare operations. The most promising of these compounds were test-sprayed on tropical vegetation in Puerto Rico and Thailand, and by the time full-scale defoliation operations got under way in Vietnam the U.S. military had settled on the use of four herbicidal spray materials there. These went under the names Agent Orange, Agent Purple, Agent White, and Agent Blue—designations derived from color-coded stripes girdling the shipping drums of each type of material. Of these materials, Agent Orange, the most widely used as a general defoliant, consists of a fifty-fifty mixture of *n* butyl esters and of 2,4-D and 2,4,5-T. Agent Purple, which is interchangeable with Agent Orange, consists of the same substances with slight molecular variations. Agent White, which is used mostly for forest defoliation, is a combination of 2,4-D and Picloram, produced by the Dow Chemical Company. Unlike 2,4-D or 2,4,5-T, which, after application, is said to be decomposable by micro-organisms in soil over a period of weeks or months (one field test of 2,4,5-T in this country showed that significant quantities persisted in soil for ninety-three days after application), Picloram—whose use the Department of Agriculture has not authorized in the cultivation of any American crop—is one of the most persistent herbicides known. Dr. Arthur W. Galston, professor of biology at Yale, has described Picloram as "a herbicidal analog of DDT," and an article in a Dow Chemical Company publication called "Down to Earth" reported that in field trials of Picloram in various California soils between eighty and ninety-six and a half per cent of the substance remained in the soils four hundred and sixty-seven days after application. (The rate at which Picloram decomposes in tropical soils may, however, be higher.) Agent Blue consists of a solution of cacodylic acid, a substance that contains fifty-four per cent arsenic, and it is used in Vietnam to destroy rice crops. According to the authoritative "Merck Index," a source book on chemicals, this material is "poisonous." It can be used on agricultural crops in this country only under certain restrictions imposed by the Department of Agriculture. It is being used herbicidally on Vietnamese rice fields at seven and a half times the concentration permitted for weed-killing purposes in this country, and so far in Vietnam something like five thousand tons is estimated to have been sprayed on paddies and vegetable fields.

Defoliation operations in Vietnam are carried out by a special flight of the 12th Air Commando Squadron of the United States Air Force, from a base at Bien Hoa, just outside Saigon, with specially equipped C-123 cargo planes. Each of these aircraft has been fitted out with tanks capable of holding a thousand gallons. On defoliation missions, the herbicide carried in these tanks is sprayed from an altitude of around a hundred and fifty feet, under pressure, from thirty-six nozzles on the wings and tail of the plane, and usually several spray planes work in formation, laying down broad blankets of spray. The normal crew of a military herbicidal-spray plane consists of a pilot, a copilot, and a technician, who sits in the tail area and operates a console regulating the spray. The equipment is calibrated to spray a thousand gallons of herbicidal mixture at a rate that works out, when all goes well, to about three gallons per acre. Spraying a thousand-gallon tankload takes five minutes. In an emergency, the tank can be emptied in thirty seconds—a fact that has particular significance because of what has recently been learned about the nature of at least one of the herbicidal substances.

The official code name for the program is Operation Hades, but a more friendly code name, Operation Ranch Hand, is commonly used. In similar fashion, military public-relations men refer to the herbicidal spraying of crops sup-

posedly grown for Vietcong use in Vietnam, when they refer to it at all as a "food-denial program." By contrast, an American biologist who is less than enthusiastic about the effort has called it, in its current phase, "escalation to a program of starvation of the population in the affected area." Dr. Jean Mayer, the Harvard professor who now is President Nixon's special adviser on nutrition, contended in an article in *Science and Citizen* in 1967 that the ultimate target of herbicidal operations against rice and other crops in Vietnam was "the weakest element of the civilian population"—that is, women, children, and the elderly—because in the sprayed area "Vietcong soldiers may . . . be expected to get the fighter's share of whatever food there is." He pointed out that malnutrition is endemic in many parts of Southeast Asia but that in wartime South Vietnam, where diseases associated with malnutrition, such as beri-beri, anemia, kwashiorkor (the disease that has decimated the Biafran population), and tuberculosis, are particularly widespread, "there can be no doubt that if the (crop-destruction) program is continued, (the) problems will grow."

Whether a particular mission involves defoliation or crop destruction, American military spokesmen insist that a mission never takes place without careful consideration of all the factors involved, including the welfare of friendly inhabitants and the safety of American personnel. (There can be little doubt that defoliation missions are extremely hazardous to the members of the planes' crews, for the planes are required to fly very low and only slightly above stalling speed, and they are often targets of automatic-weapons fire from the ground.) The process of setting up targets and approving specific herbicidal operations is theoretically subject to elaborate review through two parallel chains of command: one chain consisting of South Vietnamese district and province chiefs—who can themselves initiate such missions—and South Vietnamese Army commanders at various levels; the other a United States chain, consisting of a district adviser, a sector adviser, a divisional senior adviser, a corps senior adviser, the United States Military Assistance Command in South Vietnam, and the American Embassy in Saigon, ending up with the American ambassador himself. Positive justification of the military advantage likely to be gained from each operation is theoretically required, and applications with such positive justification are theoretically disapproved. However, according to one of a series of articles by Elizabeth Pond that appeared toward the end of 1967 in the *Christian Science Monitor*:

"In practice, [American] corps advisers find it very difficult to turn down defoliation requests from province level because they simply do not have sufficient specific knowledge to call a proposed operation into question. And with the momentum of six years' use of defoliants, the practice, in the words of one source, has long since been "set in cement."

"The real burden of proof has long since shifted from the positive one of justifying an operation by its [military] gains to the negative one of denying an operation because of [specific] drawbacks. There is thus a great deal of pressure, especially above province level, to approve recommendations sent up from below as a matter of course."

Miss Pond reported that American military sources in Saigon were "enthusiastic" about the defoliation program, and that American commanders and spotter-plane pilots were "clamoring for more of the same." She was given firm assurances as to the mild nature of the chemicals used in the spray operations:

"The defoliants used, according to the military spokesman contacted, are the same herbicides . . . as those used commercially over some four million acres in the United States. In the strengths used in Vietnam they are not at all harmful to humans or animals, the spokesman pointed out, and in illustration of this he dabbed onto his tongue a bit of liquid from one of . . . three bottles sitting on his desk."

As the apparently inexorable advance of defoliation operations in South Vietnam continued, a number of scientists in the United States began to protest the military use of herbicides, contending that Vietnam was being used, in effect, as a proving ground for chemical and biological warfare. Early in 1968, a group of twenty-nine scientists, under the leadership of Dr. John Edsall, a professor of biochemistry at Harvard, appealed to President Johnson to prohibit the use of defoliants and crop-destroying herbicides, and called the use of these substances in Vietnam "barbarous because they are indiscriminate." In the late summer of 1968, this protest was followed by a letter of petition to

President Johnson from twenty-two scientists, including seven Nobel laureates. The petition pointed out that the "large-scale use of anticrop and 'nonlethal' antipersonnel chemical weapons in Vietnam" constituted "dangerous precedent" in chemical and biological warfare, and it asked the President to order it stopped. Before the end of that year, Dr. Edsall and Dr. Matthew S. Meselson, a Harvard professor of biology, obtained the signatures of five thousand scientists to co-sponsor the petition. Despite these protests, the area covered by defoliation operations in Vietnam in 1967 was double that covered in 1966, and the acreage of crops destroyed was nearly doubled.

These figures relate only to areas that were sprayed intentionally. There is no known way of spraying an area with herbicides from the air in a really accurate manner, because the material used is so highly volatile, especially under tropical conditions, that even light wind drift can cause extensive damage to foliage and crops outside the deliberately sprayed area. Crops are so sensitive to the herbicidal spray that it can cause damage to fields and gardens as much as fifteen miles away from the target zone. Particularly severe accidental damage is reported, from time to time, to so-called "friendly" crops in the III Corps area, which all but surrounds Saigon and extends in a rough square from the coastline to the Cambodian border. Most of the spraying in III Corps is now done in War Zones C and D, which are classified as free fire zones, where, as one American official has put it, "everything that moves in Zones C and D is considered Charlie." A press dispatch from Saigon in 1967 quoted another American official as saying that every Vietnamese farmer in the III Corps area knew of the defoliation program and disapproved of it. Dr. Galston, the Yale biologist, who is one of the most persistent critics of American policy concerning herbicidal operations in Vietnam, recently said in an interview, "We know that most of the truck crops grown along roads, canals, and trails and formerly brought into Saigon have been essentially abandoned because of the deliberate or inadvertent falling of these defoliant sprays: many crops in the Saigon area are simply not being harvested." He also cited reports that in some instances in which the inhabitants of Vietnamese villages have been suspected of being Vietcong sympathizers the destruction of food crops has brought about complete abandonment of the villages. In 1966, herbicidal operations caused extensive inadvertent damage, through wind drift, to a very large rubber plantation northwest of Saigon owned by the Michelin rubber interests. As the result of claims made for this damage, the South Vietnamese authorities paid the corporate owners, through the American military, nearly a million dollars. The extent of the known inadvertent damage to crops in Vietnam can be inferred from the South Vietnamese budget—in reality, the American military budget—for settling such claims. In 1967, the budget for this compensation was three million six hundred thousand dollars. This sum, however, probably reflects only the barest emergency claims of the people affected.

According to Representative Richard D. McCarthy, a Democrat from upstate New York who has been a strong critic of the program, the policy of allowing applications for defoliation operations to flow, usually without question, from the level of the South Vietnamese provincial or district chiefs has meant that these local functionaries would order repeated sprayings of areas that they had not visited in months, or even years. The thought that a Vietnamese district chief can initiate such wholesale spraying, in effect without much likelihood of serious hindrance by American military advisers, is a disquieting one to a number of biologists. Something that disquiets many of them even more is what they believe the long-range effects of nine years of defoliation operations will be on the ecology of South Vietnam. Dr. Galston, testifying recently before a congressional subcommittee on chemical and biological warfare, made these observations:

"It has already been well documented that some kinds of plant associations subject to spray, especially by Agent Orange, containing 2,4-D and 2,4,5-T, have been irreversibly damaged. I refer specifically to the mangrove associations that line the estuaries, especially around the Saigon River. Up to a hundred thousand acres of these mangroves have been sprayed. . . . Some (mangrove areas) had been sprayed as early as 1961 and have shown no substantial signs of recovery. . . . Ecologists have known for a long time that the mangroves lining estuaries furnish one of the most important ecological niches for the completion of the life cycle of certain shellfish and migratory fish. If these plant communities are not in a healthy state, secondary effects on the whole

interlocked web of organisms are bound to occur. . . . In the years ahead the Vietnamese, who do not have overabundant sources of proteins anyhow, are probably going to suffer dietarily because of the deprivation of food in the form of fish and shellfish.

"Damage to the soil is another possible consequence of extensive defoliation. . . . We know that the soil is not a dead, inert mass but, rather, that it is a vibrant, living community. . . . If you knock the leaves off of trees once, twice, or three times . . . you change the quality of the soil. . . . Certain tropical soils—and it has been estimated that in Vietnam up to fifty per cent of all the soils fall into this category—are laterizable; that is, they may be irreversibly converted to rock as a result of the deprivation of organic matter. . . . If . . . you deprive trees of leaves and photosynthesis stops, organic matter in the soil declines and laterization, the making of brick, may occur on a very extensive scale. I would emphasize that this brick is irreversibly hardened; it can't be made back into soil. . . .

"Another ecological consequence is the invasion of an area by undesirable plants. One of the main plants that invade an area that has been defoliated is bamboo. Bamboo is one of the most difficult of all plants to destroy once it becomes established where you don't want it. It is not amenable to killing by herbicides. Frequently it has to be burned over, and this causes tremendous dislocations to agriculture."

Dr. Fred H. Tschirley, assistant chief of the Crops Protection Research Branch of the Department of Agriculture, who made a month's visit to Vietnam in the spring of 1968 in behalf of the State Department to report on the ecological effects of herbicidal operations there, does not agree with Dr. Galston's view that laterization of the soil is a serious probability. However, he reported to the State Department that in the Rung Sat area, southeast of Saigon, where about a hundred thousand acres of mangrove trees had been sprayed with defoliant, each single application of Agent Orange had killed ninety to a hundred per cent of the mangroves touched by the spray, and he estimated that the regeneration of the mangroves in this area would take another twenty years, at least. Dr. Tschirley agrees with Dr. Galston that a biological danger attending the defoliation of mangroves is an invasion of virtually ineradicable bamboo.

A fairly well-documented example not only of the ecological consequences of defoliation operations but also of their disruptive effects on human life was provided last year by a rubber-plantation area in Kompong Cham Province, Cambodia, which lies just across the border from Vietnam's Tay Ninh Province. On June 2, 1969, the Cambodian government, in an angry diplomatic note to the United States government, charged the United States with major defoliation damage to rubber plantations, and also to farm and garden crops in the province, through herbicidal operations deliberately conducted on Cambodian soil. It demanded compensation of eight and a half million dollars for destruction or serious damage to twenty-four thousand acres of trees and crops. After some delay, the State Department conceded that the alleged damage might be connected with "accidental drift" of spray over the border from herbicidal operations in Tay Ninh Province. The Defense Department flatly denied that the Cambodian areas had been deliberately sprayed. Late in June, the State Department sent a team of four American scientists to Cambodia, and they confirmed the extent of the area of damage that the Cambodians had claimed. They found that although some evidence of spray drift across the Vietnamese border existed, the extent and severity of damage in the area worst affected were such that "it is highly unlikely that this quantity could have drifted over the border from the Tay Ninh defoliation operations." Their report added, "The evidence we have seen, though circumstantial, suggests strongly that damage was caused by direct overflight." A second report on herbicidal damage to the area was made after an unofficial party of American biologists, including Professor E. W. Pfeiffer, of the University of Montana, and Professor Arthur H. Westing, of Windham College, Vermont, visited Cambodia last December at the invitation of the Cambodian government. They found that about a third of all the rubber trees currently in production in Cambodia had been damaged, and this had happened in an area that normally had the highest latex yield per acre of any in the world. A high proportion of two varieties of rubber trees in the area had died as a result of the damage, and Dr. Westing estimated that the damage to the latex-producing capacity of some varieties might persist for twenty years. Between May and November of last year,

latex production in the affected plantations fell off by an average of between thirty-five and forty per cent. According to a report by the two scientists, "A large variety of garden crops were devastated in the seemingly endless number of small villages scattered throughout the affected area. Virtually all of the . . . local inhabitants . . . depend for their wellbeing upon their own local produce. These people saw their crops . . . literally wither before their eyes." The Cambodian claim is still pending.

Until the end of last year, the criticism by biologists of the dangers involved in the use of herbicides centered on their use in what were increasingly construed as biological-warfare operations, and on the disruptive effects of these chemicals upon civilian populations and upon the ecology of the regions in which they were used. Last year, however, certain biologists began to raise serious questions on another score—possible direct hazards to life from 2,4,5-T. On October 20th, as a result of these questions, a statement was publicly issued by Dr. Lee DuBridge, President Nixon's science adviser. In summary, the statement said that because a laboratory study of mice and rats that had been given relatively high oral doses of 2,4,5-T in early stages of pregnancy "showed a higher than expected number of deformities" in the offspring, the government would, as a precautionary measure, undertake a series of coordinated actions to restrict the use of 2,4,5-T in both domestic civilian applications and military herbicidal operations. The DuBridge statement identified the laboratory study as having been made by an organization called the Bionetics Research Laboratories, in Bethesda, Maryland, but gave no details of either the findings or the data on which they were based. This absence of specific information turned out to be characteristic of what has been made available to the public concerning this particular research project. From the beginning, it seems, there was an extraordinary reluctance to discuss details of the purported ill effects of 2,4,5-T on animals. Six weeks after the publication of the DuBridge statement, a journalist who was attempting to obtain a copy of the full report made by Bionetics and to discuss its details with some of the government officials concerned encountered hard going. At the Bionetics Laboratories, an official said that he couldn't talk about the study, because "we're under wraps to the National Institutes of Health"—the government agency that commissioned the study. Then, having been asked what the specific doses of 2,4,5-T were that were said to have increased birth defects in the fetuses of experimental animals, the Bionetics official cut off discussion by saying, "You're asking sophisticated questions that as a layman you don't have the equipment to understand the answers to." At the National Institutes of Health, an official who was asked for details of or a copy of the study on 2,4,5-T replied, "The position I'm in is that I have been requested not to distribute this information." He did say, however, that a continuing evaluation of the study was under way at the National Institute of Environmental Health Sciences, at Research Triangle Park, North Carolina. A telephone call to an officer of this organization brought a response whose tone varied from wariness of downright hostility and made it clear that the official had no intention of discussing details or results of the study with the press.

The Bionetics study on 2,4,5-T was part of a series carried out under contract to the National Cancer Institute, which is an arm of the National Institutes of Health, to investigate more than two hundred compounds, most of them pesticides, in order to determine whether they induced cancer-causing changes, fetus-deforming changes, or mutation-causing changes in experimental animals. The contract was a large one, involving more than two and a half million dollars' worth of research, and its primary purpose was to screen out suspicious-looking substances for further study. The first visible fruits of the Bionetics research were presented in March of last year before a convention of the American Association for the Advancement of Science, in the form of a study of possible carcinogenic properties of the fifty-three compounds; the findings on 2,4,5-T were that it did not appear to cause carcinogenic changes in the animals studied.

By the time the report on the carcinogenic properties of the substances was presented, the results of another part of the Bionetics studies, concerning the teratogenic, or fetus-deforming, properties of the substances, were being compiled, but these results were not immediately made available to biologists outside the government. The data remained—somewhat frustratingly, in the view of some scientists who had been most curious about the effects of herbicides—out of sight, and a number of attempts by biologists who had heard about the

teratological study of 2,4,5-T to get at its findings appear to have been thwarted by the authorities involved. Upon being asked to account for the apparent delay in making this information available to biologists, an official of the National Institute of Environmental Health Sciences (another branch of the National Institutes of Health) has declared, with some heat, that the results of the study itself and of a statistical summary of the findings prepared by the Institute were in fact passed on as they were completed to the Commission on Pesticides and Their Relationship to Environmental Health, a scientific group appointed by Secretary of Health, Education, and Welfare Robert Finch and known—after its chairman, Dr. E. M. Mrak, of the University of California—as the Mrak Commission. Dr. Samuel S. Epstein, chief of the Laboratories of Environmental Toxicology and Carcinogenesis at the Children's Cancer Research Foundation in Boston, who was co-chairman of the Mrak Commission panel considering the teratogenic potential of pesticides, tells a different story on the availability of the Bionetics study. He says that he first heard about it in February. At a meeting of his panel in August, he asked for a copy of the report. Ten days later, the panel was told that the National Institute of Environmental Health Sciences would be willing to provide a statistical summary but that the group could not have access to the full report on which the summary was based. Dr. Epstein says that the panel eventually got the full report on September 24th "by pulling teeth."

Actually, as far back as February, officials at the National Cancer Institute had known, on the basis of a preliminary written outline from Bionetics, the findings of the Bionetics scientists on the fetus-deforming role of 2,4,5-T. Dr. Richard Bates, the officer of the National Institutes of Health who was in charge of coordinating the Bionetics project, has said that during the same month this information was put into the hands of officials of the Food and Drug Administration, the Department of Agriculture, and the Department of Defense. "We had a meeting with a couple of scientists from Fort Detrick, and we informed them of what we had learned," Dr. Bates said recently. "I don't know whether they were the right people for us to see. We didn't hear from them again until after the DuBridge announcement at the White House. Then they called up and asked for a copy of the Bionetics report."

At the Department of Agriculture, which Dr. Bates said had been informed in February of the preliminary Bionetics findings, Dr. Tschirley, one of the officials most intimately concerned with the permissible uses of herbicidal compounds, says that he first heard about the report on 2,4,5-T through the DuBridge announcement. At the Food and Drug Administration, where appropriate officials had been informed in February of the teratogenic potential of 2,4,5-T, no new action was taken to safeguard the public against 2,4,5-T in foodstuffs. In fact, it appears that no action at all was taken by the Food and Drug Administration on the matter during the whole of last year. The explanation that F.D.A. officials have offered for this inaction is that they were under instructions to leave the whole question alone at least until December, because the matter was under definitive study by the Mrak Commission—the very group whose members, as it turns out, had such extraordinary difficulty in obtaining the Bionetics data. The Food Toxicology Branch of the F.D.A. did not have access to the full Bionetics report on 2,4,5-T until after Dr. DuBridge issued his statement, at the end of October.

Thus, after the first word went to various agencies about the fetus-deforming potential of 2,4,5-T, and warning lights could have flashed on in every branch of the government and in the headquarters of every company manufacturing or handling it, literally almost nothing was done by the officials charged with protecting the public from exposure to dangerous or potentially dangerous materials—by the officials in the F.D.A., in the Department of Agriculture, and in the Department of Defense. It is conceivable that the Bionetics findings might still be hidden from the public if they had not been pried loose in mid-summer through the activities of a group of young law students. The students were members of a team put together by the consumer-protection activist Ralph Nader—and often referred to as Nader's Raiders—to explore the labyrinthine workings of the Food and Drug Administration. In the course of their investigations, one of the law students, a young woman named Anita Johnson, happened to see a copy of the preliminary report on the Bionetics findings that had been passed on to the F.D.A. in February, and its observations seemed quite disturbing to her. Miss Johnson wrote a report to Nader, and in September she showed a copy of the report to a friend who was a biology student at

Harvard. In early October, Miss Johnson's friend, in a conversation with Professor Matthew Meselson, mentioned Miss Johnson's report on the preliminary Bionetics findings. This was the first that Dr. Meselson had heard of the existence of the Bionetics study. A few days previously, he had received a call from a scientist friend of his asking whether Dr. Meselson had heard of certain stories, originating with South Vietnamese journalists and other South Vietnamese, of an unusual incidence of birth defects in South Vietnam, which were alleged to be connected with defoliation operations there.

