Development of the diatom flora in Prestvannet, Tromsø, northern Norway

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The diatom assemblages in the Holocene sediments of lake Prestvannet have been investigated. The diatom taxa are grouped according to their ecological requirements to give information on habitat, salinity, pH and current conditions. The diatom assemblages reflect a development from a nutrient-rich recently deglaciated environment to a lake with more moderate nutrients and more shallow conditions. At present the lake has changed back to more nutrient-rich conditions, probably as a result of agriculture. The planktic flora of the uppermost sediments probably is a result of the damming of the lake.

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The investigation of lake Prestvannet is part of IGCP Project 158 B 'Palaeohydrological changes in the temperate zone in the last 15 000 years. Subproject B. Lake and mire environments'. The vegetation history and paleolimnology of the lake were thoroughly investigated by Fimreite (1980) under the supervision of K.-D. Vorren. Material for diatom analysis was provided by them to extend further our paleolimnological knowledge of the lake.

Prestvannet at 18° 57′E and 69° 40′N is situated 96 m a.s.l. at the top of the island Tromsøya (Fig. 1). The present lake covers an area of 10 ha and has a diameter of about 200 m. The bedrock is limestone and lime silicate gneiss of Cambrian-Silurian age. The lake is to the east, northeast and southwest sheltered by higher terrain, but is still exposed to winds. It is surrounded by mires. Two small lakes originally situated in a mire were dammed in 1864 to be used as a water reservoir for the city of Tromsø. The topmost sediments could therefore be expected to have been disturbed. The original water level probably was about 93 m a.s.l. The lake is dammed in its northwestern part, there is a small inflow from the south and an outlet over the dam in the northwest. It is believed that there was little flow prior to the damming of the lake. Prestvannet is today a 4 m deep eutrophic lake that is covered by ice for a very long period, about November 1st to May 20th (Huru et al. 1979). There is thus a long lasting period of stagnation in the winter and normally a circulation of the water masses during the summer.

The diatom flora of the present lake was investigated by Foged (1960), who concluded that the lake was dominated by salinity-indifferent, alkaliphilous freshwater diatoms, but with a substantial amount of halophilous species.

The present investigation deals with the succession of the diatom floras from the transition Late Weichselian/Holocene and aims at demonstrating changes in water level, pH and current conditions.

Methods

The lake was cored with a Hiller corer to map the sediments. The lake has a southwest-northeast deepening, probably determined by the bedrock. Deposition of gyttja is mainly concentrated in this deeper part (Fig. 1B). The main coring, with a 100 mm piston corer, was therefore undertaken where the gyttja deposits were thickest, assuming that this part had the most continuous undisturbed sedimentation.

The main core was taken in six parts; Pl (450–650 cm), P2 (600–800 cm), P3 (750–950 cm), P4 (852–1046 cm), P5 (1000–1080 cm) and P6 (1060–1120 cm). Samples for diatom analysis were taken from cores P1–P4. The cores were described (Fimreite 1980) after the system of Troels – Smith (1955). Information on absolute pollen content, pH-measurements, shear-strength, grain-size distribution, water content, loss on ig-

Table 1. Diatom taxa from lake Prestvannet in alphabetical order, with their relative frequencies (%) at investigated depths. Ecological grouping: H = habitat (1 = planktic, 2 = tychopelagic, 3 = periphytic), S = salinity (2 = mesohalobous, 3 = oligohalobous halophilous, 4 = oligohalobous indifferent, 5 = halophobous), pH (1 = alkalibiontic, 2 = alkaliphilous, 3 = pH-indifferent, 4 = acidophilous), C = current (1 = rheophilous, 2 = current-indifferent, 3 = limnophilous). – = no information. See also Fig. 2.

