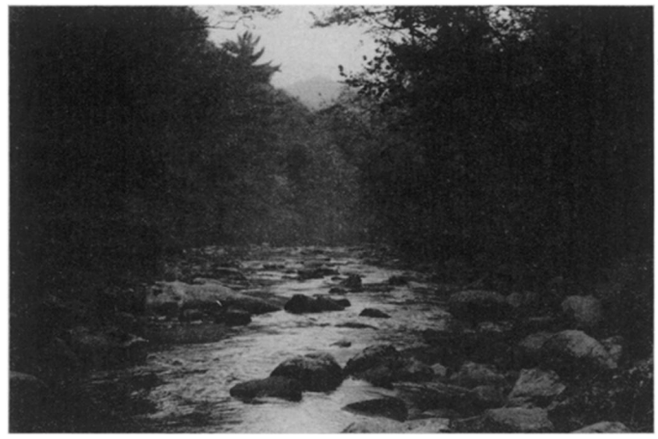
Soils and Acid Lakes: Finding Common Ground

After years of debate, scientists now agree that acid rain can acidify lakes and have identified the key factors that decide whether a particular lake or stream is sensitive to acid rain. Sulfur deposition, in the form of sulfur dioxide in air or sulfate ions in rain and snow, is largely responsible for the acidification of lakes and streams in areas like the northeastern United States, says a National Academy of Sciences panel of leading acid-rain researchers. They also say that even when sulfur deposition remains constant or begins to decline, water quality can continue to deteriorate with corresponding changes in plant and animal life.



I. Peterson

Mountain streams are particularly sensitive to acid rain.

This consensus reflects a recent shift among many acid rain researchers from the question of whether acid rain can acidify lakes to how quickly the process happens and how many lakes are vulnerable. "I had no idea that the nine of us would come out with that kind of joint understanding of what we think reality is," James N. Galloway of the University of Virginia in Charlottesville says. "That really is new." The nine panel members presented this new information to William D. Ruckelshaus, Environmental Protection Agency administrator, at a roundtable discussion last week.

"The soil is the key we're looking for," says Galloway. Soil particles are negatively charged and attract positive ions (cations), including aluminum and hydrogen ions and the base cations calcium, potassium and magnesium. Researchers have found that the more acid a soil is the higher the proportion of aluminum and hydrogen ions surrounding soil particles. When acid deposition introduces negatively charged sulfate ions into soil waters, these ions pull away cations from the soil particles. If the soils are very acidic to start with, then hydrogen and aluminum ions are more likely to be leached and travel with the sulfate into lakes and streams, increasing the water's acidity (hydrogen ion concentration) and adding toxic aluminum. Thus, watersheds surrounded by highly acidic soils become acidified, not because of the leaching of natural acids into the water, as some researchers had believed, but because of the role of sulfate, deposited from the atmosphere, in stripping aluminum and hydrogen ions from the soil.

Two processes affect the rate at which acidification occurs. One involves how quickly base cations are replaced by the weathering of minerals like limestone in the soil. The other is the ability of the soil to absorb sulfate, thus preventing it from leaking into streams and lakes. Soil scientist Dale Johnson of Oak Ridge National Laboratory in Tennessee says, "What we need to know very badly, and don't have a very good handle on right now, is the rate at which those exchangeable base cations [those ions surrounding soil particles] are replenished from the nonexchangeable reserves."

The vulnerability of a body of water to acidification due to sulfate deposition depends on how much sulfate falls into a watershed, the paths that water follows through the soil (SN: 5/21/83, p. 332), the natural acidity of a soil, the soil's ability to absorb sulfate and the rate at which base cations are released by the weathering of minerals (which depends on the type of bedrock). These factors vary widely for individual lakes and streams. Galloway likens the two extreme cases to water sitting in a marble bathtub, which has a limitless supply of base cations and never becomes acidified, and water sitting in a quartz bathtub, which responds immediately to any acid sulfate input. Natural lakes and streams can fall anywhere along the continuum between these two cases.

Years of sulfate deposition can gradually deplete a soil's ability to absorb sulfate or replace base cations. Thus, it is possible for certain types of lakes at first to show little response to acid rain for years or decades and then to suffer a sudden, rapid decline. Geologist Stephen A. Norton of the University of Maine in Orono demonstrated this effect using chemical analyses of lake-bottom sediments from lakes in the Adirondacks in New York. He also showed that the chemistry of the sediments was still changing although the level of deposition has remained virtually constant for the last few decades.

Also at last week's meeting, Richard F. Wright of the Norwegian Institute for Water Research described a similar time-lag effect for aquatic life. Although acid deposition may level off, major, long-term biological changes continue to occur. Fish and other aquatic life that manage to live in acidified waters are also much more vulnerable, for instance, to sudden rainstorms, which carry a lot of sulfate and aluminum into the water within a short time. "In Norway, there has been no significant trend in acid deposition over the last 13 years," Wright says, "but salmon kills are still occurring."

One unresolved question involves how long lakes and soils will take to recover if, for example, sulfur deposition is reduced or eliminated. Equally important is the question of how many lakes are on the verge of becoming acidified if nothing is done to reduce sulfate deposition levels. Galloway says these were questions on which the panel could not yet reach a consensus. However, he adds, "Using information we have now, we can tell what the acidification state of a lake or stream is and give a general idea of what will happen in the future. But once we get more information on this rate of base cation supply to the ion exchange pool, then we'll...also be able to predict what will happen in the future given different scenarios for sulfur deposition."

Johnson says, "I think we're finally, after all these years, in a position that most soil people agree on the important mechanisms. Now, we've just got to quantify them, to sort out what's important at each site." —*I. Peterson*

Harp seal pups are hunted again

The immensely controversial Canadian harp-seal hunt kicked off March 11 amidst a spate of violence and contradictory allegations. About the only thing that remains crystal clear is that despite press accounts to the contrary, pups are among the animals being "harvested." The latter came as some surprise both to Canadian officials and to environmentalists who had stationed themselves in the Gulf of St. Lawrence to photograph the herd; only three days earlier the Canadian Sealers Association had vowed publicly to discontinue the slaughter of "white coats" — newborn pups two weeks of age and younger.

Until recently, white coats frequently accounted for 80 percent or more of the