

## FACTS AND FALLACIES ABOUT DDT

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Between May 1944 and the fall of 1945 one news clipping service piled up a total of over 20,000 items on DDT. Some of them contain factual statements on this marvelous and mysterious chemical, which when properly diluted or formulated becomes an exceedingly potent insecticide. Many of these items, however, gave the public incorrect impressions as to what DDT will do from a beneficial standpoint, and not a few cautioned the public against its sinister and unknown dangers. The following facts and fallacies may be useful in understanding just what the limits of DDT are as an insecticide and something of its toxicity to humans and animals, as well as its role in the insecticidal field.

A few months ago my cousin dashed into our house to inform me that a friend of a friend of a friend of hers had died of DDT poisoning. There was a certain sadistic satisfaction in her voice and manner, because for many weeks she had been hearing me tell of the wonders of this new insecticide. She was sure that DDT was responsible, for had not the victim shortly before death advised his wife to sue the company for damages?

I could not immediately refute my cousin's story, but I planned at once to get the facts. I knew Paul A. Neal, chief of the Industrial Hygiene Research Laboratory, National Institute of Health, was interested in every suspected case of DDT poisoning and that his office no doubt had inquired into this unfortunate incident. This is what Dr. Neal said:

"I may state that we traced this case and found that this man had only been exposed to DDT about one month prior to the onset of his illness, this exposure being that he was in a theater during its disinfection by commercial fumigators with a 5-per cent DDT oil solution.

"His exposure was *a priori* much less than the men who did the fumigating.

Following this he took some of the solution left by the commercial fumigators and mixed this with Varsol and did quite a bit of spraying. He was under the impression that the solution left by the fumigators contained DDT, and since his illness began very soon after using this material it was natural that DDT poisoning would be suspected. However, an examination by this laboratory of the material he thought contained DDT failed to reveal DDT. A check with the fumigating company revealed also that it was Deobase and that they had left no DDT solution in the theater."

While on a trip to Chicago last fall W. E. Dove saw a suspected case of DDT poisoning in the Marine Hospital there. The victim was a professional man, a chemist. He complained of throbbing sick headache, marked tremor of the hands and weakened leg muscles, an erythematous rash, and nausea which in at least two instances was followed by temporary bleeding from the nose and throat. The tremor in his hands worried us. It looked like the real thing. We reported our information to Dr. Neal, and a physician from the Industrial Hygiene Research Laboratory was sent to Chicago to study the case.

The following is a summary of Dr. Neal's report:

"With the advent of DDT, the patient was assigned the task of determining its effectiveness as an insecticide. . . . Other than his periodic headaches, the patient had enjoyed good health until he started his experiments with DDT. During April, May, July, and August, he tested 5 per cent DDT, 3 per cent cyclohexanone, and kerosene solutions as residual sprays. At the beginning precautions were observed by wearing gloves, goggles, a handkerchief over the nose and mouth and coveralls. Later no precautions were observed. Prac-

tically every night after he had finished a test a throbbing sick headache and nausea were experienced. The other symptoms noted above were experienced from time to time. . . . After a careful physical neurological examination, supported by laboratory tests, the diagnosis and discussion of findings in part are as follows: Although the exact nature of the patient's recent acute illness is not known, its relation to DDT exposure is very doubtful. . . .

"There was no real evidence of liver, kidney, and nervous system injury such as might be expected from the experience gained from animals exposed to DDT. Based on the results of patch tests, the patient presented no evidence of sensitivity to DDT, cyclohexanone, or a combination of the two. As expected, the patient and the control subject had severe skin reactions to kerosene and xylol with and without the presence of DDT."

The report concluded, "There is strong evidence that his symptoms were due to one of the solvents, cyclohexanone, rather than DDT."

A number of persons heavily exposed to DDT solutions because of their jobs as sprayers have been examined thoroughly, according to Dr. Neal. His interviews with officers who have directed spraying crews using large volumes of DDT solutions reveal that occasionally some workers complained of transient upper respiratory irritation, headache, and nausea. These symptoms, however, were attributed to the solvents used, usually kerosene.

The following story appeared in a southern Florida newspaper on November 5, 1945:

*"Cavalier Star Ill, Blamed on DDT Spray.* DDT may stop insect-breeding, but the powerful spray is hatching a nest of trouble for Ponce de Leon's football team. For a doctor's diagnosis has cited 'allergy to DDT' the cause for the illness that kept high-scoring Dave McDonald sidelined for the Cavalier's last four games. Dave's wearing a gauze mask now to try to keep free of the stuff."