Taxon	Ecology				Depth (cm)																																		
	H	S	pH	C	595	625	635	645	655	665	675	695	705	715	725	735	745	755	765	770	775	780	785	790	795	800	820	830	840	850	860	870	880	882	887	890	892	895	897	902
Achnanthes flexella (Kütz.) Brun	3	5	4	3									+				+	3	4	+	2									+			+		+							
A. lanceolata (Breb.) Grunow	3	4	2	1	1																															+		+	
A. linearis (W. Smith) Grunow	3	5	3	2																															+	3	3						+	
Amphora coffaeformis Agardh	3	2	2	-		2		3	+	2	3				+						1					2					+	+	+						
A. ovalis Kützing	3	4	2	2								+							1	+		1		2	+			+		1	1	3	2	1	+	1	1		1	+
A. ovalis var. ped. Kütz. Van Heurck	3	4	2	2	2		1																							2		+			+	+	3	3	5	3	2
Anomoeoneis exilis (Kütz.) Cleve	3	4	2	2		3	4		4	2	2	11	1	4	12	3	7	17	6		2		+	4	1		5	2		+	2	3	1				+	1		
Asterionella formosa Hassall	1	4	2	3	51																																		
Caloneis bacillum (Grun.) Cleve	3	4	2	1									+		+															+									+	
C. silicula (Ehr.) Cleve	3	4	2	2		2			+	+	+										+									+				+								
Cocconeis diminuta Pantocsek	3	5	1	2																									2					+		+	2	3	5	77
C. placentula Ehrenberg	3	4	2	2																	+				+									+	2	+	1	3	9	8	
Cyclotella antiqua W. Smith	2	5	4	-				+			2	1			+								1					+	1	+	+	+	+	1	+	+		1	+	
C. comta (Ehr.) Kützing	1	4	3	3		2	2	+	2	1	2				3						2					1	5		7	5	7	2	3	+		+	+		+	
C. kützingiana Thwaites	2	4	3	2			1					+	4	+		+				1		3	3	4	2		4	8	3	16	21	12	5	9	1	1	4	2	3	
C. pseudostelligera Hustedt	1	4	2	-								2					2	+	4	+		+	+	3	+			2	+										
Cymbella aequalis W. Smith	3	4	2	-																					+							2	3						
C. amphicephala Naegeli	3	4	3	2			+	7	3	2			4	8		11	13	7	14	6		4	5	10	11	1		7	+			+	2						
C. aspera (Ehr.) Cleve	3	4	2	2							1																												
C. cuspidata Kützing	3	4	3	2																											+	+	+		+	+				
C. ehrenbergii Kützing	3	4	2	3						+		+																		2	+		1						
C. gracilis (Ehr.) Kützing	3	5	3	-														2																	+					
C. hebridica (Grun.) Cleve	3	5	4	-																																			1		
C. helvetica Kützing	3	4	2	3		15	2	5	3	3	7	4	2	2	8	8	15	19	10	20	14	5	7	9	6	4	5	3	5	3	2	2		+	+	1	+	1	+	
C. leptoceros (Ehr.) Kützing	3	4	2	3																									+										
C. prostata (Berkeley) Grun	3	4	2	1									+																										
C. ventricosa (Agardh) Kützing	3	4	3	2		2		+	1		2	1	5	2	4	5	3	1	1	2		+	4	4	1	+	2	5	2	2	4	5	6	6	2	4	5		+	2
Denticula tenuis Kützing	3	5	1	-																			+			1		1	+			1	17		1	+	1	2		
Diploneis elliptica (Kütz.) Cleve	3	4	3	3																														+				+		
D. ovalis (Hilse) Cleve	3	4	2	2																																				+	
Epithemia argus (Ehr.) Kützing	3	4	2	1		2									+						4						1								+			+	1		
E. muelleri Fricke	3	4	2	3																													+						
E. sorex Kützing	3	4	2	2		10		15	3	9	6	4	1	+	1	3	5	8	13	20	29	40	13	15	34	11	4	13	9	14	2	1	1	1	1	2	1	5	3	
E. zebra (Ehr.) Kützing	3	4	2	2	1																																		
Eunotia pectinalis (Kütz.) Rabenh.	2	5	4	2		2	1							+																									
E. praerupta Ehrenberg	3	5	4	2						1		2																						+	+	+		+	
Fragilaria brevistriata Grunow	3	4	2	2											+															+	10	6	10	61	39	25	12	13	9
F. capucina Desmazières	2	4	2	2	2																																		
F. construens (Ehr.) Grunow	2	4	2	2	2		4	2	3	1	1		1	8		7	5	1				1	+			+					+	1	2	2	3	14	13	12	17	2
F. cons. var. binodis (Ehr.) Grun.	2	4	2	2																					+							3	4	10	6	5	5	2	2
F. elliptica Schum.	2	4	2	2			+																																
F. lapponica Grunow	2	4	-	3		1	+									4												1														
F. leptostauron (Ehr.) Hustedt	2	5	2	3											3						+																	+	+		+
F. pinnata Ehrenberg	2	4	2	2	3		4				1	1	12	39	5	12	3	1				2	1	+	+	+	+	+		+	+	+	1	6	10	17	10	6	10	4
F. virescens Ralfs	2	5	3	2	1											1						2																		
Frustulia rhomboides (Ehr.) De Toni	-	5	3	-						+																													
G. acuminatum Ehrenberg	3	4	2	3																															+					
G. constrictum Ehrenberg	3	4	2	3																																			1		
G. intricatum Kützing	3	4	2	3																																			1		
G. montanum var. subclavatum Grunow	3	4	3	2																													+	1	+	1	1		1	
G. olivaceum (Lyngby) Kützing	2	4	1	2																										+										
Mastogloia smithii var. lac. Grunow	-	5	2	3																											1	+	+		+	+	+			
Meridion circulare (Grev.) Agardh	3	4	2	1				+																															

