Pesticides

The extent of pesticide hazards and whether the present use of pesticides constitutes a public health problem of considerable or of minimal importance were discussed at the first American Medical Association Congress on Environmental Health Problems, 1–2 May 1964, in Chicago, Illinois.

Opinions, of course, were divergent. The cleavage was more apparent depending upon whether the participant sought to forecast events along theoretical lines or to understand the present and foreseeable future effects of pesticides upon man and the environment. However, in spite of the different attitudes, the need for further study was clearly evident. More research is needed, particularly on the threshold levels, the storage of pesticides in human fats, and the assimilation routes of pesticides—ingestion, respiration, and dermal absorption.

Pesticides—which by definition include herbicides, fungicides, rodenticides, as well as insectides—have pervaded much of the environment and have established a feedback routing to man, according to Irma West (California Department of Public Health). The avenues by which pesticides find ingress are not always the obvious ones, such as contaminated soil, water, air, and food. Residues left on clothing by cleaning solvents and mothproofing solutions, furnace filters, and paper used for lining shelves and drawers in the kitchen may also transmit pesticides to man. Furthermore, many pesticides accumulate in living tissues, with the result that many unforeseen, irrevocable, and undesirable side effects have arisen on a sizable scale.

Too little was known about chlorinated hydrocarbons, such as DDT, when they were brought into massive agricultural use. That some mistakes were made was to be expected, West said, but these mistakes should be recognized and analyzed to prevent similar misadventures in the future. Major concern has been given to the establishment of tolerances and appropriate safety margins in connection with the use of pesticides on food crops. But this has, in effect, served as somewhat of a barrier to checking out other areas connected with the use of pesticides. No monitoring and human surveillance system to provide comprehensive and representative data about locations, amounts, and trends of overall environmental contamination has been established. Nor are we technically prepared to predict what, if any, significant long-term effects this contamination may have on animal and human life.

Mitchell R. Zavon (University of Cincinnati College of Medicine) presented a more clinical view of the matter. Any discussion of the use of pesticides, he said, must be prefaced with the overriding consideration that war and pestilence—the result of an inadequate food supply for the world's increasing population—is a much more certain route to human oblivion. There are no definitive answers concerning pecticides and the environment. More study is certainly needed. But answers, in many instances, may have to await the development of basic analytical methods for measuring parts per billion or parts per trillion—the quantities of pesticides which may need consideration. Perhaps more beclouding, however, are the prejudice, hysteria, and political considerations which have made it difficult at times for rational scientific objectivity to prevail. Allegations, for instance, that pesticides may cause subtle, ill defined effects cannot be refuted because science does not know what to refute.

From his own standpoint, Zavon found nothing particularly mysterious or abnormally threatening in the use of pesticides. The fact is, he pointed out, we have no evidence at present that the extremely small amounts of certain pesticides which may be found in our food or general environment cause us any harm. Furthermore, reports indicate the pesticide-wildlife problem is probably manageable if those concerned can work in a spirit of cooperation. The problem, then, becomes one of human pesticide intoxication, and here effects are known and can be discussed objectively. To begin with, he said, pesticide intoxication is actually an uncommon occurrence, and is mostly a case of accidental ingestion. More often than not, diagnosis of pesticide poisoning poses no new problem. Arsenic, mercury, thallium, fluorine, phosphorus, and their compounds are commonly used and cause the same type of intoxication they did before the appearance of DDT and other synthetic organic compounds. More people are known to die from these older pesticides each year in the United States than die from overexposure to all of the newer pesticides combined. Moreover, most reports of DDT intoxication have proved to be due to the solvent, frequently kerosene. This has not been true, however, of some other chlorinated hydrocarbon compounds.

In general, illness resulting from exposure to chemicals used in pesticides demonstrates a disease pattern which is specific for that particular chemical. And while there may be variations in response to the chemical, they are comparatively narrow, and treatment is possible for acute type intoxication —the only type known.

Elaborating on the point of pesticide intoxication incidence, Wayland J. Hayes, Jr. (U.S. Public Health Service Communicable Disease Center), pointed out that in the United States, pesticides cause about one-tenth of the annual accidental poisoning mortality, or about 1 death per 1,000,000 population. The introduction of new pesticides has not changed this figure, which has remained fairly uniform the past 25 years. Perhaps deaths from the newer pesticides have merely offset deaths caused by the substances, such as arsenicals, which they have partially replaced. Nor is there anything remarkably different in those cases of pesticide poisoning which do occur. They follow the same general pattern as poisoning caused by other substances, including higher prevalence among children.

The overt hazards of the new pesticides, then, do not appear to be too great, especially in view of the fact that the United States is producing over 700 million pounds of pesticides annually—twice as much as in 1949. There can be no doubt that wise administration of the extensive state and federal regulations, under which pesticides are sold and used, is responsible for the relatively good safety record of pesticides in this country.

Turning to the matter of severity of illness imposed by pesticide poisoning, the ratio of nonfatal to fatal cases appears to be about 100 to 1 for the entire population. It is clear from the record that many of the nonfatal cases are so mild that they might not have been reported if they had not been covered by workmen's compensation.