A few days later, after his friend sent him further information, Mr. Meselson decided to obtain a copy of the Bionetics report, and he called up an acquaintance in a government agency and asked for it. He was told that the report was "confidential and classified," and inaccessible to outsiders. Actually, in addition to the preliminary report there were now in existence the full Bionetics report and a statistical summary prepared by the National Institute of Environmental Health Sciences, and, by nagging various Washington friends, Dr. Meselson obtained bootlegged copies of the two latest reports. What he read seemed to him to have such serious implications that he got in touch with acquaintances in the White House and also with someone in the Army to alert them to the problems of 2,4,5-T, in the hope that some new restriction would be placed on its use. According to Dr. Meselson, the White House people apparently didn't know until that moment that the reports on the adverse effects of 2,4,5-T even existed. (Around that time, according to a member of Nader's Raiders, "a tremendous lid was put on this thing" within government agencies, and on the subject of the Bionetics work and 2,4,5-T "people in government whom we'd been talking to freely for years just shut up and wouldn't say a word.") While Dr. Meselson awaited word on the matter, a colleague of his informed the press about the findings of the Bionetics report. Very shortly thereafter, Dr. DuBridge made his public announcement of the proposed restrictions on the use of 2,4,5-T.

In certain respects, the DuBridge announcement is a curious document. In its approach to the facts about 2,4,5-T that were set forth in the Bionetics report, it reflects considerable sensitivity to the political and international issues that lie behind the widespread use of this powerful herbicide for civilian and military purposes, and the words in which it describes the reasons for restricting its use appear to have been very carefully chosen:

"The actions to control the use of the chemical were taken as a result of findings from a laboratory study conducted by Bionetics Research Laboratories which indicated that offspring of mice and rats given relatively large oral doses of the herbicide during early stages of pregnancy showed a higher than expected number of deformities.

"Although it seems improbable that any person could receive harmful amounts of this chemical from any of the existing uses of 2,4,5-T, and while the relationships of these effects in laboratory animals to effects in man are not entirely clear at this time, the actions taken will assure safety of the public while further evidence is being sought."

These actions, according to the statement, included decisions that the Department of Agriculture would cancel manufacturers' registrations of 2,4,5-T for use on food crops, effective at the beginning of 1970, "unless by that time the Food and Drug Administration has found a basis for establishing a safe legal tolerance in and on foods," and that the Departments of Agriculture and the Interior, in their own programs, would stop the use of 2,4,5-T in populated areas and in all other areas where residues of the substance could reach man. As for military uses of 2,4,5-T, the statement said, "The chemical is effective in defoliating trees and shrubs and its use in South Vietnam has resulted in reducing greatly the number of ambushes, thus saving lives." However, the statement continued, "the Department of Defense will [henceforth] restrict the use of 2,4,5-T to areas remote from the population."

All this sounds eminently fair and sensible, but whether it represents a candid exposition of the facts about 2,4,5-T and the Bionetics report is debatable. The White House statement that the Bionetics findings "indicated that offspring of mice and rats given relatively large oral doses of the herbicide during early stages of pregnancy showed a higher than expected number of deformities" is, in the words of one eminent biologist who has studied the Bionetics data, "an understatement." He went on to say that "if the effects on experimental animals are applicable to people it's a very sad and serious situa-

tion." The actual Bionetics report described 2,4,5-T as producing "sufficiently prominent effects of seriously hazardous nature" in controlled experiments with pregnant mice to lead the authors "to categorize [it] as *probably dangerous*." The report also found 2,4-D "potentially dangerous but needing further study." As for 2,4,5-T, the report noted that, with the exception of very small subcutaneous dosages, "all dosages, routes, and strains resulted in increased incidence of abnormal fetuses" after its administration. The abnormalities in the fetuses included lack of eyes, faulty eyes, cystic kidneys, cleft palates, and enlarged livers. The Bionetics report went on to report on further experimental applications of 2,4,5-T to another species:

"Because of the potential importance of the findings in mice, an additional study was carried out in rats of the Sprague-Dawley strain. Using dosages of 21.5 and 46.4 mg/kg [that is, dosages scaled to represent 21.5 and 46.4 milligrams of 2,4,5-T per kilogram of the experimental animal's body weight] suspended in 50 per cent honey and given by the oral route on the 6th through 15th days of gestation, we observed excessive fetal mortality almost 80 per cent and a high incidence of abnormalities in the survivors. When the beginning of administration was delayed until the 10th day, fetal mortality was somewhat less but still quite high even when dosage was reduced to 4.6 mg/kg. The incidence of abnormal fetuses was threefold that in controls even with the smallest dosage and shortest period used. . . .

It seems inescapable the 2,4,5-T is teratogenic in this strain of rats when given orally at the dosage schedules used here."

Considering the fetus-deforming effects of the *lowest* oral dosage of 2,4,5-T used in Bionetics work on rats—to say nothing of the excessive fetal mortality—the White House statement that "relatively large oral doses of the herbicide . . . showed a higher than expected number of deformities" is hardly an accurate description of the results of the study. In fact, the statistical tables presented as part of the Bionetics report showed that at the lowest oral dosage of 2,4,5-T given to pregnant rats between the tenth and fifteenth days of gestation thirty-nine per cent of the fetuses produced were abnormal, or three times the figure for control animals. At what could without much question be described as "relatively large oral doses" of the herbicide—dosages of 21.5 and 46.4 milligrams per kilogram of body weight of rats, for example—the percentage of abnormal fetuses was ninety and a hundred per cent, respectively, or a good bit higher than one would be likely to deduce from the phrase "a higher than expected number of deformities." The assertion that "it seems improbable that any person could receive harmful amounts of this chemical from any of the existing uses of 2,4,5-T" also appears to be worth examining for this is precisely what many biologists are most worried about in relation to 2,4,5-T and allied substances.

It seems fair, before going further, to quote a cautionary note in the DuBridge statement: "The study involved relatively small numbers of laboratory rats and mice. More extensive studies are needed and will be undertaken. At best it is difficult to extrapolate results obtained with laboratory animals to man—sensitivity to a given compound may be different in man than in animal species. . . ." It would be difficult to get a biologist to disagree with these seemingly sound generalities. However, the first part of the statement does imply, at least to a layman, that the number of experimental animals used in the Bionetics study had been considerably smaller than the numbers used to test commercial compounds other than 2,4,5-T before they are approved by agencies such as the Food and Drug Administration and the Department of Agriculture. In this connection, the curious layman could reasonably begin with the recommendations, in 1963, of the President's Science Advisory Committee on the use of pesticides, which proposed that companies putting out pesticides should be required from then on to demonstrate the safety of their products by means of toxicity studies on two generations of at least two warm-blooded mammalian species. Subsequently, the F.D.A. set up new testing requirements, based on these recommendations, for companies producing pesticides. However, according to Dr. Joseph McLaughlin, of the Food Toxicology Branch of the F.D.A., the organization actually requires applicants for permission to sell pesticides to present the results of tests on only *one* species (usually, in practice, the rat). According to Dr. McLaughlin, the average number of experimental animals used in studies of pesticides is between eighty and a hundred and sixty, including animals used as controls but excluding litters produced. The Bionetics studies of 2,4,5-T used both mice and rats, and

their total number was, in fact, greater, not less, than this average. Including controls but excluding litters, the total number of animals used in the 2,4,5-T studies was two hundred and twenty-five. Analysis of the results by the National Institute of Environmental Health Sciences found them statistically "significant," and this is the real purpose of such a study: it is meant to act as a coarse screen to shake out of the data the larger lumps of bad news. Such a study is usually incapable of shaking out anything smaller; another kind of study is needed to do that.

Thus, the DuBridge statement seems to give rise to this question: If the Bionetics study, based on the effects of 2,4,5-T on two hundred and twenty-five experimental animals of two species, appears to be less than conclusive, on the ground that "the study involved relatively small numbers of laboratory rats and mice," what is one to think of the adequacy of the tests that the manufacturers of pesticides make? If, as the DuBridge statement says, "at best it is difficult to extrapolate results obtained with laboratory animals to man," what is one to say of the protection that the government affords the consumer when the results of tests of pesticidal substances on perhaps a hundred and twenty rats are officially extrapolated to justify the use of the substances by a population of two hundred million people—not to mention one to two million unborn babies being carried in their mothers' wombs?

The very coarseness of the screen used in all these tests—that is, the relatively small number of animals involved—means that the bad news that shows up in the data has to be taken with particular seriousness, because lesser effects tend not to be demonstrable at all. The inadequacy of the scale on which animal tests with, for instance, pesticides are currently being made in this country to gain F.D.A. approval is further indicated by the fact that a fetus-deforming effect that might show up if a thousand test animals were used is almost never picked up, since the studies are not conducted on that scale; yet if the material being tested turned out to have the same effect, quantitatively, on human beings, this would mean that it would cause between three and four thousand malformed babies to be produced each year. The teratogenic effects of 2,4,5-T on experimental animals used by the Bionetics people, however, were not on the order of one in a thousand. Even in the case of the lowest oral dose given rats, they were on the order of one in three.

Again, it is fair to say that what is applicable to rats in such tests may not be applicable to human beings. But it is also fair to say that studies involving rats are conducted not for the welfare of the rat kingdom but for the ultimate protection of human beings. In the opinion of Dr. Epsteln, the fact that the 2,4,5-T used in the Bionetics study produced teratogenic effects in *both* mice and rats underlines the seriousness of the study's implications. In the opinion of Dr. McLaughlin, this is even further underlined by another circumstance—that the rat, as a test animal, tends to be relatively resistant to teratogenic effects of chemicals. For example, in the late nineteen-fifties, when thalidomide, that disastrously teratogenic compound, was being tested on rats in oral dosages ranging from low to very high, no discernible fetus-deforming effects were produced. And Dr. McLaughlin says that as far as thalidomide tests on rabbits were concerned, "You could give thalidomide to rabbits in oral doses at between fifty and two hundred times the comparable human level to show any comparable teratogenic effects." In babies born to women who took thalidomide, whether in small or large dosages and whether in single or multiple dosages, between the sixth and seventh weeks of pregnancy, the rate of deformation was estimated to be one in ten.

Because of the relatively coarse testing screen through which compounds like pesticides—and food additives as well—are sifted before they are approved for general or specialized use in this country, the Food and Drug Administration theoretically maintains a policy of stipulating, as a safety factor, that the maximum amount of such a substance allowable in the human diet range from one two-thousandth to one one-hundredth of the highest dosage level of the substance that produces no harmful effects in experimental animals. (In the case of pesticides, the World Health Organization takes a more conservative view, considering one two-thousandth of the "no-effect" level in animal studies to be a reasonable safety level for human exposure.) According to the standards of safety established by F.D.A. policy, then, no human being anywhere should ever have been exposed to 2,4,5-T, because in the Bionetics study of rats *every* dosage level produced deformed fetuses. A "no-effect" level was never achieved.

To make a reasonable guess about the general safety of 2,4,5-T for human beings, as the material has been used up to now, the most appropriate population area to observe is probably not the relatively healthy and well-fed United States, where human beings are perhaps better equipped to withstand the assault of toxic substances, but South Vietnam, where great numbers of civilians are half-starved, ravaged by disease, and racked by the innumerable horrors of war. In considering any potentially harmful effects of 2,4,5-T on human beings in Vietnam, some attempt has to be made to estimate the amount of 2,4,5-T to which people, and particularly pregnant women, may have been exposed as a result of the repeated defoliation operations. To do so, a comparison of known rates of application of 2,4,5-T in the United States and in Vietnam is in order. In this country, according to Dr. Tschirley, the average recommended application of 2,4,5-T in aerial spraying for woody-plant control is between three-quarters of a pound and a pound per acre. There are about five manufacturers of 2,4,5-T in this country, of which the Dow Chemical Company is one of the biggest. One of Dow Chemical's best-sellers in the 2,4,5-T line is Esteron 245 Concentrate, and the cautionary notes that a drum of Esteron bears on its label are hardly reassuring to someone lulled by prior allegations that 2,4,5-T is a substance of low toxicity:

"Caution—may cause skin irritation, avoid contact with eyes, skin, and clothing keep out of the reach of children."

Under the word "warning" are a number of instructions concerning safe use of the material, and these include, presumably for good reason, the following admonition:

"Do not contaminate irrigation ditches or water used for domestic purposes

Then comes a "notice":

"Seller makes no warranty of any kind, express or implied, concerning the use of this product. Buyer assumes all risk of use or handling, whether in accordance with directions or not."

The concentration of Esteron recommended—subject to all these warnings, cautions, and disclaimers—for aerial spraying in the United States varies with the type of vegetation to be sprayed, but probably a fair average would be three-quarters to one pound acid equivalent of the raw 2,4,5-T per acre. In Vietnam, however, the concentration of 2,4,5-T for each acre sprayed has been far higher. In Agent Orange, the concentrations of 2,4,5-T have averaged *thirteen times* the recommended concentrations used in the United States. The principal route through which quantities of 2,4,5-T might be expected to enter the human system in Vietnam is through drinking water, and in the areas sprayed most drinking water comes either from rainwater cisterns fed from house roofs or from very shallow wells. It has been calculated that, taking into account the average amount of 2,4,5-T in Agent Orange sprayed per acre in Vietnam by the military, and assuming a one-inch rainfall (which is quite common in South Vietnam) after a spraying, a forty-kilo (about eighty-eight-pound) Vietnamese woman drinking two litres (about 1.8 quarts) of contaminated water a day could very well be absorbing into her system a hundred and twenty milligrams, or about one two-hundred-and-fiftieth of an ounce, of 2,4,5-T a day: that is, a daily oral dosage of three milligrams of 2,4,5-T per kilo of body weight. Thus, if a Vietnamese woman who was exposed to Agent Orange was pregnant, she might very well be absorbing into her system a percentage of 2,4,5-T only slightly less than the percentage that deformed one out of every three fetuses of the pregnant experimental rats. To pursue further the question of exposure of Vietnamese to 2,4,5-T concentrations in relation to concentrations officially considered safe for Americans, an advisory subcommittee to the Secretary of the Interior, in setting up guide-lines for maximum safe contamination of surface water by pesticides and allied substances some time ago, recommended a concentration of one-tenth of a milligram of 2,4,5-T in one litre of drinking water as the maximum safe concentration. Thus, a pregnant Vietnamese woman who ingested a hundred and twenty milligrams of 2,4,5-T in two litres of water a day would be exposed to 2,4,5-T at six hundred times the concentration officially considered safe for Americans.

Moreover, the level of exposure of Vietnamese people in sprayed areas is not necessarily limited to the concentrations shown in Dr. Meselson's calculations. Sometimes the level may be far higher. Dr. Pfeiffer, the University of Montana biologist, says that when difficulties arise with the spray planes or the spray apparatus, or when other accidents occur, an entire thousand-gallon load of herbicidal agent containing 2,4,5-T may be dumped in one area by means of

the thirty-second emergency-dumping procedure. Dr. Pfeiffer has recalled going along as an observer on a United States defoliation mission last March, over the Plain of Reeds area of Vietnam, near the Cambodian border, during which the technician at the spray controls was unable to get the apparatus to work, and thereupon dumped his whole load. "This rained down a dose of 2,4,5-T that must have been fantastically concentrated," Dr. Pfeiffer has said. "It was released on a very watery spot that looked like headwaters draining into the Mekong River, which hundreds of thousands of people use? In another instance, he has recalled, a pilot going over the area of the supposedly "friendly" Catholic refugee villages of Ho Nai, near Bien Hoa, had serious engine trouble and dumped his whole spray load of herbicide on or near the village. In such instance, the concentration of 2,4,5-T dumped upon an inhabited area in Vietnam probably averaged about a hundred and thirty times the concentration recommended by 2,4,5-T manufacturers as both effective and safe for use in the United States.

Theoretically, the dangers inherent in the use of 2,4,5-T should have been removed by means of the steps promised in the White House announcement last October. A quick reading of the statement by Dr. DuBridge (who is also the executive secretary of the President's Environmental Quality Council) certainly seemed to convey the impression that from that day onward there would be a change in Department of Defense policy on the use of 2,4,5-T in Vietnam, just as there would be a change in the policies of the Departments of Agriculture and the Interior on the domestic use of 2,4,5-T. But did the White House mean what it certainly seemed to be saying about the future military use of 2,4,5-T in Vietnam? The White House statement was issued on October 20th. On October 30th, the Pentagon announced that no change would be made in the policy governing the military use of 2,4,5-T in South Vietnam, because—so the *Washington Post* reported on October 31st—"the Defense Department feels its present policy conforms to the new Presidential directive." The *Post* article went on:

"A Pentagon spokesman's explanation of the policy, read at a morning press briefing, differed markedly from the written version given reporters later.

"When the written statement was distributed, reporters were told not to use the spokesman's [previous] comment that the defoliant . . . is used against enemy 'training and regroupment centers.'

"The statement was expunged after a reporter asked how use against such centers conformed to the Defense Department's stated policy of prohibiting its use in 'populated areas.'"

But the statement wasn't so easily expunged. A short time later, it was made again, in essence, by Rear Admiral William E. Lemos, of the Policy Plans and National Security Council Affairs Office of the Department of Defense, in testimony before a subcommittee of the House Foreign Affairs Committee, the only difference being that the phrase "training and regroupment centers" became "enemy base camps." And in testifying that the military was mounting herbicidal operations on alleged enemy base camps Rear Admiral Lemos said:

"We know . . . that the enemy will move from areas that have been sprayed. Therefore, enemy base camps or unit headquarters are sprayed in order to make him move to avoid exposing himself to aerial observation."

If one adds to the words "enemy base camps" the expunged words "training and regroupment centers"—centers that are unlikely to operate without an accompanying civilian population—what the Defense Department seems actually to be indicating is that the "areas remote from the population" against which the United States is conducting military herbicidal operations are "remote from the population" at least in part because of these operations.

As for the Bionetics findings on the teratogenic effects of 2,4,5-T on experimental animals, the Department of Defense indicated that it put little stock in the dangers suggested by the report. A reporter for the *Yale Daily News* who telephoned the Pentagon during the first week in December to inquire about the Defense Department's attitude toward its use of 2,4,5-T in the light of the Bionetics report was assured that "there is no cause for alarm about defoliants." A week or so later, he received a letter from the Directorate for Defense Information at the Pentagon which described the Bionetics results as based on "evidence that 2,4,5-T, when fed in large amounts to highly inbred and susceptible mice and rats, gave a higher incidence of birth defects than was normal for these animals." After reading this letter, the *Yale Daily News*

reporter again telephoned the Pentagon, and asked, "Does [the Department of Defense] think defoliants could be affecting embryo growth in any way in Vietnam?" The Pentagon spokesman said, "No." And that was that. The experimental animals were highly susceptible: the civilian Vietnamese population, which even under "normal" circumstances is the victim of a statistically incalculable but clearly very high abortion and infant-mortality rate, was not.

Nearly a month after Dr. DuBridge's statement, another was issued, this one by the President himself, on United States policy on chemical and biological warfare. The President, noting that "biological weapons have massive, unpredictable, and potentially uncontrollable consequences" that might "impair the health of future generations," announced it as his decision that thenceforward "the United States shall renounce the use of lethal biological agents and weapons, and all other methods of biological warfare." Later, a White House spokesman, in answer to questions by reporters whether this included the use of herbicidal, defoliant, or crop-killing chemicals in Vietnam, made it clear that the new policy did not encompass herbicides.

Since the President's statement did specifically renounce "all other methods of biological warfare," the reasonable assumption is that the United States government does not consider herbicidal, defoliant, and crop-killing operations against military and civilian populations to be part of biological warfare. The question therefore remains: What does the United States government consider biological warfare to consist of? The best place to look for an authoritative definition is a work known as the Joint Chiefs of Staff Dictionary, an official publication that governs proper word usage within the military establishment. In the current edition of the Joint Chiefs of Staff Dictionary, "biological warfare" is defined as the "employment of living organisms, toxic biological products, and plant-growth regulators to produce death or casualties in man, animals, or plants or defense against such action." But the term "plant-growth regulators" is nowhere defined in the Joint Chiefs of Staff Dictionary, and since a certain technical distinction might be made (by weed-control scientists, for example) between plant-growth regulators and defoliants, the question of whether the Joint Chiefs consider military defoliation operations part of biological warfare is left unclear. As for "defoliant agents," the Dictionary defines such an agent only as "a chemical which causes trees, shrubs, and the other plants to shed their leaves prematurely." All this is hardly a surprise to anyone familiar with the fast semantic legerdemain involved in all official statements on biological warfare, in which defoliation has the baffingly evanescent half-existence of a pea under a shell.

To find that pea in the official literature is not easy. But it is reasonable to assume that if the Department of Defense were to concede officially that "defoliant agents" were in the same category as "plant-growth regulators" that "produce death . . . in plants," it would thereby also be conceding that it is in fact engaging in the biological warfare that President Nixon has renounced. And such a concession seems to have been run to earth in the current edition of a Department of the Army publication entitled "Manual on Use of Herbicides for Military Purposes," in which "antiplant agents" are defined as "chemical agents which possess a high offensive potential for destroying or seriously limiting the production of food and defoliating vegetation," and goes on "These compounds include herbicides that kill or inhibit the growth of plants; plant-growth regulators that either regulate or inhibit plant growth, sometimes causing plant death. . . ." The admission that the Department of Defense is indeed engaging, through its defoliation and herbicidal operations in Vietnam, in biological warfare, as this is defined by the Joint Chiefs and as it has been formally renounced by the President, seems inescapable.

