Meetings

Air Pollution

A clear conflict exists between the use of the atmosphere to sustain human life and its use as a repository for the waste products of human civilization, according to three members of the AAAS Air Conservation Commission. The question is whether the conflict can be resolved in favor of biologic man without substantially altering his civilization. One member suggested that we may one day have "air zoning" even as we now have land zoning.

The three participated in a symposium, "The Scientist Looks at Air Conservation," held 29 December 1963 at the AAAS annual meeting in Cleveland. Chairman of the panel was James P. Dixon, Jr. (president of Antioch College and chairman of the commission). The speakers were John R. Goldsmith (Air Pollution Medical Studies Unit, California State Department of Public Health, Berkeley), François N. Frenkiel (Applied Mathematics Laboratory, David Taylor Model Basin, Washington, D.C., and University of Minnesota), and Howard Higman (University of Colorado).

Goldsmith, viewing the problem as a biologist, outlined the known and possible effects of air pollution on humans, animals, and plant life. He pointed out that the problem is not confined to a few major cities or a few areas with odd atmospheric problems. The smog damage first noticed in vegetation in Los Angeles in 1944 may now be found in 20 states on the eastern seaboard and in the District of Columbia. Its effects are evident in cities throughout the world. He said, "From this time forth, we must recognize that air pollution is a universal and permanent problem, and from the biologic view of man, it requires long-range, widespread, preventive action in order to maintain man's favored biologic position."

Goldsmith referred to the air-pollution disasters that have struck in London, in Donora, Pennsylvania, and in the Meuse Valley, Belgium, and suggested that in other places air pollution may have resulted in higher rates of morbidity and mortality by aggravating cardiopulmonary diseases. He also noted the epidemiologic studies in Great Britain that have demonstrated a significant association between air pollution and lung cancer, chronic bronchitis mortality, and morbidity from chronic bronchitis. He suggested that air pollution may be a factor of etiologic importance in chronic lung disease in the United States.

He also referred to the effects of specific pollutants: (i) sulfur dioxide and its effect on resistance to air flow into and out of the lungs of man and animals; (ii) carbon monoxide and the consequences to the body of its combination with hemoglobin; and (iii) motor vehicle exhaust, after being transformed by sunlight into ozone and other pollutants, and its effect on the eye and respiratory tract. Goldsmith suggested that these several pollutants may increase the work of breathing and may seriously affect the survival of persons with acute vascular accidents. Specific industrial wastes may also cause devastating damage to vegetation. Certain species of ornamental plants cannot be grown in the Los Angeles area; commercial production of certain crops, such as alfalfa and leafy vegetables, is now impossible in the Los Angeles basin. He suggested that air pollution may adversely affect citrus crops although no leaf damage is evident.

Although the effects of air pollution on invertebrates has not been the subject of extensive study, Goldsmith said that one report shows they are also affected. The mottled coloring of the moth *Biston betularia* has changed in a mutant strain. This moth customarily spends its adult life on the bark of the oak tree; however, in the heavily industrialized sections of England the oak bark has been so darkened by air pollution that a black mutant variety developed to match the new coloration.

The effect of air pollution on cattle has also been noted, Goldsmith said. Long-term pollution of foliage in pastures by fluoride pollutants resulted in crippling and fatal illnesses during the 1952 London disaster. "Thus, it is established that air pollution has killed, caused chronic disease, led to impaired functions and sensory irritation in humans, destroyed crops and property, has killed or crippled cattle, and has produced drastic ecologic changes. The threat of air pollution includes the possibility of aggravation of pre-existing lung and heart disease, the possibility of further chronic disease production, and the possibility that commonly occurring levels of pollution may handicap persons with acute illness, premature infants, or those recovering from surgery. These hazards are widespread and they tend to increase with increasing pollution: the very pollution that tends to increase with rising living standards and increased populations. These effects may be produced by agents that may not provide a warning signal by the production of visible or odorous clues."

With large segments of the world population now striving anxiously to improve their material standard of living through industrialization, the problem will become even more acute. "We can no longer expect both a global increase in living standards and, without special precautions, an atmosphere that can sustain a full range of biological adaptability." ". . . Air conservation," Goldsmith said, "implies deliberate planning for the reduction of atmospheric wastes associated with technical progress."

Frenkiel, who presented a physical scientist's view of the problem, spoke in terms of distribution in space and time rather than absolute quantity of pollutants. "The main problem in air conservation," he said, "is related to the distribution of pollutants in the lower atmosphere as a function of time and space, rather than the overall quantity of each pollutant in the world atmosphere. The application of criteria permitting a selective use of the atmosphere for dispersal of pollutants seems to be desirable and could be very effective. At the same time we should be concerned with the possibility of saturating the atmosphere, at least in the future, with some pollutants to a degree at which they become harmful and indeed could lead to some permanent damages."