Of this incident our colleague, Fred H. Stutz, says:

"I talked to the doctor, one of four that seem to have treated the boy the greater part of the time he was indisposed. He advised me that DDT was not thought of or mentioned in connection with his disability. The boy, apparently, had a congestion in the head and inflammation of the sinuses. No doctor said DDT had anything to do with his condition. The father stated there was no proof or evidence that DDT was involved."

Yet according to the news article the coach was convinced that "if the city decides to spray again before Thursday, we're sunk." A new and interesting alibi for a football team's failure, but a fallacy as to the effects of DDT.

To these and many other stories of DDT injury the best reply we have is given by Dr. Neal in a letter to me dated December 26, 1945, "Up to this date no cases of DDT poisoning in humans in the United States have been found to be due to DDT *per se*."

G. H. Bradley, chief of the Entomology Division, Malaria Control in War Areas, U. S. Public Health Service, wrote on December 27, 1945:

"On the MCWA operational program we have used over 300 tons of DDT in emulsions, solutions and dusts and have no authentic records of injury to humans caused by it. A few cases of dermatitis have been reported, none serious, presumably caused by workmen failing to use rubber gloves when mixing solutions. These probably were due to the solvent. Our men are instructed to use respirators when applying DDT. However, I think more of them work without than with respirators."

As far as I can learn, the following cases of DDT poisoning are the only authentic ones on record. The first case is that of a laboratory worker in England who deliberately rubbed into his skin strong solutions of DDT in a way that is not likely to happen in practice. Symptoms characteristic of DDT poisoning as revealed

by experiments on animals were produced, but recovery was gradual and complete.

The death due to DDT of a 19-months-old child of a West African soldier was reported in the British Medical Journal. The child died four hours after drinking approximately an ounce of 5 per cent DDT in crude kerosene. It is reported that the insecticide and not the kerosene caused the death, although the evidence given is open to question.

Lt. Col. O. R. McCoy, chief of the Tropical Disease Control Branch, Office of the Surgeon General, U. S. Army, has given me the following information on the death due to DDT poisoning of several natives on Okinawa. A native woman obtained a can containing DDT and, believing it to be baking powder or baking soda, used it for preparing fritters. These fritters did not rise quite so well as expected and she added a little more powder. Exact amounts were not known, or the number of fritters prepared or consumed. No one knew whether the powder was 100 per cent DDT or whether it was the DDT louse powder (10 per cent).

The total number of persons eating the fritters has not been determined, but about 35 consumers developed symptoms. The onset for severe cases was between 24 and 48 hours after ingestion, but others developed symptoms 3 to 5 days later. Extreme hyperesthesia of fingers and toes, with a sense of numbness, was the first thing noted. The feet became extremely tender and painful so that walking became impossible. There was no gastro-intestinal irritation, no nausea, vomiting, or diarrhea. These symptoms lasted for 1 or 2 weeks or longer.

Twelve of the victims suffered a progression of symptoms, became comatose and eventually died. Autopsies were performed on some of the fatal cases, and tissues as well as some of the fritters were sent to the U. S. Public Health Service for quantitative DDT determinations.<sup>1</sup>

<sup>1</sup> After the above was written it was learned that thallium, not DDT, had been found in the fritters and tissues submitted for quantitative analysis.

The toxicity of DDT in aerosols has been studied by P. A. Neal and W. F. Von Oettingen. Three years ago they exposed two human subjects for 1 hour on 6 consecutive days in a sealed chamber to 10.4 grams of an aerosol containing 5 per cent of DDT, 10 per cent of cyclohexanone, and 85 per cent of Freon. According to their report these tests "failed to show any subjective or objective manifestations referable to DDT." These workers also point out that the amount of DDT to which these two individuals were exposed was at least 10 times as great as would result from the household use of a single DDT aerosol bomb.

A year later one of these subjects was given 475 milligrams of DDT dissolved in olive oil by mouth on an empty stomach and a few months later 770 milligrams under the same conditions. Careful and thorough examinations have given no untoward effects from the ingestion of DDT in the manner described, according to Drs. Neal and Von Oettingen.

Since there is no specific antidote for DDT poisoning, the treatment has to be symptomatic. It is of paramount importance to prevent further absorption by removing any DDT from the skin by washing with soap and warm water or, in the case of ingestion, by removing it from the stomach by lavage with warm water or from the intestine by saline cathartics. Nervous manifestations, such as tremors and convulsions, experiments with animals by H. O. Calvery and co-workers in the Food and Drug Administration, indicate, can be controlled by phenobarbital, which, may prove lifesaving even in severe cases.

Interesting accounts of the poisoning of animals and wildlife, some of which are fallacious and unfortunate, have reached us.

