

An Overture

Why Acid Rain?

In graduate school I took a course entitled "Introduction to Biological Research" from the geneticist A.M. Winchester. We were to design and complete a research project in biology. I initiated a study on the effects of chronic low-intensity gamma radiation on the eggs, larvae, and pupae of *Drosophila melanogaster*. I vaguely remember the actual results. But I learned something that I have never forgotten. Chronic low-intensity changes of a system are as important as acute high-intensity changes. The concept of "chronic low intensity" has stayed with me. I now realize how universal this concept is; I also realize how few people pay attention to problems that don't have immediate and dramatic consequences. Every day we read about some environmental problem that has apparently been going on for some time and only now is it dramatic enough to gain attention. Some examples that come to mind are the effects of smoking, poor nutrition, and disposal of hazardous waste. People simply do not think about the long-term results of small, but continuous, changes of a system, be that respiratory system, human system, or ecosystem.

Exploring and understanding a concept such as the chronic low-intensity effects on a system makes it fairly easy to extend that idea to related problems. The important point is to be found in the change in percepts and concepts. Many science-related social issues require this type of perceptual and conceptual shift. For example, problems have shifted from those identified with a specific science discipline to those requiring an interdisciplinary approach, from local to global, from isolated to interactive phenomena, from obvious to subtle problems, from short to long term; and many have shifted from acute high-intensity to chronic low-intensity changes in human ecological systems.

In the next decades biology teachers will develop a new emphasis in their programs. We have already read of science, technology, and society themes in this journal. Acid rain is a prime candidate for such a new emphasis in science programs. The effects of CO₂ on the atmosphere and world climate will also deserve such emphasis.

In many places, rain is much more acidic than before the Industrial Revolution. Historically, uncontaminated rain usually had a slightly acidic pH, one between 5.6 and neutral (7.0). Acid rain is defined as precipitation having a pH of less than 5.6. Acid rain has an effect on all aspects of the human environment. It seems to me that the inclusion of acid rain in life science programs needs very little justification. It also serves as a prime example of a problem that is chronic, low intensity, complex, interacting, interdisciplinary, and global. I have made no claim that teaching about acid rain is easy, only that it may be necessary.

Acid rain is a good example of a scientific problem that is also related to economic and political issues. In recent years some of the best scientific minds have investigated the phenomenon of acid rain. Conclusions about the consequences of acid rain on human ecological systems seem relatively clear. The results are detrimental and efforts should be made to reduce the problem. On the other hand, individuals who view the situation from an economic and political perspective are reluctant to accept the scientists' conclusions. Many of their arguments betray old perceptions and conceptions of the environment. They claim the problems are isolated phenomena, restricted to a single discipline, effects are short term, not significant, and so on. I believe we now know enough about acid rain that the topic should clearly be a part of biology programs. The scientists have done their work; now it is time the science educators do theirs.

Why acid rain? As biology teachers we have a commitment to inform the public about science-related social issues. Certainly acid rain is one of the important issues of our age. The environmental consequences of acid rain are topics of scientific study; but the consequences are also a public concern. The public will ultimately be required to make decisions about acid rain. Science teachers can provide

the critical link between research in science and education of the public about science. We are just beginning to understand the long-term detrimental changes caused by acid rain. The need for biology teachers to introduce the topic of acid rain is essential. Biology teachers could play a very important role in the public's understanding and reducing the detrimental effects of acid rain on the biosphere.

The first article in this special focus issue is an overview of the history, status, and trends of acid precipitation research by Ellis Cowling. Then Eville Gorham takes on the always difficult task of arguing that we have sufficient evidence of the effects of acid rain to begin action to reduce the causes. The third article is a discussion of acid rain in the context of public policy and human ecology.

The next articles are intended to provide concrete, practical suggestions and materials for biology teachers. The Acid Precipitation Awareness Program developed by ESEA Title IV and the Minnesota State Department of Education is described by its director, Harriett Stubbs. The article includes activities on pH, solutions, and buffering—topics that are basic to further study of acid rain. The How-To-Do-It article on page 228 contains activities specifically developed for this issue of *ABT*. The activities extend the concepts introduced in the Stubbs article by examining the sources and effects of acid rain.

In addition, a biology teacher, Janet Carlson, has provided a Perspective entitled "Why Teach About Acid Precipitation?" This issue also contains a resource guide and book reviews on acid rain. My aim is simple—to provide the biology teacher with one issue of *ABT* containing everything needed to begin teaching about acid rain.

I wish to acknowledge George Watts Hill, Jr., the Acid Rain Foundation, the Sloan Foundation, and the Science, Technology and Public Policy program at Carleton College for their support in the production of this issue of *ABT*.

Rodger W. Bybee, *Guest Editor*



(Photograph courtesy of the Canadian Embassy.)