Paleolimnological Evidence Indicates Adirondack Lake Acidification Due to Atmospheric Inputs

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It is often difficult to know how to respond to public statements such as Dale French's article, "Acid rain — So What?" Scientists depend on each other to ruthlessly critique one another's hypotheses. However, most of Mr. French's information appears to come from a single non-technical article by Dr. Edward Krug (1990), who is an extremely controversial figure in the field. I myself was once impressed by Dr. Krug's challenges to current thinking about acid rain damage, and by his willingness to face powerful intellectual opponents. By reading the technical literature and by speaking with investigators in the field over the last several years, I have now become convinced that the "mainstream" idea of acid rain as a major damaging force in the Adirondacks is basically correct, and that Krug is in fact a fringe figure because his ideas are poorly supported by the weight of evidence. Nonetheless, his writings still represent a favorite resource for those who wish to resist environmental policies.

What finally convinced me was the evidence generated by the field of study which both Dr. Krug and Mr. French refer to in their writings; paleolimnology (the study of lakes of the past through sediment microfossil and chemical analyses). In this vein, French quotes Krug's citation of sediment studies as showing that Lake Colby (actually Lake Colden) has been acidic and fishless for most of its history. The naturally acidic condition of Lake Colden is largely a result of peatland growth and is corroborated by sediment studies (Douglas and Smol, 1988). But Mr. French is mistaken when he concludes that the Colden story is typical of most Adirondack lakes and, by extension, that atmospheric pollutant deposition is only a minor problem and that the costs of reducing it by cutting industrial emissions are therefore too great.

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A RESPONSE TO DALE FRENCH'S ARTICLE, "ACID RAIN — SO WHAT?," *AJES FALL/WINTER '96*

The weight of paleolimnological evidence clearly indicates that widespread lake acidification has developed in concert with increasing industrial emissions over the last century (Husar, 1986), both in the Adirondacks and elsewhere. According to evidence from diatoms and midge remains preserved in lake sediment cores, Big Moose Lake's pH was about 5.8 for at least 150 years until the early 1950's, after which it declined to about 4.6 (Charles et al., 1987). These changes cannot be linked to watershed disturbances or natural processes because there has been very little fire, wind, or logging damage in the vicinity, because natural, vegetation-related acidification rates in Adirondack lakes studied thus far are much slower than the trends observed recently (Whitehead et al., 1989), and because there is no evidence of acid-producing peatland increases or other vegetation changes near the lake during that time period. However, acid rain is known to fall in the region today, and other pollutants produced by fossil fuel combustion have also increased in the sediments along with acidification (see below). By far the most reasonable explanation for these findings is that airborne pollutants are the primary causes of the recent changes in Big Moose Lake.

Chryosphyte algae and diatoms in the sediments of Upper Wallface Pond show that the lake's pH has fluctuated with changes in vegetation over the last 11,000 years (Christie and Smol, 1986), in much the same manner as that suggested by Mr. French and Dr. Krug. This is not surprising, since lakes are well known to change in response to long-term changes in climate, soils, and vegetation. However, the most rapid and dramatic acidification of the Upper Wallface record occurred in concert with increasing industrial emissions over the last few decades. Microfossils preserved in the sediments of Bear and Windfall Ponds and Deep Lake displayed a similar pattern (Smol and Dixit, 1990); again, the timing of the acidification was unrelated to local watershed disturbances. Re-

cent acidification and other pollutant impacts unrelated to watershed disturbances are also indicated by multiproxy evidence in the sediment records of Barnes, Merriam, and Queer Lakes (Charles et al., 1990).

In 1990, an overview of then-current paleolimnological knowledge of Adirondack lake acidification indicated that 7 out of the 48 lakes studied were acidic in pre-industrial times and that the degree of acidification in the other lakes was generally somewhat less than previously supposed (Sullivan et al., 1990). However, the overall conclusion of that paper remained that significant anthropogenic acidification has been widespread in poorly buffered Adirondack waters. A later report on the paleolimnological records of 20 low-alkalinity lakes concluded that only a few of the lakes show little or no response to anthropogenic acidification (Cumming et al., 1994). Of the majority, even those which were naturally acidic experienced pH declines in recent decades.

There is now virtually no reasonable doubt that atmospheric deposition has acidified a significant number of Adirondack lakes, although at present most of them are small and lie at high elevations. In addition, the problem of atmospheric pollution actually extends well beyond Mr. French's focus on sulfur inputs. Nitrogen compounds in fallout from acid rain have been shown to alter even marine ecosystems (Fanning, 1989), and they are likely to severely affect Adirondack lakes as well (Stager, 1996). It is also important to remember that acids are not the only undesirable substances falling out of the air from industrial and autombile emissions. Big Moose Lake's sediment record shows pronounced rises in the atmospheric depostion of lead, copper, vanadium, coal soot, and polycyclic aromatic hydrocarbons since the industrial revolution, and this pattern has been found in several other Adirondack lakes as well (Charles et al., 1987).

The mainstream scientific position on the acid rain issue is not "flimflam" (Krug, 1990), although there must inevitably be some degree of exaggeration and hype on both sides of any national issue of such emotional, economic, and political importance. If anything, the diversity and magnitude of the damage accumulating from atmospheric pollution from industry and internal combustion engines has been masked by the tendency to focus attention heavily on acid damage to sport fisheries in remote wilderness ponds. Emissions reduction policies are necessary in order to slow the continental-scale effects of acidification, airborne nutrient buildups, heavy metal toxicity, tropospheric ozone production, climatic disruptions, and organic poison accumulation in food chains. Those who undermine such environmental regulations through the spread of misinformation end up supporting the interests of a few over the public good, in opposition to the principles upon which this nation was founded.

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