nition, and chemical analysis (organic carbon, Kjeldahl – N, C/N, Fe, Mn, Fe/Mn, P, Na, K, Mg) can be found in Fimreite (1980).

The diatom content of thirty-six samples was analysed. The samples were oxidized in 30% H_2O_2 and the residues mounted in Hyrax. The analyses were carried out at maximum magnification of the light microscope (1250 x) with oil immersion and phase contrast. A relative analysis was attempted with the aim of counting at least 200 valves in each sample.

One hundred and four species were identified

Taxon	Ecology				Depth (cm)																																			
	H	S	pH	C	595	625	635	645	655	665	675	695	705	715	725	735	745	755	765	770	775	780	785	790	795	800	820	830	840	850	860	870	880	882	887	890	892	895	897	902
Navicula anglica Ralfs	3	4	2	1											6						3						3													
N. cryptocephala Kützing	3	4	2	2		20	4	2	5	2	33	22	5	5	15	8	3	6	6	3	22	5	11	13	10	5	25	13	7	6	6	3	1	6		1	1		3	
N. gracilis Ehrenberg	3	4	2	2																															+					
N. gregaria Donkin	3	3	2	1																											3									
N. lanceolata (Ag.) Kützing	3	4	2	3																																		4		
N. microcephala Grunow	-	4	-	-					2	6																21				5	1		+	3		+	1	2	1	
N. oblonga Kützing	3	4	2	2																											+									
N. peregrina (Ehr.) Kützing	3	2	2	-			1																						4											
N. pseudoscutiformis Hustedt	3	4	3	2										+																										
N. pupula Kützing	3	4	3	2	3	3	14	2	11	8	6	1	5	4	2	2	+		3	1	+			+		1		5	7	3	2	3	3	2	+	1	1	6	3	
N. radiosa Kützing	3	4	3	2	1		19	27	28	21	2	21	19	10	2	14	13	22	18	26		16	30	20	18	13	2	19	25	12	15	14	2	3	+	1	3	1	4	
N. reinhardtii Grunow	3	4	1	2		+																																		
N. rhynceocephala Kützing	3	4	2	2																													4							
N. roteana (Rabh.) Grunow	3	4	3	1	1																																			
N. semen Ehrenberg	3	4	3	-																								1	+											
N. simplex Krasske	-	4	2	-																												1								
N. tuscula (Ehr.) Kützing	3	4	1	3												+																+	+				+			
Neidium affine (Ehr.) Pfitzer	3	5	3	3		1	2		5	+	1		1		+																+	+	+			+		1		
Nitzschia amphibia Grunow	3	4	2	2	1	+																															2	4		
N. angustata Grunow	3	4	2	3		2	1	2	2	2		2	+	+		1	+	3	1	4		2	1	+	2	3		+		+	+	+	1				+		1	
N. bremensis Hustedt	3	3	3	-		+																																		
N. constricta (Kütz.) Ralfs	3	2	3	2							3				1																									
N. denticula Grunow	3	4	2	2		4	4	8	12	2	4	3	15	10	17	17	8	4	5	3	+	+	3	2	+	+	5	2	8	6	6	16	20	4	6	3	5	3	4	
N. dissipata (Kütz.) Grunow	3	4	2	2	2																								2											
N. fonticola Grunow	2	4	1	2																													11	33	1	2	10	8	6	
N. frustulum (Kütz.) Grunow	3	4	2	3				2	1	1																													1	