One clear effect of exposure to certain pesticides, he continued, is their storage in the body; however, unlike mortality and morbidity, storage does not necessarily imply injury. The most recent survey shows that storage of

DDT-derived material in body fat averaged 12.9 ppm for the general population, and repeated surveys have shown that there has been no significant change since these levels were first measured in 1950.

The well established clinical picture of pesticide intoxication does not, of course, exclude the possibility that individual pesticides or groups of pesticides may have effects not yet detected. Certainly more objective study by professional toxicologists is needed, particularly concerning the means by which poisoning occurs. The fact that the use of biological threshold limits has proved difficult, as with mercury, brings us face to face with our ignorance of the dynamics of the storage of chemicals in the human body and the need for further research.

In any event, added Robert Blackwell Smith, Jr. (Medical College of Virginia), it is necessary to accept one fact of life: safety is a negative condition, the absence of hazard, and no amount of research or study will ever provide absolute assurance of safety. Concerning the use of insecticides on food crops there is no cause for alarm, for it is now possible to assure practical certainty of safety. And, as research improves our knowledge, the degree of assurance will improve, he said. In the future it may be possible to control many of our major insect pests with nonchemical or specific chemical methods without even the minimal hazards of our present methods. For the present, however, insecticides will be needed.

As for regulation, Parke C. Brinkley (National Agricultural Chemicals Association) said he believes that a good, strong regulatory program wisely administered at both the state and federal levels is in the best interest of all concerned. At the same time, needless laws, rules, and regulations discourage the developing and marketing of new and better products for farmers and public health officials.

To summarize, there are uncertainties in the use of pesticides, but the overt hazards are no greater today than a decade ago and are probably far outweighed by the advantages of food production and the potential control of some 27 diseases which afflict mankind.

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Organic Solid State

The physics and chemistry of the organic solid state is a rapidly advancing field which recently has been very fruitfully explored by spectroscopists, chemists, and molecular biologists. Much of the discussion of this progress has been conducted at exclusive little meetings, which may account for the high quality of the work but tends to leave the rest of the scientific community unapprised of recent concepts and discoveries. A symposium on the organic solid state, held annually at the Franklin Institute, Philadelphia, Pennsylvania, serves as a channel of communication and discussion between specialists in this field and others whose interest is not so direct. The second symposium held 25 May 1964, presided over by M. M. Labes, consisted of four tutorial lectures by specialists in phenomena of excitation transfer, electron spin states, microbiology, and polymerization uniquely found in organic solids.

Recent experiments by G. W. Robinson, R. G. Kepler, and M. Silver, for example, have shown what happens when a photon interacts with a whole organic crystal. The photon migrates through the crystal as an exciton until it encounters either another exciton or a lattice site of special nature, or until its natural lifetime expires. The special mechanisms which permit this behavior were reviewed by J. Jortner; he presented a model of a molecular aromatic crystal whose molecules interact through electron exchange as well as by the usual electrical multipole forces. This mechanism for excitation and charge exchange is as intriguing as it is controversial, because it might be involved in the phenomena of photoconductivity and redox reactions in organic and biological structures. Jortner showed cases where transitions to these charge-transfer states are significant enough to explain the spectral features of other weakly allowed electron transitions in crystals of pure aromatic compounds.

The concept of electron exchange in homomolecular organic crystals is a generalization from charge transfer complex crystals. Such solids are often stoichiometric mixtures of electron donors with acceptors which interact very little even in the crystal. The excited states in which an electron is transferred from a donor molecule to an acceptor are observed spectroscopically and are often characterized by strong absorption of light in the visible region. Solids containing good donors and strong acceptors sometimes display this exchange as a ground state reaction and result in a class of paramagnetic organic solids. D. B. Chesnut discussed what is known about electron states and transfer in some of these systems. He noted in particular his own work on the fascinating radical-ion salts in which tetracyanoquinodimethan appears in two oxidation states, with concomitant opportunity for facile electron and excitation migration.

H. Morawetz discussed some novel chemical reactions whose course is directed by the crystalline environment when they proceed in the pure solid. Some newer developments were polymerization reactions in which the symmetry of the monomer lattice is impressed upon the resulting chain molecule. The spectacular systems discovered by Okamura were described. Single crystals of trioxane were polymerized to yield polymeric methylene oxide in the form of oriented fibers ordered in three-dimensional arrays. Vinylstearate and *p*-acetaminostyrene crystals also polymerize to give an oriented product, but only when the reaction is conducted below the glass transition temperature T_g of the polymer. Above T_g the product is isotropic, showing that this temperature is characteristic of local disordered regions of the crystal and of the finished polymer.

The general relevance of various topics of solid-state chemistry and physics to the biological sciences were surveyed by G. Tollin. The ordering present in chloroplasts, mitochondria, rod cells of the eye, and myelin sheaths are at least suggestive of solid crystalline structures. The evidence for such organization in chloroplasts was outlined: spectral shifts and polarization, energy transfer, photovoltaic and photoconductive effects, thermoluminescence, and delayed fluorescence. The appearance of photochromism at 1°K indicates that electron transfer, stimulated optically, must occur. Evidence can also be cited for solid state processes in mitochondria and in eye rod-cells, in both of which energy or electrons must travel through ordered structures over distances of 0.1 micron. Projected experimental approaches must overcome problems of low contrast in electron microscopy and permit electrical and spectroscopic measurements in vivo. Perhaps, it was sug-