urban areas. Oxidants may actually reach higher concentrations many miles downwind from cities than in the cities themselves. This is because the reactions causing the buildup of ozone are slow and allow time for the air mass to move away from the city. Also, city air contains materials that react with ozone and break it down. Other possible sources of the elevated ozone in nonurban areas are the stratospheric layer and electrical discharges such as lightning.

Most investigations of the effects of air pollution on plants have been concerned with acute exposures to one pollutant. Ambient air usually contains mixtures of noxious chemicals, however, and investigators are giving increasing attention to how they interact in producing their effects on plants. Again, no generalizations can be made. There is evidence that mixtures of two pollutants can act synergistically to produce greater effects than either would if present by itself in the same concentration. Harry Menser, now with

Speaking of Science

Communicating Mathematics: Is It Possible?

The problem of making mathematics understandable to the educated layman continues to be almost insurmountable.
—The Mathematical Sciences: A Report (*National Academy of Sciences, Washington, D.C., 1968*).

The National Science Foundation (NSF) is trying to explain mathematical research to the general public, but it is meeting with resistance from both mathematicians and the public. The NSF has hired a mathematician—Lynn Steen of St. Olaf's College in Northfield, Minnesota—to write nontechnical articles about mathematics for general interest magazines and newspapers and to study the problem of communication between mathematicians and the rest of the world. And, for the first time, organizers of the annual meeting of the American Mathematical Society and the Mathematical Association of America encouraged the press to cover their meeting. However, few articles about mathematical research have been published by the popular press, and only 4 out of the 80 members of the press who were invited to a press luncheon at the annual meeting decided to attend.

Most mathematicians agree that there is a nearly complete lack of communication between themselves and the general public. They differ, however, as to whether this situation can, or should, be changed. According to Steen, about two-thirds of the mathematicians he approached at the International Congress of Mathematicians in Vancouver, British Columbia, last summer were uninterested in explaining mathematics to those outside the field. Such an attitude is consistent with what Steen describes as a tradition in mathematics of emphasizing research communications rather than exposition. This emphasis was expressed by Fritz John of the Courant Institute of New York University who, when asked about his goals as a mathematician, said he was not interested in fame, fortune, or public acclaim but wanted only "the grudging admiration of a few colleagues."

Some mathematicians are enthusiastic about the possibility of explaining their subject to the general public, but even most of these researchers concur that the task may be nearly impossible. The problem, they agree, is caused by the language of mathematics. Although English and the mathematical language have common words such as group, field, model, and stability, the mathematical words have precise technical meanings. Johannes Weissinger of the Karlsruhe Institute of Technology in Germany once explained that mathematicians are trained to use only clearly defined terms and concepts. Yet English or other natural languages owe their expressiveness to the ambiguity of their words and phrases. Translating mathematics into English was described by one mathematician as being more difficult than translating Chinese poetry.

A few mathematicians are famous for their ability to explain their subject to others outside their field and often these expositors are among the most able mathematicians. This is no coincidence, according to Ronald Graham of Bell Laboratories in Murray Hill, New Jersey. Graham believes that those researchers who come up with the most innovative or the most profound results have the greatest insight into their subject. Because these people truly understand what they are doing, they can explain it to others. Lesser mathematicians, who extend the work of these leaders, may not have the intuition that leads to the concepts they use in their work.

Dale Lick of Old Dominion University in Norfolk, Virginia, says that mathematicians are finally becoming concerned about how little nonmathematicians know about their subject. This concern, he believes, is stimulated by the bleak employment prospects in mathematics. However, Lick admits that research in mathematics is exceedingly difficult to explain to the general public. An expedient, he suggests, is to seek publicity about other aspects of mathematics, such as employment, applications of mathematics to other fields, and mathematics education.

Although press coverage of other aspects of mathematics may help mathematicians feel that they are doing their part to gain national attention and perhaps increase their allotment of federal funds, nevertheless there remains the major difficulty of explaining to others exactly what mathematicians think about and why they care about their subject. Few mathematicians choose their subject so as to apply it to other fields. Often they choose it because they consider mathematical concepts to be beautiful. And, like other forms of beauty, mathematical beauty is highly subjective and difficult to communicate.—GINA BARI KOLATA