N. heufleriana Grunow	-	4	-	-										+																										
N. kützinginana Hilse	3	4	2	2		17	24	9	11	19	18	10	18	5	10	11	8		7	4	+	7	14	11	4	33	33	13	14	12	15	17						+		
N. paleacea Grunow	-	4	-	-			+																																+	
N. recta Hantzsch	3	4	2	1																														+						
Pinnularia dactylus Ehrenberg	-	4	-	-		+																																		
P. gibba Ehrenberg	3	4	3	2		2		3	+	6	+	2		+																1	+	+		+			+		+	
P. interrupta W. Smith	3	4	3	2					3			1	1				+					+			+															
P. major (Kütz.) Rabh.	3	4	3	3				+																																
P. mesolepta (Ehr.) W. Smith	3	4	3	2		1	3		1	1	2		+								+					+		+		1	+	+		1	1	1			+	+
P. microstauron (Ehr.) Cleve	3	4	3	2				+		2																				3	+			1	+	+	+	4	2	
P. nobilis Ehrenberg	3	5	4	3				+																																
P. parva (Ehr.) Greg.	3	4	3	2																																				+
P. viridis (Nitzsch) Ehrenberg	3	4	3	2		+																										1			+	+				
Rhopalodia gibba (Ehr.) Müller	3	4	2	2			+																			2				5	+	+	+	1					2	
R. parallella (Grun.) Müller	3	4	3	3		7	2	6		6	3	7	4	1	2	+	10	3	9	11	18	12	4	6	10	3	4	6	5	5	3	1		1			+	2		
Stauroneis anceps Ehrenberg	3	4	3	2		1	1	+	+	1		+	+	+							+						+		1			+		+	1	+		1	+	
S. phoenicenteron (Nitzsch) Ehrenb.	3	4	3	2	3	+	1								+		1	1		+		1		+	+			+		2	+	+		1			1	2	1	
Stephanodiscus dubius (Fricke)Hust.	1	4	1	3	7																																			
Surirella biseriata Brébisson	3	4	2	3				+																																
S. linearis W. Smith	3	4	3	2																																			+	
Synedra acus Kützing	2	4	2	3			3	+	2	+		+	+																											
S. nana Meister	1	4	-	-	18																																			
S. rumpens Kützing	3	4	3	3											+				+					+																
S. ulna (Nitzsch) Ehrenberg	2	4	2	2													+									+			2											
Tabellaria flocculosa (Roth) Kütz.	2	5	4	2	1	+	+	+	+	+		1		+				+													+									
No of valves					110	204	242	203	203	203	209	187	241	353	234	225	202	185	211	205	193	198	211	204	209	312	196	202	217	299	338	319	344	435	1201	836	618	295	414	206
Unidentified					11	13	2	4	0	0	9	12	2	11	11	20	17	28	11	11	15	5	4	8	3	12	9	4	0	7	6	0	0	2	0	11	6	16	4	12

and are listed with their relative frequencies in each sample (Table 1). The ecological requirements of the individual taxa are given by a number code based on the system of de Wolf (1982). Some modifications were made to simplify the presentation: Habitat has been divided into three groups. None of the taxa are characterized as aerophilous. Taxa from Prestvannet listed as aerophilous by de Wolf do *not* indicate an aerial habitat and have been transferred to the periphytic group. The periphytic group combines the benthic and epithytic taxa (Renberg 1976). The