Since the DuBridge statement, allegations, apparently originating in part with the Dow Chemical Company, have been made to the effect that the 2,4,5-T used in the Bionetics study was unrepresentative of the 2,4,5-T generally produced in this country, in that it contained comparatively large amounts of a certain contaminant, which, according to the Dow people, is ordinarily present in 2,4,5-T only in trace quantities. Accordingly, it has been suggested that the real cause of the teratogenic effects of the 2,4,5-T used in the Bionetics study may not have been the 2,4,5-T itself but, rather, the contaminant in the sample used. The chemical name of the contaminant thus suspected by the Dow people is 2,3,6,7-tetrachlorodibenzo-p-dioxin, often referred to simply as dioxin. The 2,4,5-T used by Bionetics was obtained in 1965 from the Diamond Alkali Company, now known as the Diamond-Shamrock Company and no longer in the

business of manufacturing 2,4,5-T. It appears that the presence of a dioxin contaminant in the process of manufacturing 2,4,5-T is a constant problem among all manufacturers. Three years ago, Dow was obliged to close down its 2,4,5-T plant in Midland, Michigan, for several months and partly rebuild it because of what Dow people variously described as "a problem" and "an accident." The problem—or accident—was that workers exposed to the dioxin contaminant during the process of manufacture came down with an acute skin irritation known as chlor-acne. The Dow people, who speak with considerable pride of their toxicological work ("We established our toxicology lab the year Ralph Nader was born," a Dow public-relations man said recently, showing, at any rate, that Dow is keenly aware of Nader and his career), say that the chlor-acne problem has long since been cleared up, and that the current level of the dioxin contaminant in Dow's 2,4,5-T is less than one part per million, as opposed to the dioxin level in the 2,4,5-T used in the Bionetics study, which is alleged to have been between fifteen and thirty parts per million. A scientist at the DuBridge office, which has become a coordinating agency for information having to do with the 2,4,5-T question, says that the 2,4,5-T used by Bionetics was "probably representative" of 2,4,5-T being used in this country—and presumably in Vietnam—at the time it was obtained but that considerably less of the contaminant is present in the 2,4,5-T now being produced. Evidently, the degree of dioxin contamination present in 2,4,5-T varies from manufacturer to manufacturer. What degree of contamination high or low, was present in the quantities of 2,4,5-T shipped to South Vietnam at various times this spokesman didn't seem to know.

The point about the dioxin contamination of 2,4,5-T is an extremely important one, because if the suspicions of the Dow people are correct and the cause of the fetus deformities cited in the Bionetics study is not the 2,4,5-T but the dioxin contaminant, then this contaminant may be among the most teratogenically powerful agents ever known. Dr. McLaughlin has calculated that if the dioxin present in the Bionetics 2,4,5-T was indeed responsible for the teratogenic effects on the experimental animals, it looks as though the contaminant would have to be at least ten thousand times more teratogenically active in rats than thalidomide was found to be in rabbits. Furthermore, it raises alarming questions about the prevalence of the dioxin material in our environment. It appears that under high heat the dioxin material can be produced in a whole class of chemical substances known as trichlorophenols and pentachlorophenols. These substances include components of certain fatty acids used in detergents and in animal feed.

As a consequence of studies that have been made of the deaths of millions of young chicks in this country after the chicks had eaten certain kinds of chicken feed, government scientists are now seriously speculating on the possibility that the deaths were at the end of a chain that began with the spraying of corn crops with 2,4,5-T. The hypothesis is that residues of dioxin present in the 2,4,5-T remained in the harvested corn and were concentrated into certain byproducts that were then sold to manufacturers of chicken feed, and that the dioxin became absorbed into the system of the young chicks. One particularly disquieting sign of the potential of the dioxin material is the fact that bioassays made on chick embryos in another study revealed that all the embryos were killed by one twenty-millionth of a gram of dioxin per egg.

Perhaps an even more disquieting speculation about the dioxin is that 2,4,5-T may not be the only material in which it appears. Among the compounds that several experienced biologists and toxicologists suspect might contain or produce dioxin are the trichlorophenols and pentachlorophenols, which are rather widely present in the environment in various forms. For example, a number of the trichlorophenols and pentachlorophenols are used as slime-killing agents in paper-pulp manufacture, and are present in a wide range of consumer products, including adhesives, water-based and oil-based paints, varnishes and lacquers, and paper and paper coatings. They are used to prevent slime in pasteurizers and fungus on vats in breweries and are also used in hair shampoo. Along with the 2,4,5-T used in the Bionetics study, one trichlorophenol and one pentachlorophenol were tested without teratogenic results. But Dr. McLaughlin points out that since there are many such compounds put out by various companies, these particular samples might turn out to be —by the reasoning of the allegation that the 2,4,5-T used by Bionetics was unusually dirty—unusually clean.

Dr. McLaughlin tends to consider significant, in view of the now known extreme toxicity and possible extreme teratogenicity of dioxin, the existence of even very small amounts of the trichlorophenols and pentachlorophenols in food wrappings and other consumer products. Since the production of dioxin appears to be associated with high-temperature conditions, a question arises whether these thermal conditions are met at any stage of production or subsequent use or disposal of such materials, even in minute amounts. One of the problems here seems to be, as Dr. Epstein has put it, "The moment you introduce something into the environment it's likely to be burned sooner or later—that's the way we get rid of nearly everything." And most of these consumer products may wind up in municipal incinerators, and when they are burned, the thermal and other conditions for creating dioxin materials may quite possibly be met. If so, this could mean a release of dioxin material into the entire environment through the atmosphere.

Yet so far the dioxin material now suspected of causing the fetus-deforming effects in experimental animals has never been put through any formal teratological tests by any company or any government agency. If the speculation over the connection between dioxin in 2,4,5-T and the deaths of millions of baby chicks is borne out, it might mean that, quite contrary to the assumptions made up to now that 2,4,5-T is rapidly decomposable in soil, the dioxin material may be extremely persistent as well as extremely deadly.

So far, nobody knows—and it is probable that nobody will know for some time—whether the fetus deformities in the Bionetics study were caused by the 2,4,5-T itself, by the dioxin contaminant, or by some other substance or substances present in the 2,4,5-T, or whether human fetuses react to 2,4,5-T in the same way as the fetuses of the experimental animals in the Bionetics study. However, the experience so far with the employment of 2,4,5-T and substances chemically allied to it ought to be instructive. The history of 2,4,5-T is related to preparations for biological warfare, although nobody in the United States government seems to want to admit this, and it has wound up being used for purposes of biological warfare, although nobody in the United States government seems to want to admit *this*, either. Since 2,4,5-T was developed, the United States government has allowed it to be used on a very large scale on our own fields and countryside without adequate tests of its effects. In South Vietnam—a nation we are attempting to save—for seven full years the American military has sprayed or dumped this biological-warfare material on the countryside, on villages, and on South Vietnamese men and women in staggering amounts. In that time, the military has sprayed or dumped on Vietnam fifty thousand tons of herbicide, of which twenty thousand tons have apparently been straight 2,4,5-T. In addition, the American military has apparently made incursions into a neutral country, Cambodia, and rained down on an area inhabited by thirty thousand civilians a vast quantity of 2,4,5-T. Yet in the quarter of a century since the Department of Defense first developed the biological-warfare uses of this material it has not completed a single series of formal teratological tests on pregnant animals to determine whether it has an effect on their unborn offspring.

Similarly, officials of the Dow Chemical Company, one of the largest producers of 2,4,5-T, although they refuse to divulge how much 2,4,5-T they are and have been producing, admit that in all the years that they had produced the chemical before the DuBridge statement they had never made formal teratological tests on their 2,4,5-T, which they are now doing. The Monsanto Chemical Company, another big producer, had, as far as is known, never made such tests, either, nor, according to an official in the White House, had any other manufacturer. The Department of Agriculture has never required any such tests from manufacturers. The Food and Drug Administration has never required any such tests from manufacturers. The first tests to determine the teratogenic effects of 2,4,5-T were not made until the National Institutes of Health contracted for them with Bionetics Laboratories. And even then, when the adverse results of the tests became apparent, it was, as Dr. Epstein said, like "pulling teeth" to get the data out of the institutions involved. And when the data were obtained and the White House was obliged, partly by outside pressure and publicity, to act, the President's science adviser publicly presented the facts in a less than candid manner, while the Department of Defense, for all practical purposes, ignored the whole business and announced its intention of going on doing what it had been doing all along.

There have been a number of reports from Vietnam both of animal abortions and of malformed human babies that are thought to have resulted from spraying operations in which 2,4,5-T was used. But such scattered reports, however well founded, cannot really shed much more light on the situation. The fact is that even in this country, the best-fed, richest, and certainly most statistics-minded of all countries on earth, the standards for testing materials that are put into the environment, into drugs, and into the human diet are grossly inadequate. The screening system is so coarse that, as a teratology panel of the MRAK Commission warned recently, in connection with thalidomide, "the teratogenicity of thalidomide might have been missed had it not produced malformations rarely encountered." In other words, had it not been for the fact that very unusual and particularly terrible malformations appeared in an obvious pattern—for example, similarly malformed babies in the same hospital at about the same time—pregnant women might still be using thalidomide, and lesser deformations would, so to speak, disappear into the general statistical background. As for more subtle effects, such as brain damage and damage to the central-nervous system, they would probably never show up as such at all. If such risks existed under orderly, normal medical conditions in a highly developed country, how is one ever to measure the harm that might be done to unborn children in rural Vietnam, in the midst of the malnutrition, the disease, the trauma, the poverty, and the general shambles of war?

DEPARTMENT OF AMPLIFICATION,
New York, March 5, 1970.

The Errors,
The New Yorker

DEAR SIR: In an article that appeared in *The New Yorker* on February 7th, I wrote that Dr. Lee DuBridge, the President's science adviser, issued a statement last October at the White House saying that because a laboratory study had shown a "higher than expected number of deformities" in the fetuses of mice and rats exposed to the herbicide 2,4,5-T, agencies of the United States government would take action to restrict the use of that substance in this country and in Vietnam, where it was being used in extensive military defoliation operations. This action, Dr. DuBridge announced, would include the cancellation, by January 1st of this year, of Department of Agriculture permits for the use of 2,4,5-T on some American food crops unless the Food and Drug Administration had by then been able to determine a safe concentration of the herbicide in foods. Dr. DuBridge further announced that the Department of Defense would thenceforth "restrict the use of 2,4,5-T to areas remote from the population" in Vietnam. His statement added that these actions and others "will assure the safety of the public while further evidence [of the alleged harmful effects of 2,4,5-T] is being sought."

Four months have passed, and 2,4,5-T is still being used as widely as ever. The Department of Agriculture has yet to cancel its permits for the use of the herbicide on food crops in this country, and the Department of Defense is continuing to use it in populated areas of Vietnam. In the meantime, officials of the Dow Chemical Company, which is one of the largest producers of 2,4,5-T, have been maintaining that the samples of 2,4,5-T used in the study cited by Dr. DuBridge, which was done by the Bionetics Research Laboratories, of Bethesda, Maryland, were uncharacteristic of the 2,4,5-T currently being produced, because the material tested by Bionetics—which did not come from Dow—was contaminated to an unusual extent by a toxic substance identified as symmetrical 2,3,6,7-tetrachlorodibenzo-p-dioxin. This contaminant, usually called dioxin, was alleged by the Dow people to be present in the Bionetics samples at a concentration of approximately twenty-seven parts per million, and they claim that the 2,4,5-T that Dow is currently producing contains the dioxin contaminant in concentrations of less than one part per million. The Dow people maintain that their currently produced 2,4,5-T does not appear to have the effect of deforming rat fetuses. In January, a Dow official told the Department of Health, Education, and Welfare, "We strongly urge that action concerning the status of 2,4,5-T be held in abeyance until [Dow's] testing program is completed [in] April." The United States government's failure so far to place the promised restrictions on the use of 2,4,5-T in this country may in part be attributed to this plea.

Because of the seriousness of the issues involved, it seems to me that the government's failure to act on the use of 2,4,5-T here and in Vietnam calls for much fuller public discussion. Even though the dioxin contaminant may now be present in 2,4,5-T in what the Dow Chemical Company apparently considers to be no more than tolerable amounts, the substance is of such potency that its release even in small concentrations must prompt deep concern. In the presumably more heavily dioxin-contaminated samples of 2,4,5-T that were used in the Bionetics work, the smallest dosages of 2,4,5-T that the test animals were given caused extensive deformities in fetuses. In more recent studies of the dioxin contaminant, conducted by Dr. Jacqueline Verrett, of the Food and Drug Administration (who earlier was responsible for revealing the carcinogenicity of cyclamates), extensive teratogenic, or fetus-deforming, effects were discovered in chick embryos when the dioxin, or a distillate predominantly consisting of it, was present at concentrations of little more than a trillionth of a gram per gram of the egg. The magnitude of this effect on chick embryos may be gathered from the fact that, according to Dr. Verrett's studies, the dioxin appears to be a million times as potent a fetus-deforming agent as the notorious teratogen thalidomide was found to be in tests on chicks. Of course, chick embryos are far down the biological ladder from human fetuses, and they are also extremely sensitive to many substances. But even if, for theoretical purposes, we reduced the teratogenic power of the dioxin, as shown in Dr. Verrett's chick-embryo studies, approximately a million times, we would *still* have to consider that we were dealing with a substance as teratogenically potent as thalidomide. That the United States government permits the presence, even in minute amounts, of such a substance in herbicidal mixtures to be sold for spraying on food crops and on suburban lawns—where some of the chemical may enter shallow wells and other drinking-water supplies—is hardly reassuring. And it is particularly disturbing when one reflects that in the quarter of a century in which 2,4,5-T was used prior to Dr. DuBridge's announcement of a new regulatory agency of the United States government, not the Department of Defense—which has been spreading huge quantities of 2,4,5-T on vast areas of Vietnam—and not, as far as is known, the researchers for any one of the half-dozen large American chemical companies producing the material had ever so much as opened up a pregnant mouse to determine whether 2,4,5-T or the dioxin contaminant in it did any systemic or pathogenic harm to the fetus. Several studies of the sort are now under way, but the United States government still seems to take the position that the 2,4,5-T produced by Dow and other large chemical companies should be considered innocent until it is proved to be otherwise. Meanwhile, 2,4,5-T is being sprayed on certain crops and on areas where it may come into contact with human beings, cattle, and wildlife. In Vietnam, it is still being sprayed by the military in concentrations that average thirteen times as great as those that the manufacturers themselves recommend as safe and effective for use in this country.

It is true that the teratogenicity of dioxin—as distinct from dioxin-contaminated 2,4,5-T—has not yet been established in tests conducted on experimental animals of mammalian species. However, the direct toxic, or body-poisoning, effects—as distinct from fetus-deforming effects—of dioxin are known to be very high both in animals and in human beings. In past studies on rats, dosages of forty-five millionths of a gram per kilo of the mother's body weight have been found to kill fifty per cent of the offspring. When dioxin was given orally to pregnant rats in recent tests, it was found, on preliminary investigation, to kill all fetuses with dosages of eight millionths of a gram per kilo of the mother's body weight, and to damage fetuses with dosages of a half-millionth of a gram per kilo.

Further, the effects of dioxin on human beings, even in small dosages, are known to be serious. In the past, in plants manufacturing 2,4,5-T an illness called chloracne seems to have been widespread among the workers. In the mid-sixties, Dow was obliged to close down part of a 2,4,5-T plant in Midland, Michigan, for some time because about sixty workers contracted chloracne as a result of contact with dioxin, which seems to be always present in varying degrees during the process of manufacturing 2,4,5-T and in the finished 2,4,5-T itself. The symptoms of this disease include extensive skin eruptions, disorders of the central nervous system, chronic fatigue, lassitude, and depression. Workers at a 2,4,5-T plant in New Jersey run by another company suffered similar symptoms in the mid-sixties, and six years later some of them were reported to be still suffering from the effects of the disease. In Germany, since the

mid-fifties, workers in factory after factory producing 2,4,5-T and polychlorophenolic compounds have been afflicted with chloracne after absorbing apparently only minute amounts of the dioxin contaminant; their symptoms have been described in several medical papers as including liver damage, nervous and mental disorders, depression, loss of appetite and weight, and markedly reduced sexual drive.

A few weeks ago, when a reporter approached an official in Dr. DuBridge's office for information on 2,4,5-T he was told that he would be given White House cooperation "only to a certain extent," because the official didn't want "wild speculation" stirred up. He cited as an example of "wild speculation" the recent controversy over the birth-control pill, which, he said, had "caused millions of women to get hysterical with worry." The reporter replied that he didn't think the analogy between 2,4,5-T and the Pill was a particularly good one, for the reason that a woman using the Pill could employ alternative methods of contraception, whereas a Vietnamese woman exposed to herbicidal spray put down by the American military had no choice in the matter.

But perhaps the comparison between 2,4,5-T (and its dioxin contaminant) and commonly used pills is worth pursuing. Suppose that such a dangerous substance as dioxin were found to be contained in a pill offered for human consumption in this country, and suppose that the contaminant were present in such minute amounts that an adult following the prescribed dosages might ingest a hundredth of a millionth of a gram of the contaminant per day. There is no doubt whatever that, according to existing Food and Drug Administration standards, the F.D.A. would immediately ban production and sale of the pill on the ground that it was highly dangerous to public health; in fact, the amount of such a potent contaminant that the F.D.A. would permit in a pill under the agency's present policy on toxicity would almost certainly be zero.

While 2,4,5-T, with or without the dioxin contaminant, doesn't come in pill form, it may be worthwhile to try to calculate, on the basis of a hypothetical pill, how much 2,4,5-T (and dioxin) a Vietnamese woman living in an area sprayed by the American military might ingest in a day. It has already been calculated by reputable biologists that, if one takes into account the average amount of 2,4,5-T sprayed per acre in Vietnam, and also takes into account a one-inch rainfall—such as is common there—after a spraying, a forty-kilo (about eighty-eight-pound) Vietnamese woman drinking two litres (about two quarts) of 2,4,5-T-contaminated water per day could be ingesting about a hundred and twenty milligrams (about a two-hundred-and-fiftieth of an ounce) of 2,4,5-T a day. If the 2,4,5-T contained the dioxin contaminant at a level of one part per million—which is what the Dow people say is the maximum amount present in the 2,4,5-T they are currently producing—the Vietnamese woman would be absorbing a little over a tenth of a microgram of dioxin per day, or ten times the amount of dioxin entering the system of an adult from the hypothetical pill that the F.D.A. would certainly find dangerous to human health. Further, if this Vietnamese woman were to conceive a child two weeks, say, after the spraying, the weight of the dioxin that by these same calculations would have then accumulated in her system (the evidence thus far is that dioxin accumulates in mammalian tissue in the same manner as the chlorinated hydrocarbons, such as DDT) would be more than the weight of the just-fertilized ovum. Considering the existing evidence of the frightening degree of teratogenicity of the dioxin in chick embryos and its highly toxic effects on mammalian fetuses, the presence of this much dioxin in a mother's body at the very beginning of a human life surely has ominous implications.

Now, what about the safety of 2,4,5-T itself? Admittedly, the dioxin contaminant seems to be a residue from one stage of its manufacture. But if by some future chemical miracle the very last trace of dioxin could be removed from the finished 2,4,5-T, would the resultant "pure" 2,4,5-T be harmless? The fact seems to be that even then 2,4,5-T, as produced in this country, would have to be viewed with suspicion, for the breakdown products of 2,4,5-T, when subjected to heat and other conditions, are themselves capable, according to a number of responsible biologists, of producing dioxin. Given this potential, the ultimate folly in our defoliation operations in Vietnam was possibly achieved during 1965 and 1966, when the military made large-scale efforts in two defoliated areas to create fire storms—that is, fires so huge that all the oxygen in these areas would be exhausted. The apparent intention was to render the soil barren. (A fire storm would also, of course, have the result of burning or suf-

focating any living beings remaining in the area.) Operation Sherwood Forest, conducted in 1965, was an attempt to burn a defoliated section of the Boi Loi Woods. In October, 1966, the military began Operation Pink Rose, a similar project. Neither of the projects, in which tons of napalm were thrown down on top of the residue of tons of sprayed 2,4,5-T, succeeded in creating the desired effect; whether they released into the atmosphere dioxin produced by the breakdown products of the 2,4,5-T will probably never be known.

There are also less spectacular ways in which conditions suitable for the release of dioxin in Vietnam may have been created. For example, after areas accessible by road have been defoliated, woodcutters move in to chop up the dead timber, which is then carted off to nearby towns and sold as firewood. Large quantities of it are said to have been entering Saigon for years. Since the fires are customarily tended by Vietnamese women, and since many of them are certainly pregnant, the hazards to health and to the lives of unborn children surely cannot be ignored.

In the United States, the potential hazards from the present use of 2,4,5-T are considerably less than they are in Vietnam. In the first place, the recommended concentrations of 2,4,5-T for spraying here are, as I have pointed out, about a thirteenth of what the Vietnamese population is sometimes subjected to. And, in the second place, a great deal, if not most, of the 2,4,5-T that would otherwise have been sprayed on American crops and grazing areas has for several years been sent to Vietnam. However, the shortage of 2,4,5-T in this country does not necessarily mean that the potential hazards are at a minimum. The substances known as the trichlorophenols and compounds of pentachlorophenol, which officials of the F.D.A. believe may be chemical precursors of dioxin under certain thermal and other conditions, are used widely in the manufacture of a large variety of consumer products, ranging from paper to laundry starch and hair shampoo. Dow Chemical puts out a whole line of polychlorophenolic chemicals known as Dowicide Products. Monsanto Chemical also puts out a line of pentachlorophenol substances, known as Penta Compounds. Since a very great many consumer products wind up being burned sooner or later, and since the polychlorophenolic compounds are suspected of being capable, under particular thermal and other conditions, of releasing dioxin, the alarming question arises whether, and to what extent, dioxin is being released into the environment through the atmosphere. Pentachlorophenol, used in certain herbicides, is readily decomposed in sunlight, and in its breakdown process a number of products, including chemical precursors of chlorodibenzo-*p*-dioxin compounds, are produced. Because of these factors, a whole range of pesticides, as well as of herbicides, now must come under suspicion of producing dioxin compounds.