On July 20 of last year the following telegram was received in our office: "We have valuable bull to which we applied spray of DDT in kerosene oil week ago. Now unable to stand up. Can you advise anything helpful?" The wire was answered by L. T. Giltner, of the Pathologi-

cal Division of the Bureau of Animal Industry:

"Experiments carried out by the Department have shown that a 900-pound cow may be given as much as  $1\frac{1}{3}$  ounces of DDT by mouth daily for 6 days without causing symptoms of poisoning. . . . In the case of your bull, it is possible that the kerosene, if used in considerable quantity over large areas of the body, may have caused severe skin inflammation as well as other symptoms of poisoning, including marked weakness and paralysis."

The bull died, apparently from oil poisoning, but DDT got the blame.

According to findings of several toxicologists, the symptoms of DDT poisoning in animals include hyper-excitability, nervousness, generalized tremors, clonic-tonic type of convulsions, and coma ending in death. The convulsions resemble closely those seen in strychnine poisoning, in that they can be elicited by mechanical stimuli, such as sudden noise and jarring. Technical DDT does not cause irritation of the skin in either animals or humans, nor is there definite evidence of a sensitizing effect on the skin or of other allergic reactions such as asthma. It should be emphasized, however, that certain solvents used in the preparation of DDT sprays and aerosols are in themselves skin irritants with sufficient exposure. It should also be emphasized that the symptoms produced by these solvents set in rather promptly, whereas symptoms produced by DDT develop only after several hours.

Wild ducks dying at the rate of about 200 daily in the Tampa Bay section of Florida last fall prompted considerable newspaper publicity. Local people attributed this loss to DDT poisoning, presumably because several weeks previously the bay had been sprayed with DDT as part of the local mosquito-control program. On January 7, 1946, Clarence Cottam, chief of the Division of Wildlife Research, Fish and Wildlife Service, wrote me, "We have been entirely unable as yet to determine the causes of this loss, but from evidence that I have seen I am convinced DDT poisoning was not responsible."

I am confident, however, that injudicious use of DDT has been responsible elsewhere for the loss of wildlife.

Last summer I witnessed the treatment by air of a peninsula several miles long and a few hundred yards wide. Mosquitoes were very annoying in the area, and immediate control measures were desired. A 20-mile wind was blowing from the west, and in order to make sure of adequate coverage along the western margin of the peninsula the pilot flew over it repeatedly, releasing several times the intended dosage of  $\frac{1}{2}$  pound of DDT per acre. The westerly wind also piled up along the shore line the DDT spray that had fallen on the waters of the bay. There is no doubt, therefore, that the concentration of DDT along the western shore was heavy.

No dead birds were observed, but 3 days later an estimated 100,000 small dead fish, menhaden, mullet, and killifish were seen along the entire shore line. This is an example of harm that can be caused when reasonable precautions are not taken. When aircraft is used for dispersing DDT, the velocity of the wind is an important factor in putting the spray where it is needed and in the amount recommended—about 0.1 pound per acre.

Workers in the Bureau of Entomology and Plant Quarantine have determined that livestock can graze in pastures sprayed or dusted with DDT in dosages as high as 2 pounds per acre without apparent injury. However, when 2 horses, 2 sheep, 2 goats, and 2 cattle were pastured in vegetation treated with  $7\frac{1}{2}$  pounds of DDT per acre, after the sixth day the cattle gave signs of stiffness which became severe. The other animals did not seem to be affected. At the end of the test the animals were moved to clean pasture and the cattle recovered fully in a week's time.

The practice of grazing milk cattle on areas treated with DDT, however, is hazardous for another reason. It has been shown that when DDT is ingested by milk cows as much as 3 parts of DDT per million can be reclaimed from the

milk. Flies and rats have been killed by feeding on milk produced by cows fed DDT, and nursing pups have been killed by feeding DDT to the mothers.

Apparently DDT dusts or water-dispersible DDT in suspensions can be dusted and sprayed on livestock without absorption or injury. We do not recommend the use of oil sprays or DDT in oil sprays on livestock.

The following account in the Florida Cattleman of reducing a population of horn flies on cattle is so incredible that it may be well to report it here as a fact:

"Orange County, Florida, raises cattle, lots of them. Last July and August a plague of horn flies hit the ranches. The cattle bunched up for protection, stood belly-deep in streams for hours, and couldn't eat or rest properly. Calves were starving because the cows couldn't stand still. W. G. Bruce, an entomologist in the Bureau of Entomology and Plant Quarantine, thought the situation would provide an ideal experiment. Seventy ranchers who own almost all the cattle in the 350-square-mile County signed up for the test. Over 25,000 cattle were sprayed or dipped and over 200,000 square feet of dairy-barn and stable surface were sprayed. Results were immediate and spectacular. Within 2 days only 2 or 3 flies could be found where some 4,000 horn flies had pestered each cow before the test."