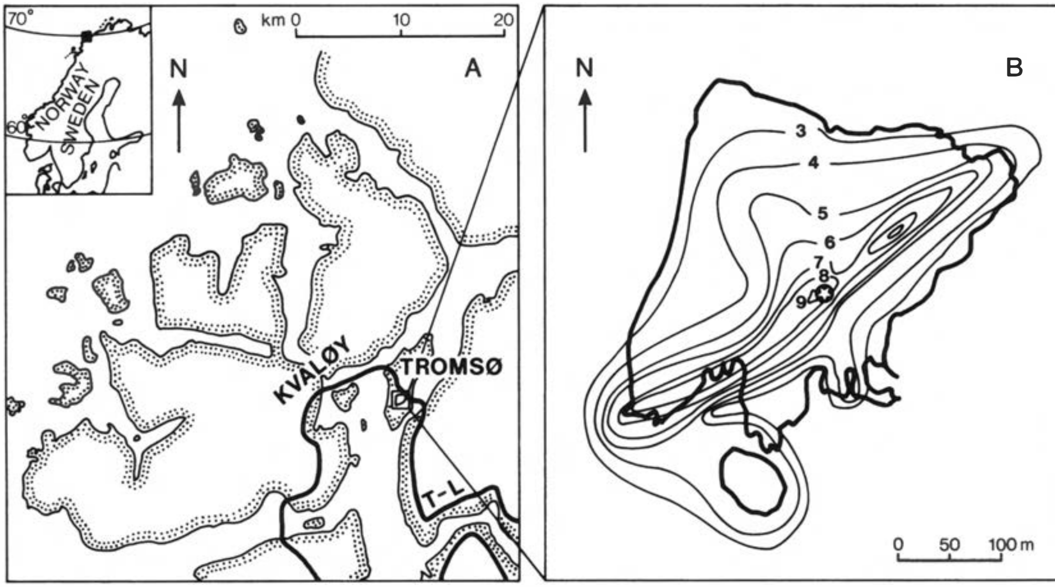

Fig. 1. A: Location map. The ice margin of the Weichselian Ice during the Tromsø-Lyngen (T-L) event after Andersen (1968). B: Detailed map of lake Prestvannet with sediment thickness contours in metres (after Fimreite 1980). Star marks core location.

tychopelagic group includes taxa which may occur both as plankton and periphyton. Salinity preferences are expressed as: taxa preferring saline water (mesohalobous and oligohalobous halophilous), salinity-indifferent freshwater taxa (oligohalobous indifferent) and salt-fearing (halophobous) taxa.

No alterations have been made for pH or current tolerance. Minor changes made in the ecological coding of de Wolf are based on information from Cholnoky (1968), Haworth (1976) and Gasse (1980).

Results

The core has been divided into five diatom zones (A–E), several of which are further subdivided so that the successional sequences can be detected. The diagrams for habitat, salinity, pH and current, covering zones A through D, are shown in Fig. 2. Zone E represents disturbed recent deposits (see below) and is therefore not included in the diagram.

Zone A, 902–900 cm

The lowermost diatom zone occurs in a silty fine-detritus gyttja with some macrofossils (Layer 4). Layer 4 is separated from the underlying layers (1–3) by a distinct lithological boundary, interpreted as representing a hiatus. Zone A is characterized by periphytic, halophobous, alkalibiontic and current-indifferent taxa. The diatom assemblage is characterized by few taxa (12). It is dominated by the eutrophic *Cocconeis diminuta* (77 %) and also includes *Fragilaria brevistriata* (9 %). Zone A is interpreted as characterizing a recently deglaciated, nutrient-rich lake environment with high pH-values. The sediments below are probably deposited in meltwater, with low opacity and unsuitable conditions for diatoms to live.

Zone B, 900–855 cm

BI, 900–885 cm. – This subzone is confined to the topmost part of Layer 4. Subzone BI is charaterized by tychopelagic, oligohalobous indifferent, alkaliphilous and current-indifferent taxa. The assemblage is dominated by *Fragilaria* spp. (mainly *F. brevistriata, F. construens* with var. *binodis* and *F. pinnata*). The percentage of *Fragilaria* spp. increases upwards to a maximum of 84 % in this subzone. *C. diminuta* decreases markedly from Zone A (77 %) to Zone B where it never exceeds 5 %. The assemblage in subzone