Although the chemical companies that manufacture 2,4,5-T have long taken pride in pointing out that 2,4,5-T itself is quite readily decomposable in soil, the crucial matters of how stable the dioxin contaminant is and to what extent it is cumulative in animal tissue have apparently been neglected. Consequently, the fact that traces of compounds virtually indistinguishable from dioxin have already been detected in this country in the human food chain—in the livers of chickens and in edible oils—clearly indicates that dioxin should be considered a hazard to man. Why, under all these inauspicious circumstances, the production and the use here and in Vietnam of 2,4,5-T has not summarily been stopped by the United States government is hard to understand.

Sincerely,

THOMAS WHITESIDE.

Appendix 4

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,
PUBLIC HEALTH SERVICE,
FOOD AND DRUG ADMINISTRATION,
Rockville, Md., March 12, 1970.

Hon. RICHARD D. MCCARTHY,
House of Representatives,
Washington, D.C.

DEAR MR. MCCARTHY: The Secretary has asked us to reply to your letter of February 3, 1970, requesting whether the Food and Drug Administration has

concluded that 2,4,5-T is now safe to use.

No tolerances have been established for residues of 2,4,5-T in food or feed crops. The whole matter of the safety of this herbicide, when its use results in a residue in or on a food crop, is currently under evaluation. This evaluation will be completed as expeditiously as possible. We are enclosing a Fact Sheet explaining the status of 2,4,5-T at this time.

We shall promptly inform you of our decision upon completion of the evaluation of 2,4,5-T.

Sincerely yours,

M. J. RYAN, *Acting Director,*
Office of Legislative Services.

FDA FACT SHEET

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,
PUBLIC HEALTH SERVICE,
FOOD AND DRUG ADMINISTRATION,
Washington, D.C.

* 2,4,5-T *

2,4,5-T (2,4,5-trichlorophenoxyacetic acid) has had extensive registered use as a defoliant and weed killer. It has also been registered by the U.S. Department of Agriculture as a pesticide chemical (herbicide) on a no residue basis on a few certain selected food crops for some years, primarily for weed control of pasture and rangeland.

TOXICITY

A research study recently completed under contract to the National Cancer Institute on a commercial lot of 2,4,5-T showed that the feeding of this material to rats and mice produced abnormal birth effects on the embryos.

Further investigation of the 2,4,5-T used in the feeding studies established that the material used contained a significant amount of one of more impurities called dioxins produced during the manufacture of 2,4,5-T. Improved manufacturing processes are claimed by one manufacturer to have reduced the dioxin impurities to insignificant amounts.

The dioxins are of concern because they are known to be extremely toxic to poultry and to have produced severe skin irritation to workers in plants exposed to dioxins inadvertently during the manufacture of other chemicals. At present a number of research studies are underway in both government and commercial laboratories to determine if the reported birth defects of the earlier study are due to 2,4,5-T itself, the dioxin impurities, or a combination of the 2,4,5-T and the dioxins.

Additional investigations are underway to improve our ability to detect very small amounts of dioxins in samples of 2,4,5-T and to determine whether other commonly used pesticides chemically related to 2,4,5-T contain significant amounts of the dioxin contaminants. Drinking water supplies are being tested for the presence of 2,4,5-T and other possible environmental sources of these chemicals studied, but no results are available at this time.

The USDA announced on February 6, 1970, that it is investigating 17 commonly used pesticides chemically related to 2,4,5-T to determine whether they contain hazardous amounts of these toxic contaminants.

FOOD IN THE UNITED STATES

The Food and Drug Administration is continually engaged in examining samples of individual foodstuffs for residues of pesticides above the safe tolerances established under the Miller Pesticide Amendment. In addition, FDA purchases food in the markets of several cities, prepares the food in the quantities and combinations typical of the diet of an average 19-year-old male, and determines the amounts of the several pesticides that might be actually ingested in the typical diet of a heavy eater.

Of 5360 food samples tested for 2,4,5-T residues during the last four-year period, 25 samples indicated trace amounts (less than the 0.1 p.p.m. limit of accuracy of present analytical procedures) and 2 samples showed higher residues. 0.10 p.p.m. 2,4,5-T was detected in one sample of milk taken in 1965 in New England, and one sample of sugarbeets from Ohio in 1966 showed 0.29

p.p.m. 2,4,5-T. The milk had been distributed before analysis was complete and processing of the sugar-beets removes the chemical. If food is found to contain finite residues of 2,4,5-T, it is subject to removal from the market.

STATUS OF 2,4,5-T UNDER THE FEDERAL FOOD, DRUG, AND COSMETIC ACT

No finite tolerances have been established for residues of 2,4,5-T or the dioxins in food. In the absence of established tolerances any detectable amount of either chemical in food would make the contaminated food illegal and subject to seizure if found in the channels of interstate commerce.

A petition was filed in December, 1967 requesting the establishment of tolerances of 0.2 p.p.m. for residues of 2,4,5-T on apples, barley, blueberries, corn, oats, rice, rye, sugarcane, and wheat. Neither the petition as originally submitted or as later supplemented provided data to support affirmative action and the petitioner withdrew his petition on December 29, 1969, as provided for under the pesticide regulations.

Petitions to establish a safe tolerance level for residues of 2,4,5-T in food may again be submitted to the FDA in the future. However, any such submission must include scientific research data to resolve the questions that have been raised concerning toxicity of 2,4,5-T and the dioxins.

CONCLUSION

The Department of Health, Education, and Welfare is continuing investigations to determine the potential hazards from the possible presence of residues of 2,4,5-T and dioxins in foods, water, and other environmental sources to which the public may be exposed.

It is to be emphasized that there is no tolerance for 2,4,5-T in food today; the testing of food over the past several years has revealed no significant problem of food contamination.

Appendix 5

PROBE INTO USE OF HERBICIDES BY CONGRESSMAN RICHARD D. MCCARTHY, D-N.Y.

Globe, Ariz., February 13, 1970

Ladies and gentlemen, I think we should begin. I am Congressman Richard D. McCarthy, and the hearings will come to order.

For more than a decade scientists have had serious misgivings about the widespread use of herbicides and pesticides in the environment. The late Rachael Carson warned of the risk of the use of herbicides, whose effects were either harmful or unknown.

In the United States 120 million acres each year are sprayed with herbicides for the clearing of railroads, for brush control, for watershed management, and for other purposes. One of these is known as 2,4,5-T. It was developed and perfected at Fort Detrick, Md., the army's chief Biological Warfare Research Center. The herbicide 2,4,5-T, and 2,4-D, a related herbicide, collectively account for some 83 million pounds of production per year—that was the figure in 1968.

I've long been concerned with the widespread use of these herbicides in Vietnam. Each day some 100 tons are dropped on South Vietnam, and scientists for many months have been concerned about the adverse ecological effects of this herbicidal inundation.

Last summer in the course of my inquiry into the Army's germ and gas warfare policies, I learned that a study, by the Biometrics Research Laboratories for the National Cancer Institute showed that the herbicide 2,4,5-T produced birth defects in rats and mice.

When the conclusions of this study were known, the President's science adviser, in October, announced a ban on the herbicide beginning January 1, 1970, unless the F.D.A. had found safe legal tolerances. I was distressed 11 days ago to learn that contrary to the White House's announcement, the Department of Agriculture continues to authorize the use of 2,4,5-T in the United States. It's incredible to me that someone, or some people should have succeeded in overruling the science adviser to the President of the United States.

We know from the thalidomide experience that if we are going to err, we should err on the side of caution, and not on the side of danger. It is my firm conviction that such chemicals should not be used unless full tests show that they are safe. It is also incredible to me that this herbicide, which has been in existence since its development some 23 years ago at the Germ Warfare Research Center, still has not been fully tested for its teratogenic effects on human beings—that is, its power to produce birth deformities.

We know that it produces birth deformities in test animals under laboratory conditions, and we continue to receive reports from Vietnam that civilian women living in this heavily defoliated area are bringing forth deformed offsprings.

The Saigon Press has reported on these in considerable detail.

Now, we have the allegations, and complaints emanating from here, Globe, Ariz. It is my hope that my investigation into these complaints and allegations will assist me in continuing my inquiry into this whole matter. I wish to determine how the White House was overruled, and why it is that we continue to use this herbicide despite the warning signals that have arisen.

As the great French scientist physiologist, Claude Bernard, once said, "True science teaches us to doubt, and ignorance to refrain."

I want to welcome all the local State and Federal officials who are in attendance. I hope to have a chance to meet with you personally during our visit.

Our first witness is Prof. Arthur W. Galston, a professor of biology from Yale University.

Doctor Galston.

Professor Galston, I wonder if, for the record, you would identify yourself, and your background, and particular expertise in the matters under inquiry.

Dr. GALSTON. Very happy to do that, Congressman.

I'm currently a professor of biology at Yale University. I'm also lecturer in forestry, and director of the March Botanical Gardens at Yale. I've been a professor of plant physiology for about 27 years. I was trained at the New York State College of Agriculture at Cornell University.

I did my graduate work at the University of Illinois, where I earned a Ph.D. degree in 1943. I then went to work for the emergency rubber project for the U.S. Government, located at Cal-Tech. During World War I was agricultural officer for U.S. Navy Military Government on the Isle of Okinawa. I then worked at Cal-Tech for 10 years, and I've been at Yale for the last 15 years.

I've published books in the area of plant physiology, and I have over 100 articles in the subject.

Congressman McCARTHY. For the record, Doctor Galston, I wonder if you could give us a scientific information about the herbicide under investigation.

Dr. GALSTON. Congressmen, what I'd like to do is to give you and the audience here some appreciation of the feeling of a large number of scientists as exemplified in this report recently delivered to the Secretary of Health, Education, and Welfare, Finch.

It is called, "The Report of the Secretary's Commission on Pesticides and Their Relationship to Environmental Health." It's dated December 5, 1960, and was prepared by the distinguished panel shared by Doctor Emil Mrak, the chancellor emeritus of the University of California at Davis.

It included many academic people, and also the vice presidents of two important companies, Dow, and Eli Lilly, both of whom manufacture herbicides and other pesticides in wide use.

The Commission takes note of the fact that there are now more than 400 different kinds of chemicals which are being used as pesticides to combat insects, fungi, weeds, and other predators.

Our modern agriculture and highly technicalized food production activities demand that we do use chemicals in agriculture.

I'd like to make it clear that I'm not alining myself with people that say, "Stop all chemicals." That's ridiculous in this day and age. We are dependent upon chemicals, and we have to keep using them.

Nonetheless, some of these chemicals are terribly noxious when introduced into the environment.

All of us are now familiar with the fact that DDT may be more of a bane than a boom. It has become global. Even a penguin picked up on an ice flow in Antarctica is full of DDT, and that was 400 miles from the application of

DDT, and we know that DDT causes oversized livers, and alteration of the steroid metabolism in everyone's genes.

This Commission agrees unanimously that DDT must be phased out as quickly as possible as a pesticide.

With that as a background, I think it's perfectly clear that as scientific information develops, we are going to want to examine every pesticide for its possible harmful effects on man and his domestic animals, and his environment.

Here I must digress to tell you about the changes that have occurred in our concept of what constitutes adequate testing for a compound of this kind.

It used to be that simple toxicology tests were conducted. A laboratory animal, such as a mouse or a rat was fed a certain amount of chemical. If that animal showed serious symptoms, the teratogenicity was calculated on the base of how many milligrams per kilogram of body weight of this material produced the toxic effects.

We now have tables which tell us roughly how toxic given materials are.

Now, based on that kind of test, 2,4,5-T, for example, is not terribly toxic, it's only a mildly toxic compound in the order of 2 to 700 kilograms milligram of body weight cause toxicity.

If, however, you use more subtle tests, you find out that 2,4,5-T may be more dangerous.

Among these tests are: Does the compound cause cancer? That takes a much more serious look than simply feeding and watching the dying of animals.

Secondly, do the compounds cause genetic effects, that is, does it break chromosomes, or cause mutations.

Thirdly, does the compound cause birth abnormalities. The word to describe that is teratogenic; that is the formation of monsters.

Now, this report which I have alluded to has as its last chapter, a chapter on teratology, and I'd like to read you just a little bit out of this chapter, and out of the summary which is written here, which gives you my concern.

"All currently used pesticides should be tested for teratogenicity in the near future in two or more mammalian species chosen on the basis of the closest metabolic and pharmacologic similarity to human beings possible. Pesticides should be tested at various concentrations including levels substantially higher than those to which the human population are likely to be exposed. Test procedures should also reflect routes related to human exposures. Apart from the obvious route of ingestion, attention should be directed to other routes of exposure, including inhalation exposures from pesticide aerosols and vaporizing pesticide strips used domestically, and exposures from skin absorption. Parenteral administration is an appropriate test route for pesticides to which humans are exposed by inhalation, or for pesticides, which are systemically absorbed following ingestion.

"The use of currently registered pesticides to which humans are exposed and which are found to be teratogenic by suitable test procedures in one or more mammalian species should be immediately restricted to prevent risk of human exposures."

I'd like to repeat that: "Currently registered pesticides to which humans are exposed and which are found to be teratogenic by suitable test procedures in one or more mammalian species should be immediately restricted to prevent risk of human exposure. Such pesticides, in current use, include—" I'll skip a lot of names, 2,4-D and 2,4,5-T are listed.

Here's the Government's most distinguished panel saying that there is evidence that 2,4,5-T has produced teratogenic effects in one or more mammalian species, its use should be restricted immediately. They also said no new pesticide found to be teratogenic, should be used only in circumstances where risk of human exposure is minimal.

Congressman McCARTHY. What's the date of that report, Professor?

Dr. GALSTON. December 5, 1969, it's now only 2 months old, Congressman, and it says a scientific group, or commission should be charged with the responsibility for continued surveillance of the whole problem of pesticide teratogenesis.

Now, the problem of determining whether a problem is teratogenic, whether it's given rise to birth defects is terribly complicated. If you do a laboratory test where you have one group of mice getting the chemical, and one group not, there's no problem to determine teratogenicity. By this kind of test it has been determined that 2,4,5-T as tested is one of the most teratogenic chemicals

known. Even as little as $4\frac{1}{2}$ milligrams per kilo of body weight have trebled the rate of abnormal production in mice and in rats a 118 milligrams per kilo of body weight has produced 100 percent abnormal litters, and 70 percent abnormal individuals in those litters.

Congressman McCARTHY. I wonder if you could translate those figures into what a human being would be likely to receive in the United States, or in Vietnam.

Dr. GALSTON. Well, if you take the lowest of those figures, $4\frac{1}{2}$ milligrams per kilogram of body weight, and you say you have a 50-kilogram woman, that's 110 pounds which is about the average weight of a Vietnamese woman, then she needs to digest only about 200 milligrams total to have a teratogenic dose, 100 milligrams per day. Now, we are spraying agent orange, which is a 1 to 1 mixture of 2,4-D, and 2,4,6-T, in Vietnam at the rate of 270 pounds per acre. I should note that is 10 times what we used locally.

Congressman McCARTHY. What would it be in Arizona?

Dr. GALSTON. I think our Forestry friends could tell us, it is in the order of two pounds per acre.

Congressman McCARTHY. We will get to that with them today or tomorrow, but that's about the range?

Dr. GALSTON. At the Vietnam dose rate, if you assume a 27-pound per acre sprayed, followed by a 1-inch rainfall, which is normal for that region and you know that the rainwater is collected off the roof, or stored in cisterns, or gotten from very shallow wells, then a woman need only consume less than 3 quarts of water per day in combined drinking and cooking operations to receive that teratogenic dose.

I have calculated on this basis that it's possible that in Vietnam people have been given this kind of teratogenic dose.

Congressman McCARTHY. Doctor, let me ask you this. Here we have the Biogenetics Research Laboratory test which showed that 2,4,5-T is teratogenic in test animals, mice and rats. Is it teratogenic in human beings—do we know?

Dr. GALSTON. One doesn't know for sure whether it's teratogenic in human beings, one doesn't experiment with pregnant women, feeding some of them 2,4,5-T, and not feeding others. That would be inhuman, we do not tolerate that kind of experimentation, but the paragraph I was about to read here in fact deals with this.

It says there are two ways that you can determine whether a chemical is teratogenic. "First, chemicals or other agents may be administered to experimental animals to determine whether they induce prenatal damage. Secondly, and on a post hoc basis, human populations may be epidemiologically surveyed to detect geographical, or temporal clusters of unusual types of frequencies of congenital malformities. Combinations of these approaches are likely to insure early detection and identification of teratogenic hazards."

Congressman McCARTHY. Now, to your knowledge, has that been done in Vietnam, or is it contemplated, is the American Association for the Advancement of Science going to do what you just read?

Dr. GALSTON. I think it's shocking that there are absolutely no studies on the possible teratogenicity of these chemicals either in Vietnam or in this country. That is why it's so important to gather data from places like globe, and from places like the Saigon area to attempt to correlate, if it's possible to do so, the use of any particular pesticide with the appearance of any birth abnormalities, or any physiological malfunctions.

Congressman McCARTHY: Doesn't the commission's study recommend that no herbicides like this be used until we are sure that it doesn't produce effects in human beings?

Dr. GALSTON. That's correct, the Commission recommends that given the suspicion that these materials are teratogenic, given their widespread use, but given also our wide dependency on these things in agriculture, we should immediately restrict the use so that we only use these herbicides where it is absolutely necessary to do so, and where there is no possibility of contact with human organisms. I believe that is the safe policy when you think you may be doing harm. You stop until you find out whether you are in fact doing harm.

Congressman McCARTHY. Do you have any information that you could give for the record here, which would suggest why The White House ban never went into effect? I have a letter here which I received just prior to leaving Washington, which needs further clarification. It is from Mr. Ned D. Bayley, director of science and education for the Department of Agriculture in

response to a letter I'd addressed to Secretary Hardin, asking why The White House ban didn't go into effect. Among other things, here's what he said. "Now, data submitted to D.H.E.W., Department of Health, Education, and Welfare, relevant to this position is that the 2,4,5-T used in the bionetics study contained about 27ppm of—"

Dr. GALSTON. Dioxin is the way it's usually referred to.

Congressman McCARTHY. It's t-e-t-r-a-c-h-l-o-r-o-d-i-b-e-n-z-o p-a-r-a dioxin

Dr. GALSTON. Tetrachlorodibenzo para dioxin.

Congressman McCARTHY. A highly toxic contaminant.

Dr. GALSTON. Yes.

Congressman McCARTHY. I'm going to seek further clarification that one of the reasons the ban was lifted was this discovery. Now, do you know anything about this in the course of your inquiry?

Dr. GALSTON. Yes, Congressman, I became aware of this new development—2,4,5-T is a chemical synthesized from the reactants that are put together in a vehicle. Depending on the method of synthesis, and the temperature of synthesis, you may or may not get certain impurities formed in that reaction that accompany the 2,4,5-T which is realized out of the reaction mixture. One of the impurities is tetrachlorodibenzo-p-dioxin.

Now, there's previous information that this compound is a highly noxious material. There have been several factory and laboratory accidents in which people exposed to this compound have developed very severe blistering, loss of sensation, and respiratory troubles. The Germans have had a similar experience.

So it's natural when you have a report of this kind about the toxicity of 2,4,5-T, to inquire whether the effect is due to the chemical itself, or to the impurity.

Congressman McCARTHY. Does it matter?

Dr. GALSTON. I'll make this statement.

I think it does matter in the long run, Congressman, because if it's the impurity, then in the future we can learn possibly how to make the chemical without the impurity, and continue its use.

Congressman McCARTHY. I've read in the long article by Mr. Whiteside in the latest issue of New Yorker Magazine, at least he made the point that you can't make 2,4,5-T without getting some dioxin.

Now, is that right?

Dr. GALSTON. That's correct, I don't know if any sample that has less than a part per million of dioxin, so all of the 2,4,5-T that has been sprayed both at home and abroad has some dioxin.

The question is: Can you lessen the dioxin level down to the point where it is no longer so dangerous?

Congressman McCARTHY. Is there any other way that dioxin can be produced after it's sprayed?

Dr. GALSTON. Oh, yes, even if you sprayed 2,4,5-T without any dioxin it might form chemicals in this Arizona sunshine. Putting all that light energy in I could easily imagine compounds like the dioxin being formed.

If there were a little fire somewhere, that's just the condition which would form the dioxin from 2,4,5-T. The only hard data on the teratogenicity of 2,4,5-T are right in this book that I have. There are no data which tell me, or anybody else, that it's the dioxin and not the 2,4,5-T that's responsible for these teratogenic effects.

I've had telephone conversations with people who have alleged this,—

Congressman McCARTHY. Who are they?

Dr. GALSTON. Well, one of them is a member of this Commission, Doctor Julius Johnson of Dow who is an old friend of mine, and I think he is very terribly concerned about this development. Naturally, he would be since Dow is the manufacturer of some of this, and he told me that there are tests going on now which are not finished. He said he would not care to quote the data as of the present moment.

Congressman McCARTHY. Mr. James Hansen of the Dow Chemical Co. visited my office last week and alluded to, I assume, the same tests.

Dr. GALSTON. Yes.

Congressman McCARTHY. That the Dow Co. itself was carrying out the following-up on this possibility that it is the dioxin.

Now, in this letter from Mr. Bayley he said new data submitted to D.H.E.W. indicated that the 2,4,5-T contained the dioxin.

Well, it sounds as if it's the same thing. What I don't understand is how the Dow Chemical Co. could, in effect, by intervening, countermand, or negate White House orders.

Now, have you discussed this with any other people in the Government, or outside the Government?

Dr. GALSTON. I have not, Congressman. I don't have any information on how this operation came about. I would only say that to me it's unthinkable that, in absence of hard data, and to protect the lives and welfare of people in the country, I don't see how this order could fail to be enforced.

We must be safe before we are sorry. I would say let's get the facts before we resume spraying with this 2,4,5-T and at the present time there are no published data that I, or any other scientists have seen, that would say that 2,4,5-T is not the culpable agent. I think it's very peculiar that the orders of Doctor DuBridge are not being followed by the Department of Agriculture and the Department of Interior. The Department of Defense, said it announced immediately it would not follow this directive.

