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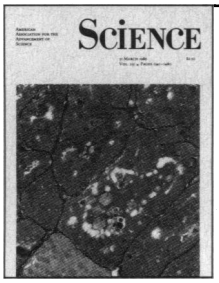

COVER Photomicrograph of pancreas from 8½-week-old transgenic mouse carrying an elastase-SV40 gene, stained with Heidenhain's Aniline Blue. A normal islet is adjacent to hypercellular and dysplastic acini, representing a preneoplastic stage associated with expression of SV40 large T antigen in exocrine cells (magnification, about ×800). See page 188. [Albee Messing, School of Veterinary Medicine, University of Wisconsin-Madison, Madison, WI 53706]

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Ozone and Acid Rain

Some level of deleterious effects of ozone, photochemical oxidants, and acid rain probably will be present for a long time. There will be no quick fixes. The phenomena involved in converting SO_2 and NO into more toxic substances are complex. Without understanding such phenomena and without knowledge to permit establishing realistic priorities on what needs to be curtailed and where, the United States could spend hundreds of billions of dollars ineffectively.

Congress was wise when in 1980 it mandated a major National Acid Precipitation Assessment Program (NAPAP). The activity involves 12 federal agencies and has a current annual budget of $85 million. Congress stipulated that efforts include programs to yield information about many aspects of acid rain. Examples are identification of sources, establishment of monitoring networks, research in atmospheric physics and chemistry, methods of controlling emissions, and identification of areas at risk. The program has led to publication of more than 1000 papers in peer-reviewed journals. It has also resulted in a recently issued interim report on acid precipitation.* The report consists of four volumes containing about 900 pages and a total bibliography of 1600 references. Preparation of the report, which is well-written, involved many authors and extensive peer reviews. The content is largely limited to research and observations performed in the United States.

In the discussion that follows, the emphasis is on the important roles of ozone and other oxidizing agents. The major polluting emissions are SO_2, NO, and volatile organic chemicals. In the usual ambient concentrations, these substances are relatively harmless. However, when SO_2 and NO are oxidized, they are converted into more acid, more toxic, substances. Oxidants, including OH, H_2O_2, HO_2, and organic peroxides, arise out of complex photochemistry that involves the ozone, the nitrogen oxides, and volatile organic chemicals. Were SO_2 the only pollutant, most of it would escape unchanged to the western Atlantic Ocean where it would be so diluted as to have no effect. At present about 35 percent of the SO_2 produced in the United States leaves the continent. In contrast, because of higher rates of reaction with oxidants, most of the NO is converted into nitric acid and deposited on land.

The nitrogen oxides are involved in the production of ozone, some of which is naturally present. But particularly in urban settings where concentrations of NO_x are elevated and volatile organic chemicals such as those in gasoline are present, ozone concentrations may rise to levels deleterious to health. The Environmental Protection Agency has set standards for levels not to be exceeded, but nearly half of urban communities are not in compliance. The NO_x involved in the formation of urban ozone comes mostly from vehicular emissions.

Ozone is toxic to plants, as has been shown by greenhouse experiments. Annually, ozone is thought to be responsible for more than $1 billion worth of damage to agricultural crops. Near Los Angeles, ozone and photochemical oxidants have damaged forests in the San Bernardino mountains. Extensive damage to trees high in the Appalachians is probably due to additive effects of ozone, oxidants, and very acid fog and rain. In the damage to forests, natural organic chemicals such as terpenes emitted from trees undoubtedly have important roles. The quantities of volatile chemicals emitted during the summer by vegetation exceeds those from anthropogenic sources.

In the past, efforts to abate air pollution have emphasized curtailment of SO_2 emissions. As a result, these have been reduced 27 percent. Comparable reduction of NO has not been achieved. Auto emissions have been reduced somewhat, but total NO from trucks has increased. Most of the reduction of SO_2 emissions was achieved by flue gas desulfurization at utility plants. That process is not effective in removing NO. A shift to more emphasis on the curtailment of emissions of NO seems necessary. Excellent technology for reducing NO emissions from new utility plants is now available. The problem of reducing NO from vehicles is more difficult and might require a costly program to replace gasoline by methanol as a motor fuel.—PHILIP H. ABELSON

*National Acid Precipitation Assessment Program, *Interim Assessment, The Causes and Effects of Acid Deposition* (Government Printing Office, Washington, DC, 1987).