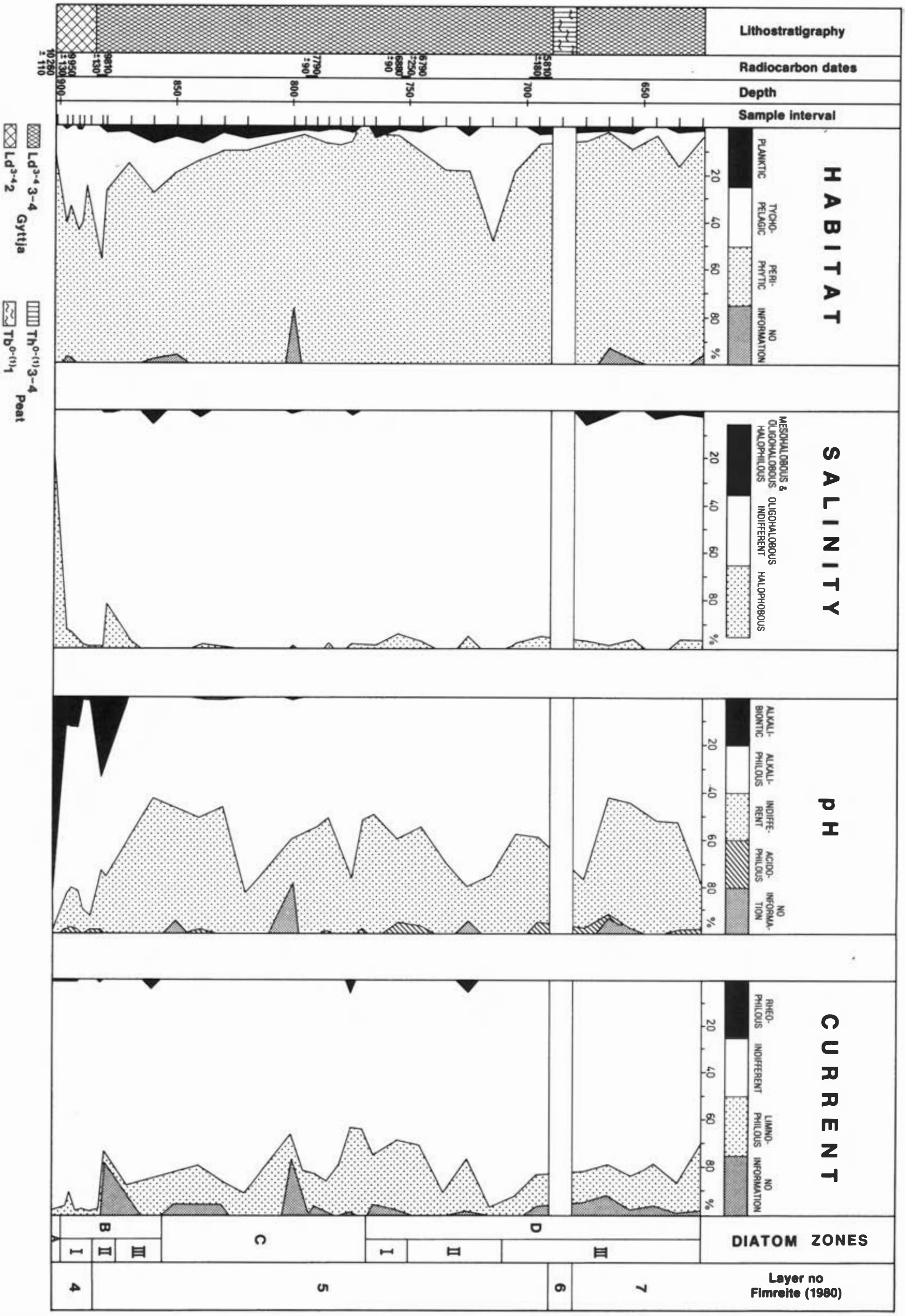

Fig. 2. Diatom assemblages of lake Prestvannet in ecological groups. Depth refers to depth below present water level. The assemblages are divided into diatom zones A–D.

BI may be interpreted as characterizing a period with rapid changes in water chemistry (Round 1957, Haworth 1976), from a eutrophic to a mesotrophic situation with a resulting decrease in pH-values.