Congressman McCARTHY. That's right. The next day on October 30th, the spokesman for the Department of Defense contradicted the DuBridge order in a verbal briefing to newsmen. He said that the 2,4,5-T would continue to be sprayed in training and regroupment areas where obviously populated areas, and of course as you know it has been sprayed in rubber plantations in Cambodia, which are also populated.

Well, Professor Galston, I appreciate very much your testimony here.

Dr. GALSTON. Do you mind if I make one more brief statement?

Congressman McCARTHY. No, please do.

Dr. GALSTON. As a biologist, I'm terribly concerned about this because I believe in herbicides, I want to see that they continue to be used. I'm afraid there may be overreaction on the part of the public. I would like to say that there are probably ways that we can safely use these compounds, and the first recommendation of this Commission—I would like to read you just two paragraphs, short ones, because they outline to me what would be a safe procedure.

It says: "A new interagency agreement is needed to strengthen cooperative action among the Department of Health, Education and Welfare, U.S. Department of Agriculture, and the U.S. Department of Interior, to protect public health, and the quality of environment from pesticides danger provided by the Secretaries of H.E.W. and Interior, as well as Agriculture, should be required for all pesticides registration, pesticide use determined by any of the three Secretaries to be hazardous should be restricted, or eliminated.

"The agreement should further require the continuous review of new scientific information on pesticides now in use with the formal reviews made 2 years after initial registration, and subsequent formal reviews by the three agencies at 5-year intervals."

That seems to be loudly, essential for the continued safe use of pesticides and it's coupled with the establishment of a national testing center for pesticides, which is also recommended, I would say that we would be well on our way for the safe use of pesticides.

Congressman McCARTHY. Do you think it's proper to delegate to the manufacturer of such a chemical the responsibility for testing its teratogenicity and carcinogenicity?

Dr. GALSTON. Well, you can certainly accept the data that are contributed by the manufacturer as relevant to the solution of the problem. I think these people have shown necessary testing laboratories which give honest data, but I would not depend on those alone. I would want to see the FDA or some other agency independently test these same compounds also, under completely different conditions. That's only a scientific rule, you don't believe anything anybody tells you, it has to be confirmed once or twice before you can believe it.

I would certainly hope the FDA, or some other agency, HEW would continue conducting further tests on these toxic chemicals.

Congressman McCARTHY. And not really solely on the research of Dow, or other manufacturers?

Dr. GALSTON. That's correct.

Congressman McCARTHY. Professor, I wonder if you would be kind enough to sit with us here, I'd like to use you as a resource person when we have the other witnesses.

Our next witness is Mr. John Pierovich, Assistant Regional Forester, from Albuquerque.

Is he in the room?

If you would be seated and identify yourself for the record, and your responsibilities in areas under scrutiny here.

Mr. PIEROVICH. Yes, sir, I'm John Pierovich, Assistant Regional Forester in Albuquerque, N. Mex. My responsibilities related to this matter are in connection with the complaints we've received here at Globe, and the overall evaluation of our Chaparral program, and our Chaparral program guidelines.

The primary reasons the Forest Service is here today is because this is a Forest Service project. I think that we need to be cognizant of such hearings as this, and we do try to keep informed through the literature of regulatory rules and concerns.

In fact, we share quite deeply the concern of the people in this community with their environment, we wouldn't want to do anything that would jeopardize their safety.

They're our neighbors, we also live here.

At the same time, we've been asked repeatedly to announce that we would not spray again in the Globe area, and like Doctor Galston, I think that we wouldn't want to overreact at this time. So we've said that such an announcement would be premature, we have our own studies going forward, and that these studies must be resolved before we can reach decisions on herbicide's use, or on the Chaparral program.

In addition to that we believe that it would be also unwise to base decisions on herbicides used particularly from the current allegations, or suspicions here in this area.

These matters need to be studied deeply, and we hope to have them studied deeply, and frankly welcome this inquiry because it will help to daylight some of the areas of concern.

That's essentially our position, Mr. Congressman. I'd be glad to answer any questions you might have.

Congressman McCARTHY. Thank you very much.

In the course of my study, I have come into possession of documents that have been exchanged between the Department of Agriculture and citizens in the area. Here is one from John A. Williams for the Task Group, U.S. Department of Agriculture, Forest Service. Are you familiar with Mr. Williams?

Mr. PIEROVICH. Yes, I am.

Congressman McCARTHY. Is he an associate of yours?

Mr. PIEROVICH. He works in our regional office.

Congressman McCARTHY. Is he here today?

Mr. PIEROVICH. No, he's not.

Congressman McCARTHY. I'd like to read you some of the things that he says: "Paul Boffin (phonetic) called a Dow Chemical representative at Davis, Calif., and requested information about Silvex. This man called Supervisor Courtney later and indicated that a publicity release was being prepared for submission to the news media concerning the known toxicity of Silvex. This if accepted and used by the news media will go a long ways towards improving the situation, and dispelling the fear of Silvex as a highly toxic, or poisonous agent."

He then goes on to say in his conclusions, "We are fully convinced that many of the people in this area honestly believe they were being subjected to a highly toxic and extremely poisonous compound with a high degree of persistence and one which would increase in concentration in the water supplies, and in the bodies of humans, and animals. These ideas are not in any way supported by research findings."

Now, that is dated July 22, 1969, and if I just would ask Professor Galston when was the Bionetics study brought to light?

Dr. GALSTON. It was handed over to the Department of Health, Education, and Welfare in December of 1968, to the best of our knowledge.

Congressman McCARTHY. So that to the best of your knowledge, the Department of Agriculture—

Dr. GALSTON. Might have had access to that information.

Congressman McCARTHY. Actually, the tests were run in 1967. Now, Mr. Williams obviously either did not know about the Bionetics report, and I would—I would accept that, I don't think he did just from the tone of the letter, but I'll ask you to comment—

Now, which do you think it was?

Mr. PIEROVICH. First of all, Mr. Williams was heading a group for a general survey of the effects here in the Globe area at the request of the Forest Supervisor, and after the initial complaints. We've had subsequent studies go forward, one of these coming out as a second task force report which is somewhat more in depth. Mr. Williams' information was then of a general nature for an initial report for the forest supervisors. Williams himself is not an herbicide man. Mr. Boffin is, and his reason for talking with the Dow was to get more information.

The second question you've asked regarding the Bionetics study was not known to these people, and only known to a few people within the Forest Service but the word of mouth communication that took place following the review of the Bionetics study for publication.

This has precipitated a lot of discussion among the science community, and in the —

Congressman McCARTHY. Are you alluding to the Whiteside article in New Yorker Magazine?

Mr. PIEROVICH. No, that's the most recent and clarifying article, at least I found it very informative.

Congressman McCARTHY. When did you first learn about the Bionetics findings on teratogenicity?

Mr. PIEROVICH. I personally learned about it in November when I was assigned to this problem area, and I learned about it through reading in the literature, seeing the discussions among others.

Congressman McCARTHY. Was the present science advisors ordered ban ever transmitted to you, or here in the area?

Mr. PIEROVICH. We were furnished a policy statement from the Secretary of Agriculture in December which referred to the DuBridge statement.

Congressman McCARTHY. Did you take that as a directive not to continue using 2,4,5-T?

Mr. PIEROVICH. We understood it to be directed towards crops, and that it was not at that time being restricted in range-land use. However, we could infer from this, and from discussions with our Washington counterparts, we learned that there were other studies underway on this compound, and as you perhaps have noted, we did defer our chaparral program in October. The last spraying on this project was in June, and these events have unfolded since that time.

It's currently our position here in this region not to use herbicides until some of these matters are researched. The studies that are underway should be most helpful to us in this regard.

Congressman McCARTHY. I think there's a little confusion about just what the DuBridge announcement banned. Doctor DuBridge said—this is October 29, 1969.

That 2,4,5-T would be prohibited for use on American agricultural products after January 1, 1970, until the Food and Drug Administration could develop information showing that it could be used with safety.

Dr. DuBridge also announced that the use of 2,4,5-T in Vietnam would be restricted in areas remote from population.

Mr. PIEROVICH. This is where we found our references to the crop production area, and the Secretary has interpreted this way. As I said the ban on crops is in effect at this time, and as near as we can tell we are also examining the future of the 2,4,5-T as it is compounded today.

Dr. GALSTON. Congressman, could I make a comment here?

Congressman McCARTHY. Yes.

Dr. GALSTON. I was unable to understand why when Dr. DuBridge issued this statement he did not also take care to specify prohibition of use in regions where 2,4,5-T might find its way into drinking water. For example, supposing you are using 2,4,5-T to clear shrubs from under a power line, and that power line is going through a town where people have wells, and they draw water from these wells. Don't we need to know if the 2,4,5-T is going to seep down in the water cable and get to these people? It seems to me applying the ban to the food crops is only a halfway measure.

Mr. PIEROVICH. I think we need to be concerned by this, and this is why we monitor water from treatment areas. It's significant in this Globe area. Our reference—or the Federal water quality control criterion of one-tenth part per million, this level has never been reached in any of the water analyzed that we've had run, or had been brought to our attention.

Congressman McCARTHY. You say you received the directive November—

Mr. PIEROVICH. We received the Secretary's explanatory information in December as I recall.

Congressman McCARTHY. Were you ever advised that the ban had been suspended?

Mr. PIEROVICH. No, sir.

Congressman McCARTHY. So the last you had was the DuBridge directive?

Mr. PIEROVICH. Yes, and a statement from our Secretary to agriculture agencies of which we are, telling us that 2,4,5-T was not to be used in crops, and incidentally, the Secretary has added to his statement that we would use alternative methods whenever these are available and practical, and is stressing within the department a use of nonchemical means where these are available to us.

Now, this is all developments since the last spraying here at Globe, I hope this is clear.

Congressman McCARTHY. Are you spraying in other parts of your region?

Mr. PIEROVICH. No, sir, and we have no plans to spray during current, or the coming fiscal year at this time.

Now, if we have some break-throughs, I'm sure we will be talking about this. Again, it would be premature to say.

Congressman McCARTHY. What's the basic rationale behind the spraying here at Globe?

Mr. PIEROVICH. You mean—

Congressman McCARTHY: What's the purpose of it?

Mr. PIEROVICH (continuing): The purpose of the project. This is the part of the region, and the Tonto National Forest chaparral management program. This program has many objectives for—if I may take a minute—fire is a very common ingredient in the life history of chaparral, and in trying to bring management to Chaparral Forest, we have excluded fire, or we are using fire by prescription, rather than have the chance of holocaust. In doing this, we attempt to bring a break to the fuels in large continuous masses by developing grassy ridge tops, or grassy openings. These have other advantages for people who want to use the forest, and for game.

It happens that the project here in the area was a water-yield project. We have learned through research at the 8-Bar experimental area, and particularly that we can substantially reach the flow of streams, particularly in the winter months where the vegetation is not using the amounts of water that chaparral vegetation does.

Now, herbicides were used here at Globe partially because of the known flooding potential of these streams, and that they also know that fire over a large area could cause floods. So rather than use prescribed fire as initial treatment, herbicides were used.

We have plans to use some small amount of fire to continue our work here.

Congressman McCARTHY. Doesn't it say right on the container that this should not be used over water?

Mr. PIEROVICH. That's correct, and as the project instructions were followed here, the applicator pilot was to interrupt his spray everytime he passed a major stream channel.

Congressman McCARTHY. "Interrupt his spray," you mean from a helicopter?

Mr. PIEROVICH. From his helicopter, yes.

Congressman McCARTHY. Do you think that is that the answer?

Mr. PIEROVICH. Well, I think it's quite practical, sir.

Congressman McCARTHY. Well, wind might carry. Aren't there restrictions under the circumstances in which you use it?

Mr. PIEROVICH. First, let me explain in spraying this area the primary pattern would be along, or parallel, or to a water course so that it isn't necessary to turn valves off as you may each time he crosses at the creek. But he was going to be crossing streams at the same time he has been spraying. So he would be than instructed to interrupt the spray before making such a crossing. Some drift did occur into the bayous, we have found some of the Sycamores in the Kellner area, the tops have been hit. We don't feel that a substantial amount of herbicide came to the water course, and the pilot was instructed not to apply this over water.

Water residues again haven't indicated any great amount of the herbicide in

Congressman McCARTHY. Are they instructed only to spray when the wind is blowing at a certain mile per hour?

Mr. PIEROVICH. Yes, that's right.

Congressman McCARTHY. What is it, eight?

Mr. PIEROVICH. In some projects it's 5-miles per hour, in this case it was 10.

Congressman McCARTHY. Ten?

Mr. PIEROVICH. Yes.

Congressman McCARTHY. Is that rigidly adhered to?

Mr. PIEROVICH. Well, I would hope that it is, here we are depending on other people to do our work, but we have a project area officer, and this project had a project area officer who works from the helispot where the copter is operating, using a pocket anemometer, and as he noticed the wind picking up he would take the pocket anemometer out and keep track of the gusts. Whenever it approaches 10-miles per hour, the project would be shut down.

I have records here with me of the shut-down on this project, if you are interested.

Congressman McCARTHY. You are undoubtedly aware that some of the residents in the area charge that spraying went on in much stronger wind velocities?

Mr. PIEROVICH. Yes, sir, I am, and I am aware that there has been drifts, and we are attempting to identify how far this drift went. In the task force 2 report, we identified a visual effects drift line, we are currently working on infrared interpretation, and I would be very happy to furnish you with a map which delineates how far the dead vegetation that shows up. That's not available to see by the naked eye.

Congressman McCARTHY. That would be very good to fill out the record. I would like to have that documentation very much.

Dr. GALSTON. Do you mind if I ask a question at this point?

As a scientist, I'm interested in following up one line of questioning here. The benefits that one wishes to derive from this program has to do with increased water flow?

Mr. PIEROVICH. In part.

Dr. GALSTON. And the other part is, I presume, to have a more accessible and manageable terrain where the Chaparral vegetation is?

Mr. PIEROVICH. That's a good generalization among other things. We would like the esthetic qualities of the area to be an indication.

Dr. GALSTON. Do you see any deleterious consequences of partial denudation of the hillsides where Chaparral is growing?

Mr. PIEROVICH. It's not our intent to denude the hillside.

Dr. GALSTON. I said partial.

Mr. PIEROVICH. In the course of making a conversion, one often has to take a compromise, and we do compromise to the extent that we will—say for example, in burning—taking out an area, we will burn only so long a slope here because any more we would have an overflow of plants and water, and erosion while it is bare from burning, it is an opportunity for a torrential thunderstorm, or wind to cause erosion. But this is also one of the compromises that a farmer must make when he plows his field.

Dr. GALSTON. And this is something you think you can keep under pretty good control with applied herbicides?

Mr. PIEROVICH. In this case we used herbicides for that reason, yes.

Dr. GALSTON. Was there any measurement for the relevant erosion rates before and after herbicide use in a given area?

Mr. PIEROVICH. In the 3-Bar area this is being noted at this time. The studies have been in progress for some time, I don't have those data with me, but I could find them for you.

Dr. GALSTON. I, personally, would be very interested in having those data. It's been my impression that some programs have been gone into fairly massively without the comfortable feeling that there's a lot of scientific data behind the original studies to tell us that this is really what we ought to do, and in calculating returns per acre, in terms of where we've applied. I think we have to have a negative quantity in there for possibly deleterious effects, that possibly are not measured.

Congressman McCARTHY. I'd be eager to see those.

Mr. PIEROVICH. I'd be happy to furnish them for you. I think something we have going right now, you may notice in the statement we've furnished you,

we are looking at alternatives, and tolerable levels, and we are approaching that very thing using projects that have been installed as a basis for arriving at this.

Congressman McCARTHY. On that I wonder if I could ask you, are you now giving licenses for the use of Kuron?

Mr. PIEROVICH. We give no licenses for chemical uses. The answer would be no.

Congressman McCARTHY. I see. From whom do they get these licenses?

Mr. PIEROVICH. The use of chemicals is done by—in our case, the approval of a project proposal by a regional and national pesticide committee. Once the forest officer who has a project wants to apply a herbicide he prepares a formal proposal, it's submitted to our regional committee, if they approve, to a national committee. And I'll tell you right at this point, our committee won't approve such a use, but we don't license.

Congressman McCARTHY. Well, thank you very much.

Will you be available today and tomorrow?

Mr. PIEROVICH. Yes, sir, I will, as will the ranger and the acting supervisor here.

Congressman McCARTHY. Thank you very much.

Our next witness is Dr. F. I. Skinner, veterinarian from Globe.

Is Dr. Skinner here?

Dr. SKINNER. I'm pleased to have a veterinarian testify in light of recent indications that the use of 2,4,5-T spray may have had harmful effects on animal fetuses. I wonder if you would, for the record, identify yourself, your background and experience.

Dr. SKINNER. I am Dr. Skinner, local veterinarian, I've been in the area 14 years, graduate of Kansas State University with a degree of T.B.M.

Now, these are my people, and I've lived amongst them. Now, any questions you'd like to ask I'll try to answer.

Congressman McCARTHY. Would you recommend the use of this Silvex Kuron spray after tests have shown that it has teratogenic effects on animals?

Dr. SKINNER. No, I wouldn't recommend it without further study, further research.

Congressman McCARTHY. You think it should be stopped until—

Dr. SKINNER. Yes, sir.

Congressman McCARTHY. You have some question about the Bionetics findings of the effects of this on animals?

Dr. SKINNER. I'm a clinician, I'm not research. I have not seen any effects of animals in this area—definitely, clinically. Now, as I say I'm not a research, I'm a clinician. I don't set myself up to be an expert on it, but I've not seen any abortions, malformations of fetuses in this area that I can clinically say it was caused by Silvex, or 2,4-D, or pesticides.

Congressman McCARTHY. As I understand it, and we hope to hear from others, that there have been allegations made that the 2,4,5-T sprayed did cause malformation in animals.

Dr. SKINNER. I cannot speak for those, I have not seen them myself.

Congressman McCARTHY. You did not. Were you ever asked to examine the animals in question?

Dr. SKINNER. No, sir.

Congressman McCARTHY. You were not—

Dr. SKINNER. No, sir.

Congressman McCARTHY. So that you just don't know?

Dr. SKINNER. I don't know, I don't pretend to know.

Congressman McCARTHY. All right. Well, maybe they will be calling on you.

Dr. SKINNER. I hope so.

Congressman McCARTHY. Well, thank you very much, Doctor Skinner.

Dr. SKINNER. Thank you, Congressman McCarthy.

Congressman McCARTHY. Our next witness we'd like to call is Mr. Robert McKusiak.

Mr. McKusiak?

Mr. SKOMP. Sir, I represent Mr. McKusiak as an attorney, and he's requested that he be called later. Can you pass him at this time? He wants to pass at this immediate time.

Congressman McCARTHY. Surely.

In that event we'd like to call Mrs. Billee Shoecraft.

Mrs. Shoecraft, I wonder if you'd identify yourself for the record, and —

Mrs. SHOECRAFT. Billee Shoecraft, Ice House Canyon, Globe, Ariz.

Congressman McCARTHY. And if you would tell us a little bit about how long you've lived here, and your own experience with the chaparral spray program?

Mrs. SHOECRAFT. We have been in the area since 1947—Mr. Shoecraft a little longer than that.

Congressman McCARTHY. I wonder if you could tell us about your experiences with the spray program, and some of the correspondence you've had with the various agencies of government in this connection.

Mrs. SHOECRAFT. I'd be glad to, thank you.

We first became aware that they were going to spray a chemical, which they asserted was harmless—

Congressman McCARTHY. You say, "they"—

Mrs. SHOECRAFT. The Forest Service.

Congressman McCARTHY. U.S. Forest Service?

Mrs. SHOECRAFT. Right, in 1965. They had published in the local paper a news item dated August the 19th, 1965, in which they said the herbicide will be 2,4-D, and 2,4,5-T mixed with diesel oil, and water. The diesel oil will serve as a weight factor to insure against wind drift. Neither 2,4-D or 2,4,5-T is harmful to birds, insects, fish, wildlife, or humans.

Congressman McCARTHY. Do you have a date and name on that?

What was the publication, what newspaper is it?

Mrs. SHOECRAFT. From the Arizona Record.

Congressman McCARTHY. Of what date?

Mrs. SHOECRAFT. Of August the 19th, 1965.

I also have the typed-up version when he initiated at that time from which he deleted the word. "I anticipate honest inquiry from many individuals and groups concerning the project. I also anticipate adverse criticism and harassment from those who devote their lives to criticizing and harassing."

I forgot to read the part where he invited the general public to come and see them spray.

If you are as curious as I am, you will want to drive up and watch the operation. I hope you will.

Again, I read from the report No. 16, Georgia Forest Research Council, Macon, Ga., 1965. On page 23 it says, "Possible harmful effects: 2,4-D and 2,4,5-T have a low toxicity, although spray applications leave no toxic residue, a tolerance of five parts per million has been established on or in apples, citrus fruits, asparagus, pears, and quinces. We can find nothing in the Department of Agriculture to back this up."

Then, they further said, "Since some persons may be allergic to the oil in the herbicide mixture, skin contact should be avoided, and when treatments are used a respirator is also a desirable piece of safety equipment."

Congressman McCARTHY. Who is saying this?

Mrs. SHOECRAFT. This is from the Southwestern Forest Experiment Station, Forest Service, U.S. Department of Agriculture, Asheville, N.C.

Congressman McCARTHY. And the day on that, please?

Mrs. SHOECRAFT. The date on this was 1965. It further says—after mentioning the respirator, the odor, or vapors may bring on a case of nausea. The Forest Service Health and Safety cautioned that 2,4-D and 2,4,5-T are mildly poisonous, and flammable in an oil base. However, we were invited to come and see the spray.

Congressman McCARTHY. Do you have any more documents that cast some—

Mrs. SHOECRAFT. Oh, I've many.

