Palaeolimnology

Sediment records of microcrustaceans confirm the ecological classification of acidified Norwegian lakes

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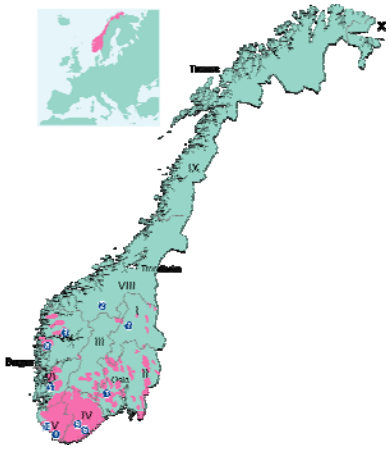

Figure 1. Norwegian monitoring lakes with palaeo-limnological records of microcrustaceans (dots). Norway is devided in 10 regions based on the extent of acidification, meteorology and biogeography.

Introduction

The Norwegian monitoring program on long-range transported air pollutants include monitoring of water chemistry, macroinvertebrates, microcrustaceans and fish populations from 100 lakes. Palaeolimnological studies have been performed for ten lakes representing different lake types. These lakes cover the gradient from non-impacted reference lakes to very severely acidified lakes.

The objectives of the palaeolimnological study are to establish the reference conditions of acidified lakes, and to evaluate the timing of loss of acid sensitive species.

Methods

The present chydorid (Crustacea, Cladocera) community was compared with palaeolimnological data from the ten lakes (Figure 1). *Daphnia* (Crustacea, Cladocera) remains including ephippia in the upper 30-40 cm of the sediment cores were also recorded. Due to problems with species identifications, palaeolimnological data gives a minimum estimate of acid-sensitive chydorids present prior to acidification. The ecological status of the acidified lakes was set by comparing the present microcrustacean communities with the fauna recorded in a number of reference lakes. Present and estimated pre-acidification water chemistry was also used for this purpose.

Results and discussion

- The time of disappearance and relative loss of species richness based on the palaeolimnological data confirm the classification of the studied lakes (Table 1).
- Lakes classified as severely acidified have a higher relative number of missing species (Figure 2), and Daphnia disappeared earlier than in lakes classified as moderately acidified (Figure 3).
- The palaeolimnological data indicate that for some lakes, the physical-chemical conditions may never have facilitated the presence of a high number of acid sensitive species. This may have implications for the establishment of reference conditions and ecological classification.

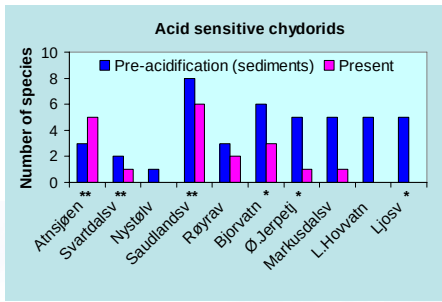

*Figure 2. Number of acid sensitive chydorids recorded in the present microcrustacean communities (1996-2004), and in the sediment layer representing the pre-acidification period. The lakes are presented in order of increasing acidification damages. Acid sensitive species: species which are found in at least twice as many lakes with pH>6.0 than lakes with pH<5.0. * Records of* Daphnia *spp. in the sediments. ** Records of* Daphnia *spp. both in sediments and in the present microcrustacean community.*

Table 1. Water chemistry and microcrustacean community (present and prior to acidification) in lakes with palaeolimnological records of microcrustaceans. Blue: non-acidified reference lake; Yellow: markedly acidified; Orange: severely acidified; Red: very severely acidified. No moderately acidified lakes were included. [1] Positive chemical trend in the period. [2] Recovered in the plankton from 2002 and also found in the upper 0 - 0.5 cm of sediment (but not in the 0.5 - 1 cm sediment layer).

No	Lake	Region	pH		L-AL, µg/L	Present microcrust.		Past microcrust.
			pre-acid.	1996-2004	1996-2004	# species	Acid sensitive, %	*Daphnia* lost, year
1	Atnsjøen	I		6.3 - 6.6	<5 - 12	35	25,7	Present
2	Svartdalsvatn	VIII	6.3	6.1 - 6.4	<5	23	13.0	Present
3	Nystølsvatn	VII	6.1	5.6 - 5.8[1]	<5 - 15	21	19.0	No records
4	Saudlandsvatn	V	6.6	5.2 - 6.1[1]	13 - 82[1]	44	27.3	1980 - 1990 [2]
5	Røyravatn	VI	6.1	5.0 - 5.6[1]	18 - 48	37	18.9	No records
6	Bjorvatn	IV		5.2 - 5.7	22 - 68	43	23.8	1980 - 1990
7	Ø. Jerpetjern	II	5.9	5.0 - 5.3	85 - 150[1]	32	18.7	1950 - 1960
8	Markusdalsvatn	VII		4.8 - 5.0	23 - 60	31	12.9	No records
9	L. Hovvatn	IV	5.0	4.6 - 5.0	46 - 122[1]	28	10.7	No records
10	Ljosvatn	V	6.2	4.7 - 5.0[1]	100 - 229[1]	30	3.3	1900 - 1920

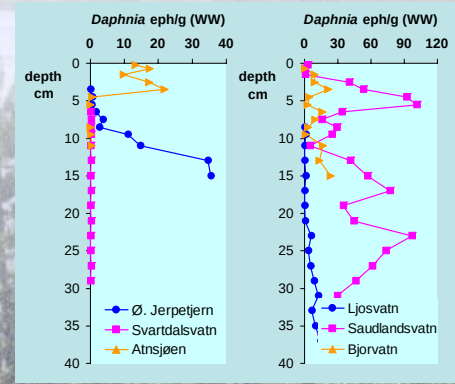

Figure 3. Presence of acid sensitive Daphnia *spp. in sediment cores from six of the monitoring lakes based on ephippia. There were no palaeo-limnological records of* Daphnia *in the remaining four lakes (see Figure 2).*

Aknowledgement

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