BII 885–875 cm. – The boundary between diatom subzone BI and BII coincides with the boundary between layer 4 and layer 5 (laminated fine detritus gyttja). Layer 5, the thickest layer of the core, contains subzone BII, BIII, C and half of zone D. The diatom assemblage of subzone BII shows a change from tychopelagic to a more periphytic, oligohalobous indifferent flora. The pH-groupings show a fairly equal amount of alkalibiontic, alkaliphilous and pH-indifferent species and the assemblage consists of current-indifferent taxa. It seems that the lake is passing into a period of more stable conditions. The flora may be characterized as changing from a fairly high (33) percentage of *Nitzschia kützingiana* to an assemblage with *Nitzschia denticula* and *Denticula tenuis* having their highest percentages.

The boundary between subzone BII and BIII is characterized by the almost total disappearance of alkalibiontic species.

BIII 875–855 cm. – The assemblage in subzone BIII is tychopelagic/periphytic, oligohalobous-indifferent, alkaliphilous/pH-indifferent and current-indifferent. The flora is diverse, with a dominance of *Cyclotella kützingiana* (the main tychopelagic element), *Navicula radiosa, Nitzschia denticula* and *Nitzschia kützingiana.*

Zone C 855–767.5 cm

The diatom assemblage in Zone C may be characterized as periphytic and oligohalobous-indifferent. The pH-groupings show a mixture of alkaliphilous and pH-indifferent taxa, with some oscillations in their relative percentages through the zone. At levels 820 cm and 775 cm there is an increase in alkaliphilous species. The current spectra show a mixture of current-indifferent to limnophilous species, with a tendency towards more limnophilous species at level 775 cm which also show an increase in alkaliphilous species. The flora in Zone C is characterized by alternations in dominance of *Cymbella helvetica, Epithemia sorex, Navicula cryptocephala, N. longirostris, N. radiosa, Nitzschia kützingiana* and *Rhopalodia parallella.*

Zone D 767.5–625 cm

DI 767.5–750 cm. – The assemblage in subzone DI may be characterized as periphytic, oligohalobous indifferent, alkaliphilous/pH-indifferent and current-indifferent/limnophilous. The flora in subzone DI is characterized by alternating fairly high percentages of *Cymbella helvetica, Epithemia sorex, Navicula longirostris, N. radiosa* and *Anomoeoneis exilis.*

DII 750–710 cm. – The assemblage in subzone DII can be characterized as tychopelagic/periphytic. The precentage of tychopelagic taxa increases and has a peak at the topmost level. The assemblage is oligohalobous-indifferent, alkaliphilous/pH-indifferent and current-indifferent/limnophilous. The flora in subzone DII is characterized by fairly high percentages of *Fragilaria pinnata, Navicula radiosa* and *Nitzschia denticula.*

DIII 710–625 cm. – The transition from layer 5 (laminated fine-detritus gyttja), through layer 6 (10 cm of peat) to layer 7 (fine-detritus gyttja) occurs within subzone DIII. Layer 6, barren in diatoms, is interpreted by Fimreite (1980) as contamination brought down by the corer and representing the peat of her layer 8. Fimreite (op. cit.) interprets the transition from laminated (layer 5) to non-laminated (layer 7) sediments as connected to a shallowing of the lake.

The assemblage in subzone DIII can be characterized as periphytic, oligohalobous indifferent, alkaliphilous/pH-indifferent (with increased tolerance for alkalinity towards the top) and current-indifferent/limnophilous (with increase of limnophilous species towards the top). The flora of subzone DIII is characterized by *Navicula cryptocephala* (a peak at 665 cm), *Navicula radiosa, Nitzschia denticula* and *Nitzschia kützingiana.*

Zone E (not shown in Fig. 2)

The peat (layer 8) above Diatom Zone D is barren in diatoms. The uppermost layers (9, 10 and 11) are interpreted by Fimreite (1980) as disturbed recent deposits. Only one sample at about 595 cm – the boundary between the peat and the uppermost deposits – has been analysed for diatoms.

Diatom Zone E shows a floral composition that is clearly different from the underlying layers. There is a dominance of planktic, oligohalobous indifferent, alkaliphilous and limnophilous forms. *Asterionella formosa* dominates (51 %) and there are high percentages of *Synedra nana* and *Stephanodiscus dubius*. The assemblage at level 595 cm is interpreted as having developed as a response to a rising water level and seems to reflect the flora of a basin more larger sized than the one in which the underlying diatom assemblage was deposited.