I have here this little item that was given to us, there were a few missing pages, it only had four, so I got in touch with Dr. Holston (phonetic) at Belleville, Md., because this is the U.S. Department of Agriculture, and I wondered where the rest of the pages were. So Dr. Holston from Belleville mailed me a package in which was included the rest of it, it totaled 25 pages, and this concerning the toxicity of some organic herbicide to cattle, sheep, and chickens. It tells about some of the things that they found in relation to the herbicides that we've been sprayed with. We don't know exactly because the reports have varied, but they have said they used 2,4-D, 2,4,5-T, and Silvex. They further said it one form, then the tests showed different forms. I quote: "We concluded—that the enlargements were caused by the chemical reaction of the diluted herbicide formulation. The necropsy—the liver was enlarged and viable. The kidneys were congested. A small abscess was found in the parotid

lymph node. In one year that developed a swelling in the region related to the chemical reaction. Associated other lymph nodes of the body were often enlarged and hemologic."

Congressman McCARTHY. Mrs. Shoecraft, I wonder if just for the record, we might just interrupt you briefly. I would like to ask Professor Galston if he would explain the difference between Silvex Kuron, 2,4,5-T, and 2,4-D just for the record.

Dr. GALSTON. These are very closely related materials, and I think from the toxicology point of view, and from the points of view—the presence of any of these impurities like the dioxin we were talking about, they would all be in the same bag.

2,4-D is 2,4-dichlorophenoxyacetic acid, 2,4,5-T has one more, that is 2,4,5-trichlorophenoxyacetic acid, and Kuron is simply a trade name for a similar preparation that I believe is a Dow product.

Is that correct, I don't whether the foresters here would—

Mr. PIEROVICH. Yes, that's correct.

Congressman McCARTHY. Is there anything significantly different between 2,4,5-T and Silvex?

Dr. GALSTON. I would say none whatsoever from the point of view we are talking about. The toxicity would not be due to the length of the chain, but due to the fluorinated aromatic nucleus, as a chemist would call it.

Congressman McCARTHY. Mrs. Shoecraft, I realize you have many documents, and we would like if we could to have any of these you would care to submit for the record.

Mrs. SHOECRAFT. I'd be glad to.

Congressman McCARTHY. Would you, this would help very much.

Mrs. SHOECRAFT. Yes.

Congressman McCARTHY. However, now, if there are any particularly salient quotations that—without being overly lengthy, you think should go into the record at this point, we would like to have those.

Mrs. SHOECRAFT. May I submit Farmers Bulletin Number 2158, U.S. Department of Agriculture, issued April 1961, slightly revised, August 1960, referring to what their rules are on what the wind velocity should be.

Congressman McCARTHY. What does that say?

Mrs. SHOECRAFT. It says, "Apply the spray when the wind velocity is less than 6 miles per hour, and the air temperature is 90° or less. Again use a coarse spray—"

They did not use a coarse spray, they used a fine spray. "Use a slowly vaporizing formulation."

They did not use a slowing vaporizing formulation, they substituted water for oil in a very small amount and released it at very high altitudes on a very hot and windy day, and they kept no records—weather records on the job.

Congressman McCARTHY. Can you substantiate those points?

Mrs. SHOECRAFT. Yes, I can.

Congressman McCARTHY. How?

Mrs. SHOECRAFT. I'm reading from file No. 2520, and it states in this left-hand corner to the file, it's from William H. Moehn, district ranger.

Congressman McCARTHY. How do you spell that?

Mrs. SHOECRAFT. M-o-e-h-n, district ranger, date July 11, 1969, subject: Watershed protection, Kellner Russell chemical maintenance, fiscal year 1969.

This memo is a resume of the fiscal year 1969, maintenance project.

"The spraying done on June 8, 9, 10, and 11, 1969, were started at 6:40 a.m. on Sunday, June 8, and the hilltop located on the Icehouse Canyon Trail, at 6:51 a.m. after the third load was through, the pilot flew to the O.C.C. Camp to check his spray. When he landed Mrs. Shoecraft arrived and told him some of the spray had landed on her. The pilot returned at the hill at 7:14 a.m. and said someone should go talk to her.

"I left the spray job at that time and did not locate Mrs. Shoecraft."

In fact, I called Washington on the third day, but they didn't find me, but they could have if they had looked.

"I left the spray job and we continued to spray from the helispot until 10:57 a.m. when we landed at the helispot the wind was coming out of the East from 6:40 a.m. to 10:57 a.m., we left and went to the Pinal Road helispot and began to spray. We continued to spray until 13:05 a.m., at which time the wind reached 10 miles per hour plus, and we shut down. We resumed spraying

at 5:03 p.m. when the wind dropped below 10 miles per hour and continued on until 7:33 p.m.

"On July 9, the first load was off the ground at 5:35 p.m. We continued to spray until 10:18 p.m., at which time we shut down because of winds in excess of 10 miles per hour. We did not spray anymore on the 9th.

"We started at 6:02 a.m. on June 10, 3 days after Mrs. Shoecraft had notified, and flew until 11:15 a.m., when wind forced us to shut down. We did not spray anymore on the 10th.

"On June 11, we started at 5:18 a.m., and flew until the project was completed. A total of 977 gallons of Silvex was used at a rate of 2 pounds acid, equivalent per acre. The total rate per acre was 8 gallons. 1,000 acres were treated. We did not keep weather records on this project.

"The wind speed and direction at the Globe Ranger Station at 1 p.m., each day of the spray job are listed on the next pages, and it shows on June 11, a speed of 16 miles per hour southwest.

"Signed and stamped by William H. Mochm."

Congressman McCARTHY. So that even in his own records he acknowledges that he exceeded the limits that had been set?

Mrs. SHOECRAFT. Yes, he did. I refer further to the Department of the Army's Circular 33661. I have a letter here from Representative Steiger's office, to apply back in 120 days, but I didn't choose to apply in 120 days. I called the Adjutant General's office, I said we needed it now, I'm one of the victims. I was informed by the Department Office that they sent it out to the printer's. My suggestion was you either get it from the printer's, or you get a copy, I need it now. I received it in 3 days.

In this it refers to the formulation which they call, Orange, and it says that it is one part 2,4,5-T, and one part 2,4-D. I have before me a letter dated October 6, 1960, from the USDA, in Phoenix. The branch of the Forest Service, the Tonto National Forest Service, signed by Mr. Jenkins for Mr. R. E. Cortney, Forest Service. He says:

Dear Mrs. Shoecraft, following is a list of chemicals purchased by the Tonto Forest as requested by you. The mixture was two gallons chemical with seven and one-half gallons per acre. In a few cases more water was used, and all of them are 2,4-D and 2,4,5-T.

Since I was curious because there was no Silvex, I further proceeded to say who bought the Silvex, and I was finally informed by Mr. Moore at Salt River Project they made the decision to purchase the Silvex. They did not purchase it as they said in the Forest Service. They have lied, it's the only word I'd like to use because it's lying when it covers things when they know better.

Congressman McCARTHY. I wonder if you could submit those documents to Mr. Riddleberger for our records?

Mrs. SHOECRAFT. All right.

Congressman McCARTHY. And if you are available we hope to go out this afternoon and tour the area.

Mrs. SHOECRAFT. Be pleased to.

Congressman McCARTHY. Thank you very much.

We would like to move on now and hear from Mr. McKusick.

Mrs. SHOECRAFT. I had requested analysis that were done on our plant back in September before another task force is to arrive, which I understand is next week. I've spoken with Mr. Tschirley this morning, he called, I told him before I wanted anymore samples taken I would like the reports of what they took in September. They seem to be still evaluating these water samples we sent in, and for your information I just learned this morning the samples taken from our own drinking water last week are still highly contaminated, and I suppose I'm the first human to go on record to be able to say that they have now found 2,4-D in my pound of flesh, and that was as of this morning from two different laboratories.

Congressman McCARTHY. That's important, could you elaborate on that? Do you have those laboratory findings?

Mrs. SHOECRAFT. These were found in the G.H.T. Laboratories in California, the other laboratory I'm not even aware of the name where the samples were sent.

Congressman McCARTHY. What's that, G. H.—

Mrs. SHOECRAFT. That's the laboratory where the Department of Agriculture, Doctor Hemton (phonetic) had recommended that the samples be sent on the plant life originally. There will be a longer report on it this afternoon.

Congressman McCARTHY. We will check that out. Did you mean to imply that a biopsy has been applied on your tissues, and 2,4-D has been found in your—

Mrs. SHOECRAFT. As of this morning they were not complete.

Congressman McCARTHY. Thank you very much.

We'd like to call Mr. McKuslak now.

Mr. McKuslak, do you care to be accompanied by counsel? If you do, it's perfectly all right.

Mr. SKOMP. We have no objection.

Congressman McCARTHY. All right. Mr. McKuslak, I wonder would you identify yourself for the record, please, your name and your background, and how long you've resided here.

Mr. McKUSLAK. I'm Robert McKuslak, and I've been an Artist in tile and mosaic for some 22 years. I have a background prior to that time, and since that time also in science. I majored in chemistry in college.

Congressman McCARTHY. What was that?

Mr. McKUSLAK. University of Arizona. I do not hold a degree.

Congressman McCARTHY. How long have you resided here?

Mr. McKUSLAK. I've lived in this area since 1932 with the exception of the time that I attended the University of Arizona.

Congressman McCARTHY. Now, I wonder if you would verbally give us a generalization of your experience with the Forest Service spray program?

Mr. McKUSLAK. My experience with the Forest Service spray program really didn't come into being fully until 1960 following the June spraying. Well, let me back up, it came into being in about May 31, 1963. I was aware prior to that time that they had been spraying, but I was not aware that the things that they were spraying were particularly harmful. I had seen unusual effects taking place, but I didn't know what to attribute them to.

Congressman McCARTHY. What unusual effects, could you cite a couple?

Mr. McKUSLAK. Yes, one in particular which I would prefer that Mrs. McKuslak documented for you because that's her field, and not mine, but specifically in 1966, in May of 1966, the brown pewee population, these are birds that live in our canyon area, suddenly started dying in great numbers in our yard. We have a waterer that birds come to, and there were birds all over during May which had matter in their eyes, and seemed to be having respiratory trouble, and were dying, and at that time we continued spraying it.

Congressman McCARTHY. You don't happen to have any photographs of that, do you?

Mr. McKUSLAK. No, I don't, I would prefer on a discussion of birds to have Mrs. McKuslak go into this because that was her field. But, in 1968, on the 31st of May, I was up at my property where I get my clay, it's private land in the area that was sprayed, it was included in the area sprayed. I had my wife and three children, and the two dogs up there, and the spraying was taking place down canyon. The helicopter came up the canyon, we have a stock pond that was between us and the edge of the property, so to speak, and the helicopter came up the canyon and made a turn southerly, in other words, it made a right-angle turn toward the mountains, and it approached. We were waving our arms because we didn't want to be sprayed. He made a turn and he was so close to us, and the spray descended upon us, and upon the pond, and upon our kids and dogs, and so forth. At that time we weren't really aware that anything was wrong with it except we both rushed home, my wife and I have both had headaches from it.

Congressman McCARTHY. The pond, is that drinking water?

Mr. McKUSLAK. This is a pond which is used for livestock water, but it's on private land.

Congressman McCARTHY. Now, you heard undoubtedly the Forest Service say that they stopped spraying when they would get over a stream, but they didn't over a pond. I suppose that would be obviously important?

Mr. McKUSLAK. It's incorrect that they stopped over streams, they sprayed directly over three different semipermanent streams that I know of, and one permanent.

Congressman McCARTHY. Did you see that yourself?

Mr. McKUSLAK. I saw them spraying in this area over it, and the devastation continues right down to the edge of the stream, it's quite visible.

Congressman McCARTHY. Will we be able to see that this afternoon?

Mr. McKUSLAK. I'm sure you will.

Congressman McCARTHY. I think it's very important.

Mr. McKUSIAK. One canyon in particular in 1968 when I was sprayed with my family on our property, and we did have illnesses and have had illnesses thereafter, continued since this time. This particular little canyon, when they flew up toward us—which has a permanent stream in it, and they flew right up the canyon to the pond, it's a stream that seeps out from the pond, and has never been dry.

Congressman McCARTHY. I wonder if you would, for the record, tell us about changes in livestock, and other animal life on your farm, which you would attribute to this spraying.

Mr. McKUSIAK. I really don't have a farm to correct the record, I have many different animals, my wife keeps ornamental fowl, she is an archeornithologist, and she works with archeological birds, and she keeps files of various types for comparative work, and also for our own enjoyment.

We have 10 or 12 milking goats that we have had for 10, or 17 years. We've kept a small population of them, and in the last 2 years we have had a number of our milk goats bear kids, they have from two to three offspring a year, each goat, and a number of these have borne deformed offspring. When I say deformed, I'm referring generally to their heads, their heads were born misshaped, and malformed in some cases their bodies, but generally their heads.

We have one goat which is already been covered by the news media, but we have one goat which wasn't as malformed as the others. We have kept it alive simply because people were denying such things happening. I would say most of the offspring that were born were born either dead, or deformed, or both. Most of them who were born deformed were born dead. In other words, the animal miscarried deformed offspring.

Congressman McCARTHY. Did you ever ask Dr. Skinner to come out and look at these animals?

Mr. McKUSIAK. No, I don't believe I've ever discussed these animals with Dr. Skinner until just recently, but Dr. Skinner and I are good friends, and we have from time to time called him to ask how much dosage to give an animal if we were going to give them a shot. Some of our animals from time to time have suffered from pneumonia, or things of this type. For example, many of our fowl in birth have died. I'm referring specifically to geese, and ducks, and some chickens, and many of them have died, and we found by giving them a shot of com-biotic, it's a penicillin streptomycin, I believe, combination, by giving them a shot, usually we could save them. These fowl would come down with what seemed to be pneumonia. There are many other people in the canyon whose fowl done the same thing.

We found by giving them a shot we could save them. We called Dr. Skinner to find out what the correct dosage would be, and we generally didn't call back telling him it came out.

Congressman McCARTHY. Well, Mr. McKusiak, I know we could go on for some time, but we have to adjourn shortly, but we will be with you this afternoon.

Mr. McKUSIAK. I would like to make one other comment, if I could, for the record.

Congressman McCARTHY. Surely.

Mr. McKUSIAK. I was talking about 1968 when we were sprayed on our own property, and our own dogs following this spraying, we went home and washed, but our own dogs that were with us, two of them became ill immediately with what we considered to be pneumonia, at that time we didn't associate it really with the spray, we didn't think about it, and we gave the dogs —we tried to call Dr. Skinner and he was out of town, and we gave the dogs com-biotics for this, and I believe it was the next day we called Dr. Skinner, he was back, and my wife checked with him and she checked the dosage she had given them, and he said it was twice too much, and give them half as much again, and we did, and the dog survived. It would have died if we had not given him the medication.

Congressman McCARTHY. You still have the two dogs?

Mr. McKUSIAK. Neither are malformed or anything, one of them has never been quite well, it's never been well. It wheezes a lot.

One other thing, there are many families in the canyon and many families in Globe and Miami who have dogs that are bleeding from all body openings.

We have dogs of this type, and people who have had dogs die from this, we could put you in contact with.

Congressman McCARTHY: We would like to have that information.

Well, thank you, Mr. McKusick. We'll look forward to seeing you this afternoon.

This hearing will stand adjourned.

Congressman McCARTHY: The hearings will come to order.

I've just received the following letter from the White House which I wish to read into the record at this point. It's from the Science Adviser to the President of the United States, Dr. Lee A. DuBridge.

"The White House, February 10, 1970.

"Dear Mr. McCarthy: This will acknowledge your February 3rd letter concerning 2,4,5-T, the October 20th announcement that you referred to was a statement of the actions that were planned to be taken by the various units of the Federal Government in relation to the 2,4,5-T. It was not a directive to agencies for the simple reason that statutory responsibility for those decisions rest in the separate agencies.

"I'm sure that by now you have heard from the Department of Agriculture. I appreciate your views on the desirability of an investigation of reports of birth of malformed children in Vietnam. By copy of this letter I'm calling your views to Secretary Laird's attention since this area is primarily his responsibility.

"As to 2,4-D, this compound is being reviewed along with other compounds being singled out as requiring additional study in the Bionettes records to which you referred."

Signed, "Lee A. DuBridge, Science Adviser to the President."

I'd like to contrast this with a statement as it was issued on October 29 where DuBridge said that the Defense Department will restrict use of 2,4,5-T to the areas remote from population, that the Agriculture Department will cancel registration of 2,4-D for food crops effective January 1, 1970. The Department of Agriculture and Interior will stop using 2,4,5-T in their own programs in populated areas, or where the residues from use could otherwise reach man. That the Department of Health, Education, and Welfare will complete action on a tolerance for 2,4,5-T, the residues on foods prior to January 1, 1970.

This is obviously a retreat from the position taken by the White House in October 29. As I read the statement at that time it was in the form of a directive that the departments will do such and such, now we find that the White House is backing off from this, and is saying that the statutory authority rests with the agencies.

It seems to me that the President of the United States has authority—the ultimate authority over these agencies, and I regret very much that the President's Science Adviser has seen fit to retreat from the decision of October 29, which I believe was the wise one. The use of this particular chemical should be banned pending tests.

On the plus side I'm delighted to be informed last night, and it's reported today in the press, that the distinguished Senator from Michigan, Philip Hart has announced he will hold hearings on 2,4,5-T. He asked Secretary Hardin, Secretary of Agriculture, Robert Finch, Secretary of Health, Education, and Welfare, and DuBridge to testify on March 11. This is further evidence to me that the compound's effects require additional evaluation, and I expect that I will testify myself before this Senate Subcommittee when they have hearings, I will make that request.

I should also announce that a report on my investigation will be prepared in consultation with Dr. Galston, and will be issued at the earliest practical point.

Now, we would like to hear again from Mr. Pierovich of the Forest Service. Is he here?

Mr. PIEROVICH: Yes, sir.

Congressman McCARTHY: I would like to say for the record, which I just said on the radio station here, that I have been very favorably impressed by the cooperation of the Forest Service. I think that anybody who has any smattering of knowledge about this whole thing must realize that this is something

transcending individual agencies out in the field, that we are talking here about national policy, and what is done out in the field really is a result of decisions made at a much higher level, and to try to focus responsibility on a field unit I think is really to carry this too far. I've been most impressed with your cooperation, and that of your colleagues, Mr. Pierovich, and I want you to know that we appreciate it very much, and our report will so indicate.

I understand you would like to elaborate on the statements you made yesterday.

Mr. PIEROVICH. Thank you, Mr. Congressman, for your kind comments, and also for the way you've conducted this hearing. I think the Forest Service is pleased with the way the hearing has gone. There are some significant elements of Forest Service concern that I felt should be made a part of the record this morning, and I'll read essentially from that statement.

First of all, the Forest Service has used phenoxy herbicides, but not since the nationwide controversy broke last fall. In fact, the last use of herbicides on the Kellner Russell project was June 11, 1969, and to the best of my knowledge, the last use of any herbicide by the Southwestern National Forest was the August, 1969, on the Gila National Forest in New Mexico.

Second, it's apparent there are several persons in this area who believe there are unknown, or suspected characteristics of these herbicides which may have caused them damage, and this is of concern to us.

Three, it's apparent we must continue our efforts to ascertain the extent of drift levels of herbicide residues, and the definite relationships between herbicides over environmental factors and the responses of plants and animals in this area.

These studies are to be made public when they're completed.

Lastly, the extent of continued deferment of herbicide use in the Chaparral program is dependent upon the outcome of our studies and of the Department's investigation of these matters.

Congressman McCARTHY: Thank you very much. I wonder if you could for the record, repeat what you told me yesterday relative to the drift of the herbicide over streams, and into adjacent private property, and what steps should this be resumed, assuming that it can be shown to be safe, what steps would be needed to correct that?

Mr. PIEROVICH. At this point, this will be my own opinion, but I first mentioned to you yesterday that our instructions to the applicator pilot were to interrupt his spray application when he crosses streams, we had definite plans for the project here to call for application away from the open water, and main stream courses. I do believe there was some drift into this stream course as evidenced by some top kill on the Sycamores on the stream bottom. There has been drift from the project area onto private property which we have established so far as the visual effects are concerned, and from this I'm certain that we will be developing new guidelines to both assure that the herbicides that we might apply in the future are confined to the project area, and to assure the safety of the public.

One definite indicator in this is that it would be desirable to use a much more restrictive windspeed in application.

Does that answer your question, sir?

Congressman McCARTHY: Yes, but what wind velocity do you think would be safe?

Mr. PIEROVICH: I wouldn't want to speculate at this time, but we do have a general rule of 5 miles per hour, and we know that herbicides were applied here to 10 miles per hour, and we see new development in the herbicide application field, the use of inverts has become more and more popular, and with some corrective work recently done in this area I feel this will help us a great deal.

Congressman McCARTHY: Another point that I definitely sympathize with you about is difficulty you have of getting information. I think the fact that you weren't apprised of the Bloncles Research Laboratory finding on teratogenicity until late last year suggests a problem in communications here, and if you have any suggestions for new legislation I'd be grateful. Do you feel you get enough information from Washington on such subjects?

Mr. PIEROVICH. I feel that in all of our—the exchange of information is a very complex thing today. We do make ourselves available to conferences with

people in these fields. Our technicians in herbicide work attend meetings regularly on this matter. We are expected to keep ourselves informed. The literature has been quite full of the controversies on 2,4,5-T, and we have been aware of the developing controversies.

The most healthy thing that could happen in this area would be a definite summary of literature that our technicians could refer to. There are abstracts available now, but the combination of inputs from the universities and from the various departments of government in one abstract bulletin would be helpful to us.

CONGRESSMAN McCARTHY. Do you have anything to add, Mr. Pierovich?

MR. PIEROVICH. No, I don't, sir.

CONGRESSMAN McCARTHY. Thank you very much, we appreciate it.

MR. PIEROVICH. Thank you.

CONGRESSMAN McCARTHY. Our next witness is Dr. Paul Martin from the University of Arizona.

Dr. Martin, I understand you are accompanied by Dr. Russell?

Dr. MARTIN. That's right.

CONGRESSMAN McCARTHY. Would you like him to sit with you?

