AIR POLLUTION research seminar

On December 18, 1956, in Cincinnati, the Public Health Service convened a national body of investigators in a 3-day seminar for planning research in the causes, effects, and control of air pollution.

Reports of four of the committees of that seminar are presented below in slightly revised form for the information of many who are interested in this work. Reports of the Medical Committee are to be published at a later date. This committee considered mainly the current toxicological studies related to air pollution.

Agricultural Committee

J. T. MIDDLETON, chairman

Air pollution significantly affects the agricultural economy of the country causing damage to animals and vegetation. Many plants respond to a concentration of air pollutants below that usually causing effects in animals, with notable exceptions such as carbon monoxide and hydrogen sulfide. Plants, therefore, may be useful indicators for the detection of air pollutants. The environment and genetic composition determine in large measure the influence of airborne toxicants to such an extent that, at present, it is difficult to prescribe allowable exposure to injurious materials.

The most important air pollutants affecting agriculture requiring additional research are the fluorine-containing compounds. The effect of compounds of bromine, chlorine, and iodine are recognized, but they are not of immediate practical importance.

Perhaps next in importance are the oxidants, such as ozone, nitrogen oxides, and oxidized organic materials acting as a complex, which are believed responsible for smog damage to plants.

Ethylene and perhaps other low-weight, unsaturated hydrocarbons are believed to produce adverse effects on a variety of agricultural crops, including flowers and other ornamentals.

Miscellaneous organic materials as represented by aromatic complexes and phenolic compounds may have adverse effects on plants and require study.

Sulfur dioxide has long been recognized as an airborne contaminant responsible for specific injury to vegetation, and has been more extensively investigated than any other air pollutant.

Other airborne contaminants include the heavy metals such as mercury, lead, arsenic, and selenium as well as miscellaneous materials

such as hydrogen sulfide, mercaptans, ammonia, and carbon monoxide.

A description of some of the principal research needs follows.

Research on the effects of fluorides upon plants and animals has shown the gross symptoms resulting from the accumulation of fluorine-containing compounds in animals and plants.

A specific need exists for a study of the mechanism of toxicity and ultimate fate of diverse fluorine-containing compounds in both animals and plants. Both chronic and acute effects of fluoride accumulation are recognized. Particular attention should be paid to studies emphasizing the effect on agriculture of realistic concentrations of fluoride such as those found in industrial areas. Such studies should include the role of fluorides in skeletal development and organ function both for laboratory and farm animals. The effects of fluorides on cellular constituents, uptake, and translocation of fluorides, fate of fluorides in cells, and the nature of resistance and susceptibility in plant material are needed to elucidate the mechanism of action of this important pollutant.

An important area of research also needing attention is the effect of fluorides upon structure and physiological function in animals and plants. Such studies should elucidate the influence of fluorides on assimilation, digestion, and metabolism of the essential nutrients, as well as their effect on lactation, reproduction, and other vital processes in animals. Related studies in plants are required to determine the effect of fluorides on the assimilation and utilization of nutrients, photosynthetic activity, respiration, and enzyme systems, as well as growth and yield. It is also necessary that the degree of foliar necrosis, fluoride content of tissue, and rate of fluoride uptake be related to possible economic plant damage.

Environment and genetic composition materially affect the manifestation of fluoride accumulation in animals and plants. Factors which may affect fluoride toxicity in animals are different levels of nutrition, the presence of other toxicants and diseases, stage of development, pregnancy, and lactation. The response of plants to fluorides under different environments, including varied climatic conditions, fertility, and water relations, requires investigation.

Some study should be made of the alleviation of fluoride effects in animals through management practices and therapeutic treatment.

Protective measures may be developed to reduce the effect of fluorides to sensitive plants.

Although methods for fluorine analysis in plant tissue are reasonably satisfactory at present, analytical methods for fluorides in air and animal tissue are somewhat less satisfactory and require further study.

Research on the influence of sulfur dioxide has been energetically pursued for the past 75 years. The results of these studies have resolved most of the problems affecting agriculture. Those that remain include the effect of sulfuric acid, aerosols, and sulfur dioxide on animals as well as the mechanism of their toxicity singly, together, and in combination with other contaminants.