Discussion

Diatom Zone A is characterized as one of a nutrient-rich eutrophic lake. Zone A is contemporaneous with pollenzone Pr 3, dominated by *Pediastrum*, also an indicator of eutrophic conditions. The sediment from diatom Zone A has been dated to 10,260 ± 110 years B.P. (T-3339B, insoluble fraction) and 9950 ± 130 years B.P. (T-3339A, soluble fraction). Loss on ignition still indicates a large supply of minerogenic material. Diatom Zone A is therefore interpreted as coinciding with the initial phase of the lake development. This is in accordance with the glacial history of the area. The Tromsø-Lyngen moraines, formed at about 10,150 years B.P. (Andersen 1968), are situated along the western margin of the lake (Fig. 1).

Diatom Zone B is characterized by a large percentage of tychopelagic species, while there is a development towards lower pH-values (decreasing nutrient supply). The lower part, Zone BI, has a large amount of *Fragilaria* spp. typical of rapid changes in water chemistry. The upper part, especially zone BIII, has a large amount of tychopelagic *Cyclotella spp.* (*C. antiqua, C. comta, C. kützingiana*), interpreted as indicative of a rise in water level. Subzone BI coincides with pollenzone Pr 3, and subzones BII and BIII are deposited during pollenzone Pr 4. Pr 4 shows a marked decrease in *Pediastrum* and increase of *Myriophyllum alterniflorum*, indications of decreasing nutrient supply. Diatom Zone B is considered as a zone reflecting changes towards more stable mesotrophic conditions in the lake.

Diatom Zone C is characterized by a periphytic flora. The pH-conditions reflect a more stable environment. There is a tendency towards more limnophilous conditions towards the top. According to Fimreite (1980), this part was deposited during the Boreal and early Atlantic periods.

Diatom Zone D is characterized mainly by a periphytic flora, but has a peak in tychopelagic forms (e.g. *Fragilaria* spp.) at the top of subzone DII. The pH-conditions reflect a stable environment, but there is a tendency towards higher pH-values (increased nutrient supply) towards the top. There is also a slight increase upwards of the limnophilous species. Fimreite (1980) interpreted a change from reducing conditions in layer 5 to oxidizing conditions in layer 7 to be result of a natural infilling and shallowing of the basin. The changes could also have been induced by a change towards more continental climate, as shown by Digerfeldt (1972) in the Late Atlantic period of southern Sweden, which fits with the radiocarbon dating of level 700–690 cm (5810 ± 180 years B.P., T-3493A). A change in water chemistry, probably connected to the climatic change, is reflected by the occurrence of *Fragilaria* spp. at the top of subzone DII. There was finally a natural, not climatically induced, overgrowth of the lake, ending in the formation of peat (layer 8).

The upper part of the peat (595 cm) is dated to 3420 ± 40 years B. P. (T-3492). The first indicators of agriculture were observed at this level (Fimreite 1980). The change towards a more alkaliphilous flora therefore seems to reflect a eutrophication caused by the introduction of agriculture in the area.

The flora in Diatom Zone E is quite similar to the one described by Foged (1960). The planktic flora reflects a rise in water level which is difficult to explain by agriculture alone. As mentioned earlier, the sediments above the peat seem to be disturbed recent deposits. Probably the damming of the lake, with a resulting rise in water level of about 3 m, caused a disturbance of the uppermost sediments. Diatom Zone E therefore most probably reflects the more recent flora.

Conclusions

It can be concluded that the diatom investigation shows a development of lake Prestvannet from a recently deglaciated nutrient-rich environment, through a phase of changes in water chemistry, ending in a stable situation with moderate nutrients in the lake. In more recent times the lake has changed back to more nutrient-rich conditions, probably caused by the introduction of agriculture. The grouping for current requirements show a mainly current indifferent diatom flora throughout the investigated part of the core. A shallowing of the lake is reflected by the diatom assemblage in the Atlantic and Subboreal periods. This may have been caused both by a drier climate and by a natural overgrowth of the lake. A change to a planktic flora reflecting deeper water occurs after about 3400 years B.P.; this is most probably a more recent change resulting from the damming up of the lake in the last century.

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