Dr. MARTIN. Yes.

CONGRESSMAN McCARTHY. Dr. Russell, would you care to join Dr. Martin?

Dr. Martin, we appreciate your being here. I wonder if you would identify yourself and Dr. Russell for the record, your background and your particular interest in this?

Dr. MARTIN. I'm Paul S. Martin, University of Arizona, Department of Geology. I had training as a professional ecologist, and with me is Dr. Stephen Russell who is a zoologist in the biology department in the University of Arizona. His special interest is in birds.

CONGRESSMAN McCARTHY. Thank you, Dr. Martin. I wonder before the record if you would tell us about your involvement with the spraying project, and any conclusions that you reached, based upon your analyses.

Dr. MARTIN. Well, I'm not involved in the spraying project, and I'm not a herbicide expert. I have no research experience with herbicides. I do have interest in the vegetation of Arizona. I've spent years studying its fossil pollen records, but the interest I had in Globe was in first seeing if indeed there was any effect on vegetation as a result of herbicide treatment that had been called to my attention. I have come up on four separate trips to visit the area that was sprayed, and see what little I could of the community.

CONGRESSMAN McCARTHY. How long did you spend on these trips?

Dr. MARTIN. These were 1-day visits.

CONGRESSMAN McCARTHY. How many did you make?

Dr. MARTIN. Four. As a result of seeing the area, and talking to some of the people in the area, I was curious to see if just what degree the community might have been affected by this. I wasn't prepared to believe that people, or animals could be affected by herbicide sprays because the little I heard indicated that those who work with herbicides stand underneath the spray plane and are occasionally drenched by the chemicals, and don't suffer ill effects.

So it seems incredible that people in this community could be complaining of such an effect, but they were.

Indeed as a result it seemed to me that it was important to listen to them and try to understand what they were saying, and try to come to terms with the only observers who witnessed an event that wasn't supposed to have happened.

It also seemed to me that some of the people involved in the work with herbicides were unprepared for this sort of experience, they weren't even listening to the complaints. So I presumed to do that.

CONGRESSMAN McCARTHY. And what did you find in the course of your four trips?

Dr. MARTIN. There is one other person that's involved in what I'm going to say next. I don't know if she's here or not.

Within the last month a student from Massachusetts by the name of Miss Adelaide Frick and she was willing to go on a door-to-door basis, and interview people in the community apart from the ones that I talked to.

Congressman McCARTHY. Excuse me, is Miss Frick present?

Dr. MARTIN. I have the results, a summary of her door-to-door investigation in the area, the purpose was to see if there complaints coming from any other source other than the individuals that I talked to. The trips that I'd made up here and the design was to on a door-to-door basis talk to approximately 50 people in the canyons close to the sprayed area, and to another 50 over in Crestwood, which I believe is east of Globe at a further—at a point further remote from the area that was sprayed.

So what Miss Frick did was then conduct a door-to-door interview with people close to the sprayed area, and another group of 50 further away from it.

Congressman McCARTHY. What did she find, do you have the report? We would like to have that for the record.

Dr. MARTIN. I'd be glad to give you a copy.

Congressman McCARTHY. Would you care to summarize it?

Dr. MARTIN. I'll simply read about a paragraph from the report that summarized it, and of course, the individuals are not identified in this report, and the complete questionnaire is not represented here, simply the highlights of it.

There are three key questions, two that have to do with personal health, and one that has to do with livestock. It turned out that few people do have livestock in either—neither the spray area, or in Crestwood, but quite a number have pets. This is what she found.

Regarding pets, 13 cases in which animals were effected, and one must presume some relationship to spraying although in no individual case perhaps could this be directly proved.

This is the experiences of people living in this community who know the nature of the community, and then feel that something has happened that's a little bit out of the ordinary.

Thirteen cases in which animals acted, three kittens lost; two dogs lost; infertile eggs, one; rabbits not breeding, two; chickens not laying, one; burro lost, one; sick dogs, three reports.

Now, as far as people are concerned near the spray area, 23 of 50 indicated illness over the past 2 years which may be spray associated. Some people had absolutely nothing wrong with them, or were not concerned. They thought that those that were complaining were imagining it happened, an event that had no bearing in the real world, that it was in the minds of the people reporting.

Other reported, and we're quite convinced that their experiences were related to the events of last June, or earlier when herbicide spraying had happened.

Of the 23 reporting illness, 21 were reporting breathing difficulties. Many of these are attributed to the times of spraying. Some are attributed to smelter smoke, there's no avoiding the fact that this area that experiences a good deal of smelter smoke. Some of these people may be reporting an effect that is indeed caused by smoke, I don't know.

There were five reports of serious diarrhea, including one entire family. Four reports of chest pains, including one false heart attack, one report of coughing of blood, one report of subnormal temperature. Two reports of numb pain in arms; two reports of hemorrhaging; two reports of irregular periods; one report of miscarriage; two others by hearsay.

Fifty-six people interviewed, 42 mentioned some damage to plants, although the purpose of this questionnaire was not to consider plant damage.

Now, in Crestwood at a great distance from the—

Congressman McCARTHY. Was the interviewer able to determine if such complaints were prevalent before the spraying began?

Dr. MARTIN. I don't know how one would do that. In fairness to the people in the Forest Service who have worked with this project, one simply can't conduct a scientific experiment at this point in time. All we can do is talk to the people who were the observers, or ones—or residents in the area, and while their memories are still hopefully fresh, recover some information, just having to take them at their word.

Congressman McCARTHY. Let me just clarify. Is the interviewer ascribing these conditions to the spraying based on the interviews with the people? Do

they say that these phenomena results were the results of the spraying, or don't they know?

Dr. MARTIN. Yes, some of them would rather not say. The question was in effect, "Have you experienced any sickness which might be related to herbicide spraying of this area."

It's a leading question in part. It's not a question that denies any ignorance of the fact that herbicide spraying had taken place in the area.

I am sure there are many faults of a questionnaire of this sort that a professional psychologist would recognize.

Congressman McCARTHY. Let me say as a point of information, we will shortly have put into the record a scientific data of the results on human beings of 2,4,5-T, which I think you will find bear a similarity to phenomena you've just described.

I wonder if you would go beyond Miss Frick's survey to give us benefit of your own observations of what you saw, and if you were able to reach any conclusions about the effects of the spraying on either humans, vegetation, or animals?

Dr. MARTIN. Well, the effects on vegetation impressed me as ones that have to be watched over a period of time. Again, this problem of who's to make the investigation, and how it's to be conducted are important. The incident is over, and in the minds of some local people, hopefully will never occur again.

The problem is, what really happened? I was up on four separate trips, or 4 separate days. I saw some things that I have not seen in Arizona vegetation before. Such as the presence on Century plants of flowering way out of season, and immature new plants going on the old stocks of old ones without normal seed being set.

I understand that this particular species of Century plant is known to do that, and other botanists have seen such a feature.

The area that was sprayed, not all plants are dead in it. Some species like Manzanita are remarkably resistant up to this point.

The effectiveness of the treatment is doubtful. The areas of spray aren't dead. The effects of spray on the outside areas on different plants have to be watched over a period of time to fully appreciate the change in phenology, the changes of flowering time, the change of time when the leaves appear, and when they fall, the way the tradition of plants may be as far as overall growth is concerned, and if one wants to demonstrate the herbicide-caused effect on vegetation. It's also necessary to take into consideration all the other environmental variations that aren't under control either, such as rainfall and temperature.

Congressman McCARTHY. But, you did find evidences of drift outside the project area?

Dr. MARTIN. Yes.

Congressman McCARTHY. Did you find evidences of 2,4,5-T in any of the adjacent streams, or did you seek to find it?

Dr. MARTIN. No, I collected samples only from within the project area, soil samples and water samples.

Congressman McCARTHY. You found evidences of 2,4,5-T in the water you've collected within the project area?

Dr. MARTIN. The samples that I collected and submitted to a laboratory in California came back with a report of the presence of 2,4-D, and smaller amounts of 2,4,5-T.

Congressman McCARTHY. In the water?

Dr. MARTIN. There was a trace in the water, there was up to one part per million in the soil of 2,4-D.

Congressman McCARTHY. Is there anything that you or your colleague could add which would be pertinent to our inquiry?

Dr. MARTIN. I would make one recommendation, and then if Steve Russell has anything he would care to add.

The recommendation would simply be that hospital records, doctors' records, the veterinary records of those doctors and veterinarians in the Globe area be gone over very carefully by proper professional people.

Congressman McCARTHY. At that point I think we should put into the record a memo of conversation with Mr. Peter Riddleberger of my staff, and

Dr. Grantville Knight, M.D., 2901 Wilshire Boulevard, Suite 345, Santa Monica, Calif.

This conversation took place on February 6, 1970.

Dr. Knight informed Mr. Riddleberger that he has two patients under his care from Globe, Ariz. While his examination is not complete, he is of the opinion that their malady is associated with the recent spraying of Silvex containing 2,4,5-T by the U.S. Forest Service. Dr. Knight is of the opinion that an investigation is warranted, and offered to submit a statement of his findings upon completion of his examination subject to the approval of his patients.

Miss Frick is here now, and I wonder if she could sit next to Dr. Martin and Doctor, if you would be good enough to reread that portion alluded to?

Dr. MARTIN. This simply summarizes the interviews that Miss Frick conducted in the canyons that is Kellner Canyon, Russell, Sixshooter, and Icehouse. Fifty-six interviews in that particular area, and some people who had serious complaints to make were not considered in this interview.

What I found just in tabulating what her questionnaire revealed was that 23 of 56 individuals indicated illness over the past 2 years, which may be spray associated, 21 individuals reported breathing difficulties, many of these are attributed to the times of spraying, but not all. Some were attributed to smelter smoke.

There were five reports of serious diarrhea, including one entire family.

Miss FRICK. Yes.

Dr. MARTIN. Four reports of chest pain, including one false heart attack; one report of coughing of blood; one report of subnormal temperature.

Two reports of pains, or numbness in arms; three reports of uterine hemorrhaging; one report of a miscarriage.

There were two others that I thought were hear-say, but I wasn't sure had really occurred in family that you interviewed, and then finally all the questionnaires wasn't directed to plant damage, there were 42 people interviewed who mentioned at least some damage to their plants in that area.

Now, the Crestwood account shows much less effect, and this is what one might expect because of the distance further away from the area of spray.

Congressman MCCARTHY. Doctor Russell, is there anything that you would add to the record here that would be helpful?

Dr. RUSSELL. I don't think I would add to the record, but I'm in agreement with Dr. Martin's statement.

Congressman MCCARTHY. You are, you've studied the information he has available?

Dr. RUSSELL. I have seen much of the general information, but I've conducted no investigation of my own into it.

Congressman MCCARTHY. Thank you, Gentlemen, and Miss Frick, very much. I'd like to now recall Prof. Galston.

Doctor, as we discussed here I understand you have some scientific data on the effects on human beings of 2,4,5-T. I wonder if you would cite the source of this information, and the findings?

Dr. GALSTON. Mr. Congressman, I'm very happy to present this information because in the course of my wanderings around on this day I have found that certain individuals tend instinctively to disapprove any allegations of direct damage to human beings or animals.

Now, as I hoped I made clear yesterday, very small doses of 2,4,5-T can cause birth abnormalities in laboratory animals, and that is now actively under investigation, and we've discussed to see whether it might be due to this impurity called dioxin, or whether it was due in fact to the chemical.

But now, the question is, can we actually produce an effect on mature individuals, let us say male individuals, totally apart from pregnant females bearing embryos in utero, and I should say that there is a fairly sizable respectable scientific literature on this, and if one looks in a variety of sources, including the sort of encyclopedia of clinical toxicology by Gleason and Coughlin, and can find citations to many articles, and I have reference to a few here.

Now, 2,4-D can produce, if it's administered in very massive quantities, it can produce death in the small animals, and there are even a few cases

recorded of its having produced very severe symptoms in man. The best data, however, comes from 2,4,5-T, and I would like to read to you a brief account of an article published in 1959 by T. Flint entitled "Dermatitis and Kidney Damage Ascribed to Weed Killer 2,4,5-T."

Flint relates an episode involving two sisters, age 4 and 6 years, who had played for several hours in a yard which had been sprayed heavily a short time before with the Ortho brand of 2,4,5-T, brush killer. This was used for the control of poison oak.

This spray contained 15.4 percent of the isopro ester of 2,4,5-T in an oil base.

Now, I should mention parenthetically, I don't have the exact data at hand, but Kuron contains much more than that, I believe in excess of 60 percent of this same ester.

The next day both girls exhibited generalized erythema—reddening of the skin—and edematous swelling of the oral and vaginal mucous membranes.

The pulse rate and body temperature were not elevated, but both children were described as appearing slightly toxic. The limbs and eyelids were slightly swollen as the mucous membranes of the mouth were inflamed. On the 3d day there were signs of kidney damage. Albumen was noticed in the urine. There was no evidence of liver injury, the urinary abnormalities persisted for about 2 weeks, but 2 months later the urine specimens for both patients were normal.

Now, there are other reports in which 2,4-D, and 2,4,5-T are alleged to have caused toxic effects on the nervous system as measured by the electroencephalogram. That is after ingestion, there was a desynchronization of the electrical activities of the nervous system, I bring these points up only to reinforce the fact that no chemical is completely innocuous. Some individuals are more sensitive than others, and some may require a big dose, and some a small dose to have these abnormal effects produced, but I share with Dr. Martin the view that when people appear and say that they have been adversely affected by these chemicals, immediate and adequate attention should be given to the possibility that these reports will furnish yet additional data to supplement the rather large amount of scientific data already existing.

Congressman McCARTHY. Thank you, Dr. Galston. I wonder if you could—give us your observations after your inspection of the sprayed area, and the area where it drifted.

Is there anything that you at this point care to have in the record?

Dr. GALSTON. Well, I'll say a few words. I want to make it perfectly clear that after 24 hours in Globe, Ariz., I don't want to pose as an expert either on the program, or the effects on vegetation, or on people, but as a biologist working in this area, there is some conclusions I think I can make which point out the need for still further investigation, and everything I say should be held in that light.

What did I see on my brief trip yesterday? Well, I would classify them in several categories.

Number 1, at the helispot, overlooking the picnic area, I observed and smelled residues, there was no doubt that you could smell residual diesel oil which was primarily the carrier for the herbicide which had been splashed during the loading operation onto the helicopter.

Now, if you could smell it, there was a good deal around, and that would indicate that there are definitely residues in certain selected areas, how much there was I can't say, how much there might be in the soil, or in the water, I cannot say, but it seems to me that I could smell evidences at various points in my trip. So that there probably are residues here and there, and those could serve as a continuous supply of leaching, I suppose, into the waters of the area, one should not discount that possibility.

The second category was definite plant damage, and the plant damage was both the desired plant damage in the canyon, and undesired plant damage in the vicinity of homes, which was due to the drifting, I assume, the herbicide.

In the canyons we could see, and these were pointed out to me by some of our Forestry friends who were with me, the desired killing of such plants as

Manzanita and Oak, and the desired persistence of what they considered more desirable plants such as gerardia.

Now, I suppose a question could be raised as some of the local residents have been raising undesirable, and desirable, according to whose criteria, and by what judgmental values. Manzanita and Oak do live on these hillsides, they do transpire to water, and I suppose their killing is desirable in the contention of wanting to avoid the evaporation of water. Whether after you are all through with the operation and plant to grass, which is the stated objective of this clearing operation, you are going to save very much water, I'm not sure, and whether, in fact, the esthetics of the environment will be improved another stated objective of this operation is also I'd say open to question, I would think it would be a very useful operation for those groups charged with making policy to hold some public hearings at which citizens could come with their points of view. I think a lot of this fracas is due to poor interchange of information between official agencies, and the citizens. If there had been open hearings, and announcements, this is what we intend to do, this is why we are doing it, and this is how we are going to do it, and have objections recorded at the time, a lot of the acrimony that's built up here might have been avoided.

Now, so far as the damage of plants around homes, there is no doubt about it, it has occurred. I have seen it, and as a plant physiologist, I could testify that this is typical damage due to herbicide drift. I think that this points up a lesson when you discharge herbicides from the nozzles of spray on a helicopter, you are getting an assortment of droplet sizes, the big drops are going to fall quickly, the small drops are going to be carried for longer distances. I think until the technology is improved, the so-called invert sprays is one possibility here, and new types of booms for spraying are another, it seems to me that it's very unwise to spray in areas where homes are so intimately associated with the forest and woodland, that you are trying to control. You cannot pinpoint the spray, you cannot keep it out of the water, and you cannot prevent inadvertent spray damage to the nearby residences, and I would say that there are certainly many sprays in the country where the application of aerosol sprays is a highly beneficial practice.

From my cursory look here that I would say the intervening of house and the canyons in which spraying is desired, is so intricate that the slightest miscalculation, the slightest air movement, the slightest malfunctions of the spray equipment would lead to damage to the property, and I don't know how that could be worked out technically, and I would want assurance that those problems are looked into.

I think the people whose plants have been damaged ought to be compensated in some way because the damage has been considerable around some homes, and I think it's unfair to expect these people to bear the brunt of this kind of inadvertent drift operation.

Now, I did see damaged animals, and I talked with humans who alleged that they were adversely affected.

All I can say here is the damage is there, and spray operations did occur, but I know of absolutely no scientific evidence which would link the spray operation to the damage, and I think the people who showed me the damaged animals showed it to me in the spirit that this could be a consequence of spray operations, but they weren't sure, and certainly I'm not sure, but unlike some people I would not immediately offhand say this is ridiculous. It could be as I have shown from my previous reading from this scientific compendium, and I could document further a lot of the symptoms that people are reporting here have been reported for massive doses of 2,4-D. So we should not leave the possibility that this did occur, but a much more scientific information is required.

My overall view after one day of looking around is one of puzzlement. I wonder why it's desired to initiate this kind of an operation in this kind of an environment. The stated objective is to improve water runoff, and water runoff will benefit, I presume, the citizens of a nearby urban area, Phoenix, which is growing rapidly, and which has a lot of water requirements, and their water

requirements will grow as the years go by. We know this is an arid area—by the way, not being an Arizona resident, and not being a politician, I perhaps could say some things here which a lot of people were thinking, but haven't brought forth.

Truly, water is going to be wiling in this area for others. So far as I can see unless nuclear technicology makes it available on a massive scale, which I don't foresee, if you take water from this area to give to another area, you are, in fact, robbing Peter to pay Paul. If you are robbing water from here, you are going to partially change the kind of vegetation, perhaps you are going to denude some of the areas in order to increase the runoff, this involves a comparative set of rules. Whose object is going to be gored here, whose interests are paramount? Well, clearly cities are not going to be able to grow indefinitely, we are going to have to put some limit on them, we know, for example, that the city of Los Angeles got into a lot of trouble with smoke because there are just too many people there. In the same way cities in the Southwest may have to limit their size ultimately based on the number of people they can support on the amount of water resources there are. The trying to take every amount of water out of the Country brings a possibility of a very serious question.

Now that President Nixon among others is calling for a campaign to restore the environment, it might be that we would want to look at this whole project in the context of what we are doing to the entire State, and to the entire countryside.

Finally, I would like to merely renew my suggestions that the people who formulated this policy, who set up this whole spray program should identify themselves, and should request the contributions of the citizenry as an input to this whole program.

I think that policy should not be made without question. This is a democratic society in which citizens have responsibility to interest themselves in the making of policy, and—my faith in the American people, and in their desire to run their own country has been to a certain extent reinforced by seeing a group of aroused citizens here out to protect their rights.

Thank you very much.

Congressman McCARTHY. Thank you, Doctor Galston. I think the points you make are valid. One that I would just enlarge on a bit is that I am presently working on legislation to be established to support a National Growth Policy, I think growth has to be commensurate with the resources and of course, in this case, water is a critical resource.

I would conclude these hearings now with a couple of observations. I think it's important to know that 2,4,5-T was developed at the Army's chief Germ Warfare Research Center at Fort Detrick, Md. My experiences in investigating the Army's chemical and biological warfare programs, and policies, has not encouraged me about some of the actions that have been taken, without taking into consideration some of the unforeseen consequences. For instance, when they wanted to dispose of waste from nerve gas production at the Rocky Mountain arsenal near Denver, they first dumped this material into ponds on the arsenal's property. They didn't expect that it would find its way out. They thought it would be just absorbed in the water on the pond. It wasn't, it was carried out into adjacent streams, and the neighboring countryside, and killed among other things livestock and 6 square miles of sugar beets.

They then dug a deep well and figured the best way to dispose of it was by dumping it deep into the earth. That set off 1,500 earthquakes in the Denver area, some of them up to six on the Richter scale, and caused great alarm in the community. They finally had to pull out this material, and of course the earthquakes stopped.

Then, they thought they should ship it across the entire United States. They thought this would be safe. Scientists later said it would risk the lives of thousands of people, the plans also called for dumping this large quantity of nerve gas and other materials into the Atlantic Ocean. They thought that would be safe.

Scientists later said it could destroy all marine life in 600 cubic miles of the Atlantic Ocean, with a cataclysmic effect on ocean's production cycle.

Now, I cite these instances not in reproaching the Army, or the C.B.W. establishment, but I think that this particular program has a questionable record.

We find 2,4,5-T developed by the Army's Germ and Gas Warfare establishment, 25 years ago to this date. We do not know for sure whether it will produce birth defects in human beings, I find it unwise to say the least to use such a substance without being sure that it is safe. For some reason the burden of proof seems to be on me and my colleagues in the sense that the attitude is, "we'll keep using it until you can prove it unsafe." Well, I quarrel with the basic assumption, I think that it should be just the reverse, I don't think that any toxic substance whether herbicide, pesticide, drug, whatever, should be used, sold in the United States until it can be shown that it is not harmful to human beings, that it doesn't produce cancer, or birth defects, or genetic effects.

One would think that we have learned from the Thalidomide experience, but apparently we haven't.

I also find it incredible that the Dow Chemical Corp. could have succeeded in helping reverse an order from The White House.