Oxidants have been recognized as plant damaging agents for more than a decade in certain urban areas, notably in Los Angeles. Although some of the oxidants have been identified as ozone and nitrogen oxides, the agents responsible for most of the injuries to vegetation remain unknown though they are believed to be oxidized organics arising from photochemical reactions in the atmosphere.

There is a real need to develop analytical methods for the identification and determination of oxidants, and to determine the mode of action of the toxicants and their effect on metabolism and growth of plants and possible effects on animals. The gross manifestations of oxidants on plants are generally known.

Organic materials comprise a group of contaminants which have adverse effects upon plants and possibly animals. Ethylene and perhaps other low-weight, unsaturated hydrocarbons may be intimately associated with significant economic damage to orchids, floricultural and ornamental plants, as well as a variety of other agricultural crops. It is believed that ethylene is damaging to some plants at concentrations in parts per billion range, while no effect is recognized in animals at this concentration. A critical need exists for analytical techniques suitable for the detection and monitoring of ethylene and related materials.

Other organic compounds such as those found in the aromatic complexes have been implicated in certain instances of damage to vegetation but insufficient information is available to determine the exact nature of the material and its biological effect. It is presumed that a variety of miscellaneous organic materials might likewise be incorporated in this research area, such as growth regulators, fungicides, insecticides, and other agricultural chemicals.

Although mercury has a low vapor pressure, it has been known for some time to be an air pollutant, responsible for plant injury in enclosed spaces. The recent introduction of mercurial paints for use in greenhouses has renewed interest in this problem and emphasizes the need for a reevaluation of this toxicant. Similarly other elements including heavy metals are known to produce adverse biological effects; among these are arsenic, cadmium, lead, and selenium which in the past have been known to occur as air pollutants and should be reviewed periodically and kept in mind as air contaminants of possible importance to agriculture.

Other known air pollutants exemplified by hydrogen sulfide, mercaptans, ammonia, nitric acid, and carbon monoxide, while toxic to plants and animals, are not considered of importance to agriculture except under conditions of gross accidental discharge to the atmosphere.

Though they are recognized as important, this report does not include consideration of radioactive materials.

The air pollution research program in agriculture requires assistance and cooperation of chemical groups in developing needed analytical techniques, engineers for developing corrective and protective devices as well as air handling facilities for specific fumigation studies, meteorologists for assistance in understanding air contaminant dispersion patterns, and medical groups in developing and evaluating bioassay systems for identification and distribution of air pollutants.

The U. S. Department of Agriculture should augment funds available to existing research facilities and management services so that they may actively study from basic and applied points of view the factors affecting the occurrence and result of air pollution upon agriculture. The U. S. Department of Agriculture with the Public Health Service should support liaison with private, industrial, and public research organizations.

The suggested research needs fall within the disciplines and competence of a large number of existing research organizations and they should be supported and encouraged to attack these problems.

Chemical, Aerosol, and Instrumentation Committee

LEWIS H. ROGERS, chairman

The projects listed below represent the combined efforts of some 30 scientists assembled to outline research areas and projects in the aerosol, chemical, and instrumental field which, in their opinion, require additional research. Taking cognizance of existing projects, the Chemical, Aerosol, and Instrumentation Committee attempted to develop projects not now being carried on. The order of presentation of projects is by subject matter and should not be taken to imply relative ranking according to importance. The group feels that sampling and analyses are such essential tools in all phases of air pollution that work in this field is needed before other problems can be attacked. Specifically, methods must be developed with precisely known accuracies, reproducibilities, and freedom from interference.

It is further recognized that an early start must be made in the study of certain basic problems because of the length of time required for their solution. During the discussions, it became apparent that one of the great needs of the field is for breakthroughs which fundamental research fosters.

In the following list short-, medium-, and long-range projects are designated by the letters S, M, and L, respectively.

Aerosols

Formation of Aerosols

Mechanism of smoke and fume formation including methods of modification (M).

Formation of aerosols during photolysis of polluted atmospheres (M).

Application of the particle-size spectrometer to nucleation studies (S).

Relationship of the composition of aerosols