Frenkiel said that air pollutants may be solid particles, liquid droplets, vapors, or gases. The heavy materials usually fall near the source; the others are dispersed and often travel considerable distances. During their dispersion they may be changed chemically or physically by sunlight, rain, or fog. They may also be changed by interaction with other normal constituents of the atmosphere by interaction among or between themselves and form still other pollutants. Many are washed from the air by rain and end up on land or in the sea, others escape into outer space, and still others remain in the atmosphere for a considerable amount of time.

Pollutants usually are the undesirable or incidental consequences of industrial processes, Frenkiel said. Cities are not the sole contributors; a large number of small towns can produce a considerable addition to the pollution of the atmosphere.

The airborne cycle of pollutants begins with emission at the source; the other stages in the cycle are transfer, contact (with vegetation, animals, or man), and, sometimes, damage. At each point an effort could be made to reduce pollution. But, Frenkiel pointed out, it may be "quite impractical to get rid of atmospheric pollution altogether. A community, like a human being, breathes in clean air and breathes out pollutants. The very life of the community is accompanied by air pollution. The main problem is to prevent this companion of human activities from reaching a magnitude that becomes a great inconvenience and danger to the population."

Pollutants are dispersed by two basic kinds of air movements: the general air stream and air turbulence (both thermal and mechanical). To these are added the effects of size and weight of particles and the speed with which they fall to the ground or move upward. This vertical dispersion is affected not only by the nature of the pollutant, but also by the "stability" of the atmosphere. In a stable atmosphere, vertical air motion is at a minimum; in an unstable one, there is considerable motion upward and downward. When the normal situation is reversed, and temperature increases with altitude instead of decreasing, the resulting condition, known as an inversion, prevents almost all vertical motion and there can be no dispersion.

Frenkiel said that it is possible to construct a mathematical model in order to study the probable pollution patterns over an urban area. A simple model would include distribution of pollution sources, emission conditions, and the micrometeorological characteristics that directly effect dispersion of pollutants. It would then be possible, he said, to determine the mean concentration of pollutants due to each source and the effects of the several sources combined. It would be possible to find the mean concentration pattern of pollution over the urban areas as a function of time and the relative contributions of each of the sources of contamination at various points in the area analyzed.

The mathematical model could be used to determine (i) temporary emergency measures to be taken when pollution neared an allowable level, (ii) efficacy of plans to reduce pollution, (iii) effects of a new pollution source, (iv) pollution patterns for the urban area after expansion, and (v) effect of urban planning proposals on pollution levels.

The ultimate answer to the air pollution problem in cities may be "air zoning." "Land zoning is now an established practice to prevent deterioration of residential neighborhoods, the growth of slums, etc. Zoning the air above communities, however, would be a much more difficult problem, involving knowledge of the possible sources of pollution, local geographic and weather conditions, chemical changes of pollutants in the atmosphere, necessity for applying purification methods, and several other factors. . . .

"Zoning may be a good method to control pollution. It should be noted, however, that as far as air pollution is concerned, it is not the land that should be zoned, but the atmosphere. Such a zoning would differ from the usual land zoning since it does not have to lead to unconditional restrictions for the location of a pollution source in any desired area. . . . [A] pollution source could be given the choice among several or a combination of appropriate restrictions that would vary according to the location of the source in the community."

Higman, presenting the view of a social scientist, outlined some of the obstacles to adopting air conservation proposals: (i) Those who object to adoption of controls may argue that more research is needed. Although this is true, enough is known already, he said, to warrant the establishment of controls now. (ii) It might be difficult to determine who should take steps to reduce pollution—the biggest source or the newest one. (iii) Some will argue for local controls rather than the much broader control base needed. (iv) The public will be confronted with the necessity of mass transportation systems. (v) Disagreement among scientists may cloud the issue. (vi) Some may maintain that scientists should not become involved in public policy.

The Air Conservation Commission was established by the AAAS Committee on Science in the Promotion of Human Welfare in 1962. The 12 members of the commission represent the medical, physical, and social sciences.

JAMES P. DIXON
Antioch College, Yellow Springs, Ohio

Early Man in the New World

The material complexes of the late Pleistocene cultures of North America were the focus of a three-session symposium of Section H of the AAAS. The purpose of the symposium was to present and evaluate problems of chronology, typology, and terminology in current Paleo-Indian studies. Recent research and discoveries in these earliest known complexes and their subsequent development and divergence were the main topics of the papers presented.

In 1962 Juan Armenta Camacho and Cynthia Irwin-Williams conducted archeological investigations in the Valsequillo Reservoir region near Puebla, Mexico. These investigations were designed to provide concrete evidence for or against the association of man-made artifacts with the large extinct faunal assemblage of the Valsequillo gravel formation of the late Pleistocene period. The assemblage includes mastodon, mammoth, horse, camel, dire wolf, and other extinct ungulates and