Now, I read this section from the statement of October 29 wherein the President's science adviser said that certain agencies of Government, the Department of Defense, the Department of Interior, the Department of Agriculture would do certain things, will inaugurate a new policy. Now we have the letter received today from The White House addressed to me, advising me that The White House is backing off from this directive, and is saying that the statutory responsibility resides with the individual agencies.

I find it personally unconscionable that in light of the Bionetics findings, and the scientific data cited by Doctor Galston this morning about the proven effects of 2,4,5-T on females, that this substance would be continued to be used on wide scale in the United States, and for that matter in Vietnam where even larger quantities are used.

I welcome the U.S. Senate Subcommittee on Investigation into this. I will prepare a full report which will appear in the public documents that will be developed as a consequence of our trip will be made available to not only the Senate Commerce Committee, but appropriate other committees of the Congress, as well as to the study of the American Association for the Advancement of Science under the directorship of Professor Messelson of Harvard.

We finally conclude by thanking the officials who have been most helpful, and to the residents of Globe who have been most hospitable, and I would hope that this experience here might have effects far more reaching than the small area of Globe, Ariz., and that perhaps as a result at least in part of what we have discovered here, that we will stop using 2,4,5-T around the world until we can run a series of tests that show that it is not harmful to this generation, and to the next generation.

Thank you very much.

Appendix 6

ALBUQUERQUE, N. Mex., February 26, 1970.

Hon. RICHARD D. MCCARTHY,
House of Representatives,
Washington, D.C.

DEAR MR. MCCARTHY: Thank you for your letter of February 16 and for the opportunity to furnish additional documents or statements for the record of your hearing in Globe.

FOR THE RECORD REGARDING WINDS

In my testimony I promised to furnish you with additional data on wind-speeds during the 1969 spray project. While windspeed was measured by the Project Air Officer who used a pocket anemometer, no record of observations was made. He did, however, maintain a record of application flight times

which shows when the work was shut down due to winds exceeding 10 miles per hour. The following table summarizes these important times from this record:

Date	Time	Remarks
June 8, 1969	1505	Shutdown (wind exceeds 10 m.p.h.).
June 8, 1969	1703	Resume operations (wind below maximum).
June 8, 1969	1935	End operation for day.
June 9, 1969	1018	Shutdown (wind exceeds 10 m.p.h.).
June 9, 1969		End operation for day.
June 10, 1969	1115	Do.
June 11, 1969	1250	Do.

Because allegations of "gale winds" during application have been made, it is of interest to compare the above shut-down times with winds recorded at the Globe Fire Weather Station. The Globe Station records are for observations made only once daily at 1300 hours, but do not indicate the presence of "gale winds" on any day of the project. These 1300 hours observations are as follows:

Date	Direction	Speed (m.p.h.)
June 8	SW	5
June 9	SW	16
June 10	W	14
June 11	SW	16

As can be seen from the two tables, the only day on which applications extended beyond 1300 hours was June 8, when the 1300 hours observation was only 5 miles per hour. The June 11 shut-down time of 1250 hours would tend to infer that winds did possibly exceed 10 miles per hour when compared with the 1300 hours observation of 16 miles per hour. Ranger Moehn has stated that winds did not exceed 10 miles per hour in the area of the spray application, and this is quite possible since spray work was high up in Russell Gulch, in the lee of sheltering mountains to the Southwest, on that date.

OTHER ITEMS FOR THE RECORD

Additional copies of the Forest Service Interim Position Statement and of the map showing the limit of infrared detection of dead and distressed vegetation (as of October 1969) are enclosed for the record.

As I recall, Professor Galston asked for additional information on the 3-Bar research studies related to water yield. Since the Interim Position Statement digests these, I suggest that the Statement will serve for the record, but would be glad to arrange for you or for Dr. Galston to receive a copy of the rough draft of the manuscript referenced in the Statement.

Since the herbicide container converted to a trash barrel, and found in Kellner Canyon during your field tour, became a matter of importance to the press, the following additional information may serve as a useful insertion for the record: (1) The Dow Chemical Company label does not specify that the container be destroyed (copy of specimen label enclosed); (2) As a matter of good practice, we prefer that all pesticide containers not be reused, and when it was found that trash barrels were being made of the containers by the Globe District, the Regional Forester directed by memorandum on January 29 that all Southwestern Region Ranger Districts discontinue such uses; (3) Ranger Moehn, in response to the Regional Forester's direction, had all such trash barrels picked up earlier in the week of your visit; (4) presence of the container in the creek at the Kellner recreation area cannot be explained by District personnel who were in the area and had not seen it prior to your field tour; (5) the container had been washed with water and detergent prior to painting for use as a trash barrel.

Also on your field tour, there seemed to be some misunderstanding regarding application of herbicide to the live stream in Kellner Canyon. While the stream was flowing when you were in the area, it was not a live stream at the point visited at the time of application. We do not deny that some herbicide may have drifted to live streams, as evidenced by some tip damage to trees in the Kellner Recreation Area where there was a live stream, but that drift actually reached the water has not been established.

While the Interdepartmental Panel of Scientists headed by Dr. Fred H. Tschirley arrived following your hearing, their findings are of sufficient importance to the matter under consideration, that we desire to have the enclosed press release issued by them inserted in the record.

It was a pleasure working with you and Mr. Riddleberger during your visit. If the Forest Service can be of any further assistance, please let us know. We will appreciate receiving three copies of the hearing record when available.

Sincerely,

JOHN M. PIEROVICH,
Assistant Regional Forester.

FOREST SERVICE INTERIM POSITION: KELLNER CANYON-
 RUSSELL GULCH HERBICIDE SPRAY PROJECT AND THE SOUTHWESTERN
 REGION CHAPARRAL PROGRAM, February 9, 1970

INTRODUCTION

Background on Kellner Canyon-Russell Gulch Project

The Kellner Canyon-Russell Gulch Project is a part of the Chaparral Management Program of the Tonto National Forest. The primary objective of this project is to improve water yield, but other program objectives and resulting benefits are intended to be met as well. Improved water yield and other Chaparral Program objectives are discussed below.

This project was initiated in 1965 following extensive local discussions and a press release which appeared in the local paper. Rather than the usual practice of applying prescribed fire as the initial treatment, herbicides were used. This was because of the known tendency for streams in this area to produce flash floods; herbicide treatment was considered to be unlikely to contribute to flooding, whereas large areas treated by fire could.

Chemicals used in this project are listed by year of use in Table 1, which is appended. These are all Federally Registered Compounds and were applied in keeping with the laws and label instructions governing their safe use.

Following the 1969 Application of Herbicide, Tonto Forest Supervisor Robert Courtney received a complaint in the form of a petition bearing 154 signatures of people in and near Globe, Arizona. Following the initial complaint, Courtney requested a team of qualified individuals to visit the area for a general assessment of alleged herbicide damage. This team reported some limited damage to vegetation on certain private properties.

Chaparral Management Objectives

Objectives of managing chaparral on the Southwestern National Forests are to:

1. Improve water quality and yield through reductions of the potential for sedimentation following wildfire and through reductions in evapotranspiration losses where modification of existing vegetation is proper.
2. To maintain the broad value of the Chaparral zone through development of diverse patterns resembling the natural varied conditions found in ungrazed chaparral; these patterns range from savanna-like grass and forb areas to newly regrown chaparral, to relic stands of mature chaparral.

3. To improve wildlife habitat through creation of additional edge effect and through maintenance of vigor and new growth in desirable species.
4. To reduce the high costs of protecting chaparral from wildfires through the establishment of breaks in heavy fuel continuity, making it more possible to avert fires of conflagration proportions.
5. To increase forage production for wildlife and livestock through the release of native grasses and the establishment of new grass stands.
6. To improve access for both the observer of wildlife and the hunter through a system of near-primitive roads to strategic fire control locations and through the openings that will result in treated areas.

It is intended that each of the above objectives will be met through Multiple Use Coordination Procedures. These require that regardless of the primary purpose of any project, proper consideration be given to other forest uses and values. Because of the intense interest in improving Southwestern water quality and yield, both Federal watershed management and cooperator funds have been made available for this work as a primary purpose. Each of the objectives of chaparral management is fairly well understood by the interested public except for this one of improvement in water yield. Even some experts have, until recently, discounted the potential for augmenting water supplies through alteration of shrub cover in the chaparral type.

Much of the research leading to improved understanding of the potential for additional water has been done on the 3-Bar Experimental Watersheds near Roosevelt Dam on the Tonto National Forest. Work there was begun in 1956. Two reports from this work are of particular interest.

Pase, C.P., and P.A. Ingebo, 1965, "Burned chaparral to grass: early effects on water and sediment yields from two granitic soil watersheds in Arizona," Proceedings Ninth Annual Arizona Watershed Symposium, 4 pp illus.

Hibbert, Alden R., Unpublished 1970 Manuscript on file with Rocky Mountain Forest and Range Experiment Station: "Increases in streamflow vary with rainfall after converting brush to grass."

The latter report is cited because it contains data not previously available which are regarded as more reliable (due to additional years of streamflow measurement) and which indicate greater promise of improved water yields than previously expected. Increases due to watershed treatment have varied from 1.5 area inches to 14.0 area inches. The two test watersheds averaged an increase in water yield, for the period 1959 through 1969, of from 4 to 6 area inches.

Progress and Direction of Studies--The Kellner Canyon-Russell Gulch ProjectTask Forces No. 1 and No. 2 (Completed Work)

The first two teams to examine the area were concerned with visually detectable effects of the 1969 herbicide application. Due to the similarity of some insect and disease symptoms to symptoms of herbicide effects, the second team included specialists in entomology and plant pathology. It was on the basis of this team's findings that many plants alleged to be damaged from herbicide drift were determined to be affected by other causes.

It should be noted that while all complainants have been advised of Forest Service claim-for-damage procedures, only one formal claim has been filed. This claim was not for properties identified as damaged in the Task Force No. 2 Report, and has thus been disallowed.

Infrared Photography and Interpretation for Distressed Vegetation (Work in Progress)

While the second Task Force reported that some visually detectable herbicide drift had occurred from the 1969 spray project, extending approximately one-fourth mile north of the project, their assessment did not include previous years' effects, nor was it concerned with delineation of the sprayed area as a whole.

In order to more accurately define the limits of herbicide effect on plants from all years of spraying, aerial infrared photography has been employed. Interpretation of these aerial photographs has made possible a preliminary delineation of the exterior boundary of distressed and dead vegetation. Both the visually detected drift line reported by Task Force No. 2 and the External Limit of Infrared-detected distressed and dead vegetation are shown on the appended PRELIMINARY map. It is important to note that internal exclusions have not been delineated and that field verifications are not yet completed for the infrared interpretation.

Environmental Effects (Work in Progress)

Work is underway in this study to assess the total effect of the Kellner Canyon-Russell Gulch Project on the environment. Some of the key considerations included in this study are listed below.

1. Possible further evidence of drift of herbicide sprays through such herbicide residues as are detected in soil samples north of the project area. Initial soil sampling was within the project and on two transects toward the

northeast corner of the project. This corner was selected as the best to test the hypothesis that soil residues from drift might be found, since prevailing winds are from the Southwest.

Initial laboratory analysis reports have indicated low concentrations of Silvex and 2, 4-D at some locations (maximum detected concentration off the project to date is 0.16 p.p.m. Silvex). Especially at these low levels of concentration, it is possible that other sources of contamination may induce "background" which could lead to erroneous conclusions. For this reason, we are proceeding to cross-check analysis procedures while, at the same time, widespread sampling north of the project is scheduled.

It would be premature to reach any conclusion regarding drift at this time.

2. Herbicide levels in water samples. Water sampling and analyses have been underway for some time. Project methods called for interruption of application at all stream channel crossings, and as far as we have been able to determine, no herbicide was applied directly to water. Some soil-leaching and runoff is to be expected. All samples we have taken, or taken by private individuals and brought to our attention, are less than the Federal water quality criterion of 0.1 p.p.m. ^{1/}
3. Effect of Treatment on Esthetics. While it is evident the dead vegetation over this area is not pleasing, our concern here is with the next needed steps to actually provide enhancement of the scenic resource. It is sometimes necessary to tolerate temporary degradation of the appearance of an area as a cost of ultimate improvement. This study is intended to better define tolerable limits, explore alternatives, and recommend treatments to completion. Concurrently, we are assessing the past, present, and projected fire hazard in order to build conflagration control concepts into the landscape design.
4. Effects on Animals and Plants. Initial observations by wildlife experts have shown no marked effect upon wildlife.

^{1/} Surface water criteria for public water supplies table appearing in: Water Quality Criteria issued as a report to the Secretary of Interior, April 1, 1968, and published by the Federal Water Pollution Control Administration.

On the other hand, repeated claims have attributed varied maladies of humans and animals to the project's herbicide sprays. Lacking private medical histories or other solid bases for evaluation, we believe it more sound to rely on published results of laboratory tests. These are to be used in determining expected effects on animals for rates of application used. Yet to be published laboratory results are needed to complete this study as it relates to animals.

A further consideration of this study is that for proper perspective, all of the environmental influences on the area must be weighed. Two examples help to bring this need to focus. One is the frequent presence of smoke from nearby smelting operations, especially when an inversion and northwest winds combine to produce a thick accumulation in the basin north of the Pinal Mountains. The other is household and industrial uses of herbicides which may have induced additional residues into the affected area.

While neither the effect of possible air pollution in the area nor the possible contamination by other herbicide uses are known, their importance as suspect environmental effects cannot be discounted.

FOREST SERVICE POSITION

We share deeply the concern of the people in this area with their environment. The Forest Service has no intention of pursuing a course which will adversely affect the health and safety of its National Forest neighbors, nor which will permanently detract from the scenic or other qualities of the Forests.

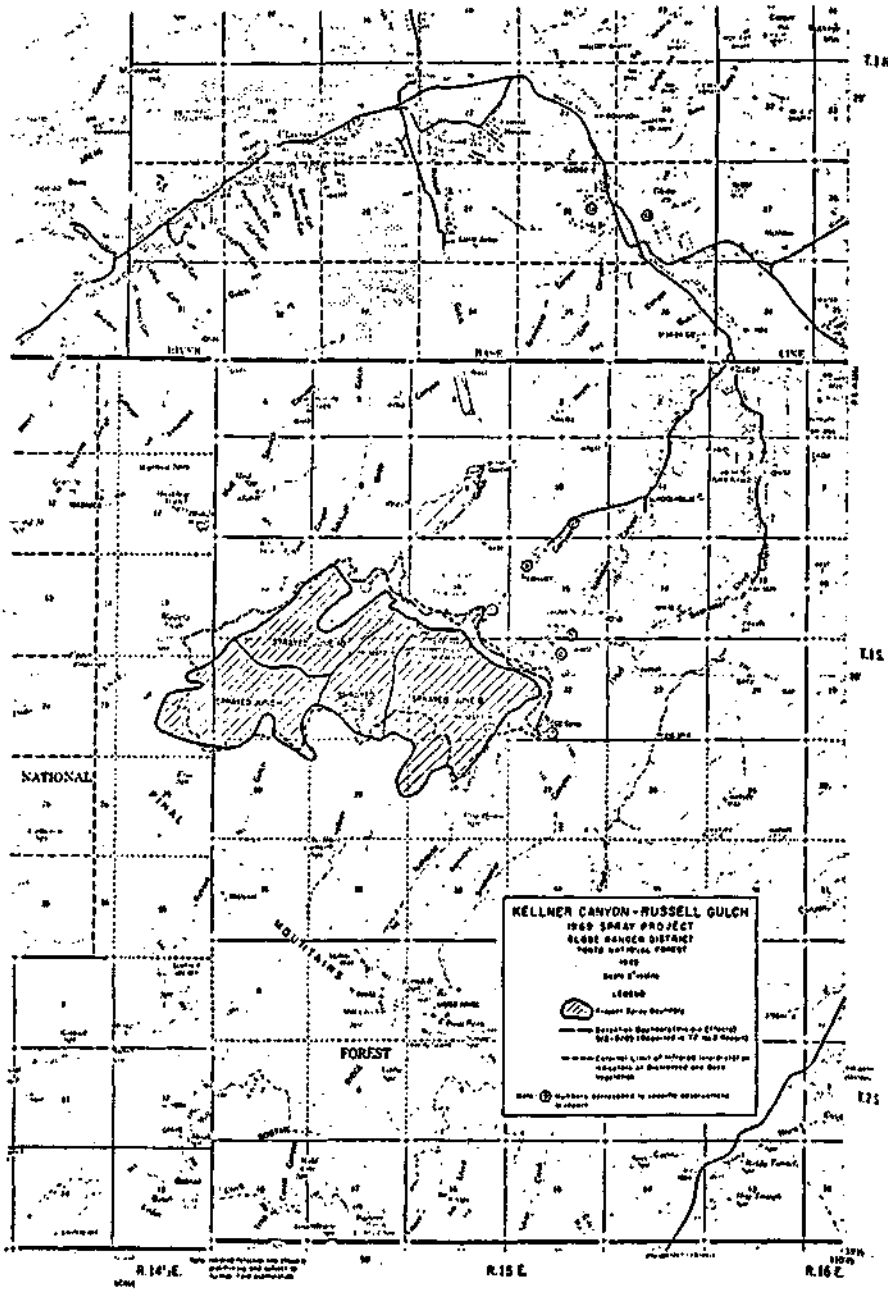
It is our position that the studies we have underway, as well as the outcome of public meetings concerned with herbicides and with the overall conduct of the chaparral program, must determine the ultimate decision on deferment. For this reason, we believe it would be premature to state at this time either when the deferment may be lifted, or what new guidelines will be followed.

It is our further position that it would be unwise to base decisions on the future use of the herbicides employed, solely upon alleged or suspected effects in the vicinity of the Kallner Canyon-Russell Gulch Project. There are many environmental influences operating in this area which must be better understood. Also, many of the questions raised about these chemical compounds can be resolved only through carefully controlled laboratory experiments.

Year	Chem. Name	Brand/Trade Name	UGDA Ref.	Abn. Acid Equivalent per Gal. of Mixture	Application Rate/Acre (% Acid Equivalent)
1965	2 4 D	Monsanto	524-115	6	1 lb.
	2 4 5 T	Thompson-Hayward	148-431	6	1 lb.
1966	2 4 D	Monsanto	524-115	6	1 lb.
	2 4 5 T	Thompson-Hayward	148-431	6	1 lb.
1968	Silvex	Kuron (Dow)	464-162	4	2 lbs.
1969*	Silvex	Kuron (Dow)	464-162	4	2 lbs.
	2 4 D	Monsanto	524-115	6	1 lb.
	2 4 5 T	Thompson-Hayward	148-431	6	1 lb.
	2 4 5 T	Hercules	891-46	4	2 lbs.
	2 4 5 T	Hercules	891-45	4	2 lbs.

*In recent discussions with project personnel, we have learned that in addition to the Silvex reported on the project accomplishment report and used in our earlier correspondence, a small amount of Monsanto 2,4 D and Thompson-Hayward 2,4,5-T arrived mixed with the mixing equipment and was applied in 1969. Registration numbers, mixtures and rates were the same as reported above for 1965 and 1966. There was also a 30-gallon supply of Hercules 2,4,5-T on hand from earlier field trials which was used.

TABLE 1 - Record of Herbicides Applied to the Kellner Canyon-Russell Gulch Project



PRESS RELEASE - February 20, 1970

Government Interdepartmental Panel of Scientists

The panel is carefully examining the evidence collected during its visit. The study will continue and will include analyses of the numerous samples of blood, soil, water, fruit and plants for the herbicides, a possible contaminant (dioxin), as well as various agents producing disease in man, animals and plants. However, to date, we can summarize a few of our findings as follows:

1. The application of herbicides in the Pinal Mountains near Globe, Arizona was made by the Tonto National Forest starting in 1965. The most recent application of the herbicide was made by helicopter on June 8, 9, 10 and 11, 1969.

2. The materials used in the treatments in 1965, 1966, 1968 and 1969 included 2,4-D, 2,4,5-T, and silvex. These chemicals came from different sources. In 1969, 30 gallons of 2,4,5-T produced by the Hercules Chemical Company and 935 gallons of silvex produced by the Dow Chemical Company were used. The silvex is reported by Dow Chemical Company to contain less than 1 ppm of the dioxin. Analyses will be made of silvex and the other herbicides for dioxin and the active herbicide ingredients.

3. There are reports of the aircraft flying over private properties but not spraying; and other reports of the herbicide being applied just outside the project area. There is clear evidence of drift of the herbicides on a number of plants on some of the nearby properties.

4. Human illnesses have been reported by several residents in the Globe region. Many of the residents with complaints were interviewed by a medical member of the panel. These are complaints that commonly occur in the normal population; the eye irritation in one individual may be related to the spraying. Nine doctors serving the area of Globe were interviewed and there was general agreement that there had been no significant increase in human illness related to the spraying. However, blood samples were obtained and additional studies are planned to verify or rule out this possibility.

5. Reports from the wildlife specialists indicate no significant effects on birds, deer, and other wildlife. There are reports of reductions of birds on a few properties but there are other reports that bird and other wildlife populations in and near the project area are normal.

6. Information obtained from owners of livestock and observations of animals did not indicate any illnesses that do not commonly occur in other regions. It is doubtful that the spraying of the herbicides or dioxin caused the afflictions in the goat and duck because the goat was born before the treatment and the duck was hatched about 4 miles away from the treated area.

7. There was evidence of woody plant mortality from root rot, and also visible damage to certain yard trees from several kinds of insects and woodpeckers or sapsuckers. Other plant injuries were observed that appeared to be caused by low soil moisture, air pollution and unusual soil properties.

8. The phenoxy herbicides following normal use do not usually persist for more than 6 months in soil and water. Additional analyses are in progress to determine the presence or absence of herbicides.

Senator HART. We are adjourned to resume on the 15th of this month in this room.

(Whereupon, at 5:15 p.m., the Subcommittee was adjourned, to resume on April 15, 1970.)