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*Phil. Trans. R. Soc. Lond. B* 1990 **327**, 423-425
doi: 10.1098/rstb.1990.0084

*Phil. Trans. R. Soc. Lond.* B **327**, 423–425 (1990)
*Printed in Great Britain*



# Lake acidification in Finland

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Although pioneer work on the relation between diatoms and the hydrogen-ion concentration of lakes was done in Finland, recent lake acidification studies did not begin until the 1980s. Now, pH reconstructions for about 50 lakes are available and approximately half of these show clear signs of acidification during the 20th century.

Almost every lake in Finland has been affected by human activity. Agriculture, especially slash-and-burn agriculture, has played an important role since the 16th century, and more recently problems from peatland drainage, fertilization of forest soil, and domestic and industrial waste-waters have occurred. The new threat is the increase in airborne pollution.

The seriousness of lake acidification was recognized in Finland later than in other Nordic countries. The Finnish government started a nationwide research programme on acidification in 1985. The final reports of the project will be published in 1990 but some of the conclusions are presented here.

Finland has not officially participated in international acidification projects, but the results of national investigations have been reported at several international scientific meetings, and the methods and results of earlier Finnish limnological and palaeolimnological projects have influenced the design of acidification projects in other countries. One such project was started in 1978 in eastern Finland on 151 lakes. The lake-water was sampled during the summer stagnation and autumn turnover period and the surface sediments were sampled in winter through the ice. More than 60 physical and chemical variables were measured from the lakes and their catchments. Following an earlier study (Meriläinen 1967) the main focus of this project was the relation between diatom assemblages of surface sediments and water chemistry (Meriläinen & Huttunen 1984; Huttunen & Meriläinen 1986*a*, *b*, *c*). The same chemistry data-set has been used to explore relations between water chemistry and also cladoceran remains (Cotten 1985; Huttunen *et al.* 1988), chrysophyte scales (Christie *et al.* 1988), and phytoplankton (Ilmavirta *et al.* 1984; Ilmavirta 1988; Ilmavirta & Huttunen 1989*a*, *b*, *c*). In addition, several multivariate methods have been adopted and tested (Oksanen *et al.* 1988; Oksanen & Huttunen 1989) to find suitable criteria for the ecological classification of lakes in Finland.

Tolonen & Jaakkola (1983) were the first to describe the recent acidification history of Finnish lakes. They showed that the pH of their three study sites had decreased between 1.1 and 1.5 pH units since about 1960. Later, Tolonen *et al.* (1986) studied 11 small lakes of which four indicated a clear recent acidification, and Simola *et al.* (1985) described the acidification history of three additional sites. Together with the results of the Finnish acidification project (Huttunen *et al.* 1989) the recent history of 50 small or medium-sized head-water lakes in different parts of Finland has been described. Twenty-three of the lakes had clearly acidified during this century, and the remaining sites were naturally acid or indicated some slight acidification (figure 1).

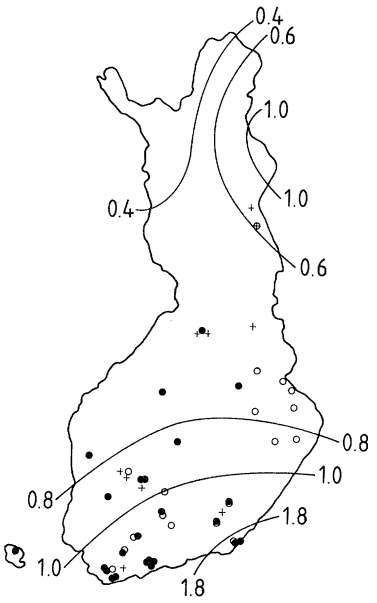


FIGURE 1. The sites studied in palaeolimnological investigations of recent lake acidification in Finland (Tolonen & Jaakkola 1983; Simola *et al.* 1985; Tolonen *et al.* 1986; Huttunen *et al.* 1989). Recently acidified lakes are indicated by (○), naturally acidic lakes (●) and lakes with no clear change (+). The sulphur deposition (in g $m^{-2}$ $a^{-1}$) in 1985 is shown by isolines.

Unpublished modelling results from the MAGIC model showed the same trends as the diatom assemblages. Kamari (1985) estimated that the general trend of acidification in small, sensitive forest lakes in south Finland ranged from 500 to 100 μeq $l^{-1}$ in alkalinity. Huttunen *et al.* (1989) have recently reported an even greater acidification than that indicated by chemical models, and they stressed the sensitivity of planktonic diatoms to acidification.

For natural reasons, most Finnish lakes are very vulnerable to acid deposition. Almost half of the study sites have lost a substantial portion of their buffering capacity during the last three decades. Though serious, recent acidification in Finland has not yet led to widespread damage, but the threat is real and almost all aquatic systems might be affected if acid deposition increases further.

Despite the clear link between acid deposition and lake acidification described above, future palaeolimnological research in Finland should be more focused on the causes of acidification. Only then can defence strategies against the acidification problem be effectively constructed. Representative reference areas would be needed, and, fortunately, they can still be found in the Komi region of northeast Europe.

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