Although we have had second- or third-hand reports of dogs killed by treatment with DDT, our entomologists have observed no injury to 45 dogs receiving a total of more than 200 treatments in flea and dog tick control tests. These animals have been dipped in 5 per cent of DDT in benzene emulsion, in 1 per cent of DDT in pine oil emulsion, in 1-per-cent water-dispersible DDT suspension, and have been dusted with 10 per cent of DDT in pyrophyllite or talc.

Cats on the other hand, have been killed when dipped in 5-per-cent DDT emulsions or treated with 10-per-cent DDT dusts.

DDT has not been found more effective than derris wash for the control of ticks

on dogs, and we still prefer derris for this purpose.

When fish are involved, extreme caution should be exercised in the use of DDT. For mosquito control we suggest the use of less than  $\frac{1}{2}$  pound of DDT per acre in an oil solution to avoid injury to fishes, crabs, and crayfish. This dosage is sufficient to control mosquito larvae and adults under most conditions. Preliminary tests have indicated that emulsions are most toxic to fish, solutions next, and suspensions considerably less so. We also recommend using DDT only in calm, dry weather, so that coverage can be controlled and overdosage reduced to a minimum.

We have called DDT the perfect answer for the bedbug problem. It is very effective against adult flies but not against their larvae. When thoroughly applied it gives great promise in the control of most other insects affecting the household such as brown dog ticks, silverfish, carpet beetles, clothes moths, and cockroaches. DDT solved the body louse problem, and consequently knocked out typhus in World War II. It is the most effective insecticide known against the Japanese beetle, but it is of little use against the cotton boll weevil, the Mexican bean beetle, the cattle grub, the screwworm, chiggers, the sugarcane borer, the cotton leafworm, red spiders, and certain scales.

Information to date indicates that when used in recommended amounts it does not affect most plants although it does injure squash and related species. However, when used at the rate of 25 pounds per acre, it has been found to retard the growth of some kinds of vegetables and flowering plants. Workers in the Bureau of Plant Industry, Soils, and Agricultural Engineering are also testing the effect of DDT on the growth of several kinds of field crops.

The chemical DDT alone is not suitable for use as an insecticide. It should only be used in greatly diluted formulations. For example, a 10-per-cent dust is the highest concentration of any DDT product recommended for final use

whereas 5 and 2.5 per cent and even lower strengths are recommended for sprays. DDT insecticides are now available in several forms—in aerosols, in solutions, in concentrates for use in preparing emulsions, in water-dispersible powders for use in suspensions, and in dusts. Of these forms, the water-dispersible powders are probably the most practical and safest for use on livestock and around farm buildings. Within homes a greaseless refined kerosene containing 5 per cent of DDT is preferred for use as a residual spray.

Purchasers should insist that the preparations they buy show the DDT content. Some labels describe the contents as 100 per cent active, but the contents can be 99.9 per cent of kerosene and 0.1 per cent of DDT without violating the law.

There is some evidence that temperature has a marked influence on the effectiveness of DDT. Unlike many other insecticides, the chemical is more effective at low temperatures than at high temperatures, at least, against some insects.

We have had many reports of unsatisfactory results from the use of DDT. In most of these instances the insecticide was haphazardly used. The householder did not differentiate between its value as a space spray and a residual spray, or the spray contained too little DDT or none at all.

While in Mexico last September I saw a bottle the label of which read "Contains DDT." The material, however, failed to kill bedbugs, and if bedbugs are not killed with this insecticide something must be

radically wrong. The contents were, therefore, analyzed and no trace of DDT was present. No doubt other examples of this kind are known.

Within 5 years DDT has risen from an obscure chemical curiosity to one of our most efficient insecticides—when properly applied to the proper insect. And this, of course, is true of all insecticides. DDT should never be considered as a general all-purpose spray. It must be used wisely and according to directions. In the absence of such directions, it is preferable to use other standard insecticides.

In citing these facts and fallacies, we do not wish to minimize the hazard of using the chemical. It is a poison, and it is toxic to man, but it is not so dangerous as lead arsenate, paris green, sodium fluoride, and some other insecticides that are in common use. The experience of the Bureau of Entomology and Plant Quarantine, the Public Health Service, and the Rockefeller Foundation, the extensive use of large quantities by the armed forces all over the world, and experimental work on animals by the Food and Drug Administration and the National Institute of Health have shown that it can be used safely if properly labeled, if properly applied, and if reasonable precautions for poisons are followed.

Fortunately for us who are interested in controlling *Anopheles* mosquitoes and malaria, DDT offers an entirely new and economical method of attack. I refer to its use as a residual spray to the interior surfaces of native homes. When used in this manner it kills the anopheline without injury to other life.