

Macrofossil studies of Holocene lake sediments from Jameson Land, East Greenland

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Previous records of Holocene terrestrial and limnic environmental changes in East Greenland, mostly based on pollen analysis, have failed to extend beyond c. 9000 years BP (9 ka BP) because the lakes sampled were situated below the marine limit. The record obtained thus only goes back to the time when the lake basins became isolated from the sea (Funder, 1978; Björck *et al.*, 1994; Funder & Hansen, 1996). In 1994, a lake near the coast of Jameson Land (Fig. 1) was cored with the aim of extending this record. This work was part of the 'Arctic Terminations Project', dealing with the timing and character of the last glacial maximum, the Flakkerhuk Stade, in the extensive Scoresby Sund fjord system (e.g. Hansen & Funder, 1995). By selecting a lake basin situated above the local marine limit and by applying macrofossil analysis instead of pollen analysis, the hope was that the sedimentary record could be extended further back in time and that far transported or reworked interglacial material could be avoided.

Unfortunately, however, the minerogenic sediments were devoid of *in situ* organic remains, and thus could not be dated by radiometric methods; furthermore, the onset of organic sedimentation in this lake basin occurred later than in previously investigated lake basins at lower altitudes. In spite of these disappointing aspects, the results merit publication because they provide new evidence of post-glacial climate, environment and biogeography in the area and support the conclusions reached by pollen analysis.

Setting

The lake studied is a large kettle hole, located at the margin of an area of kames and kettle holes dating from the last glacial maximum, the Flakkerhuk Stade. The lake is c. 475 m long and 275 m broad and is situated 80 m above sea level, 3.3 km from the coastline (70°55.3'N, 24°07.7'W, Fig. 1). The water depth at the



Fig. 1. Map showing the location of the lake (A) sampled on the west coast of Jameson Land, East Greenland and the position of lake 'Boksehandsken' (B).

coring site in the central, deepest part was 135 cm. The terrain around the lake is low-lying and flat with a thick, continuous cover of Quaternary deposits. Open dwarf shrub heaths dominated by *Cassiope tetragona* and *Salix arctica* with scattered *Betula nana* are widespread in the area. The aquatic bryophyte *Drepanocladus exannulatus* is common on the lake floor, and the invertebrate fauna includes *Colymbetes dolabratus*, *Lepidurus arcticus* and cladocera.

Methods

The sediments were sampled with a Russian corer (Jowsey, 1966) from a small inflatable rubber boat with

a wooden deck. Two sites (A & B) were cored, core site B being slightly closer to the shore. The cores were described in the field and cut into sections. In the laboratory, the samples were wet-sieved on 0.42 and 0.21 mm sieves, and material was extracted for radiocarbon dating by accelerator mass spectrometry (AMS).

Results and discussion

Lithology and geochronology

The lower part of the cored sequence consists of organic-poor clay (Table 1). This is overlain by organic sediments. At 14–16 cm above the transition from minerogenic to organic sediments, a bryophyte layer is found, in contrast to several other lakes in the region where organic sedimentation was initiated by the accumulation of a similar bryophyte layer (Funder, 1978). The sediments contain very few macroscopic remains of terrestrial plants. A sample of *D. exannulatus* was thus dated from the bryophyte layer, giving an age of c. 8000 BP (Table 2). Although no macroscopic plant remains were observed in the lowest clay layer during field work, some remains were found during the laboratory work. However, the young age obtained from these remains indicates clearly that they represent contamination brought down by the corer from younger layers. Most of the dated material consisted of leaves and stem fragments of *Cassiope tetragona*, a species that probably did not reach this region until around 6000 BP (Funder, 1978; Böcher & Bennike, 1996). It appears that organic sedimentation in the lake started well after the regional deglaciation.

Lake evolution

The reconstruction of the biological development of the lake basin is based on macrofossil remains of plants and animals from the two cores, correlated by means of the bryophyte layer (Fig. 2). The lower part of the cored clay contains no remains of limnic plants or animals. It is suggested that the water in the lake was probably too turbid for plant, and hence animal life. The upper part of the clay contains rare remains of invertebrates, indicating the beginning of life in the lake. The beetle *Colymbetes dolabratus* was an early member of the lake fauna. The species has also been found in other Lower Holocene sediments in the region (Björck *et al.*, 1994).

Table 1. Stratigraphy at coring site A, Jameson Land

Depth (cm)*	Sediments
0–135	Water
135–139	Empty chamber
139–281	Grey-green gyttja with bryophytes, dark and light laminae. High water content.
281–297	Grey-green gyttja, laminated, few remains of bryophytes
297–299	Grey-brown gyttja with abundant bryophytes
299–313	Laminated gyttja clay, grey and brown
313–325	Light-grey, homogenous clay

*Depth below lake level

Table 2. AMS radiocarbon dates from coring site B, Jameson Land

Lab. no	Material	Depth (cm)	Age, ¹⁴ C years BP	δ ¹³ C ‰
AAR-1890	<i>Drepanocladus exannulatus</i>	275–276	7890±140	-21.9
AAR-1891	<i>Cassiope tetragona</i> <i>Polytrichum</i> sp. s.l.	284.5–289	4330±100	-24.4

Immediately after the lithological change to gyttja clay, a marked peak was observed in the number of the cladocera *Chydorus arcticus* and *Daphnia pulex*, and of the midge larvae (Chironomidae). The abundant remains of these arthropods indicate fairly nutrient-rich, clear waters. Towards the end of clay deposition, the tadpole shrimp *Lepidurus arcticus* arrived in the lake.

As the water became clearer, a rich growth of the submerged bryophyte *Drepanocladus exannulatus* became established on the lake bottom, and deposition of more organic-rich sediments began. Statoblasts of the freshwater bryozoa *Plumatella repens* are found within the lower levels of these organic-rich deposits. There are few records of freshwater bryozoa from Greenland lakes, and *Plumatella repens* has only been recorded from a single lake, in southernmost Greenland. However, its statoblasts have previously been found in sediments from lake 'Boksehandsken' on Jameson Land (Fig. 1) and from two lakes on Disko (Björck *et al.*, 1994; Bennike, 1995). It is possible that this inconspicuous animal may have been overlooked, and it may have a rather wide geographical range in low arctic Greenland. However, it is also possible that conditions were suitable for this species only during the early stages of lake development, and that it may have become locally extinct in many lakes.

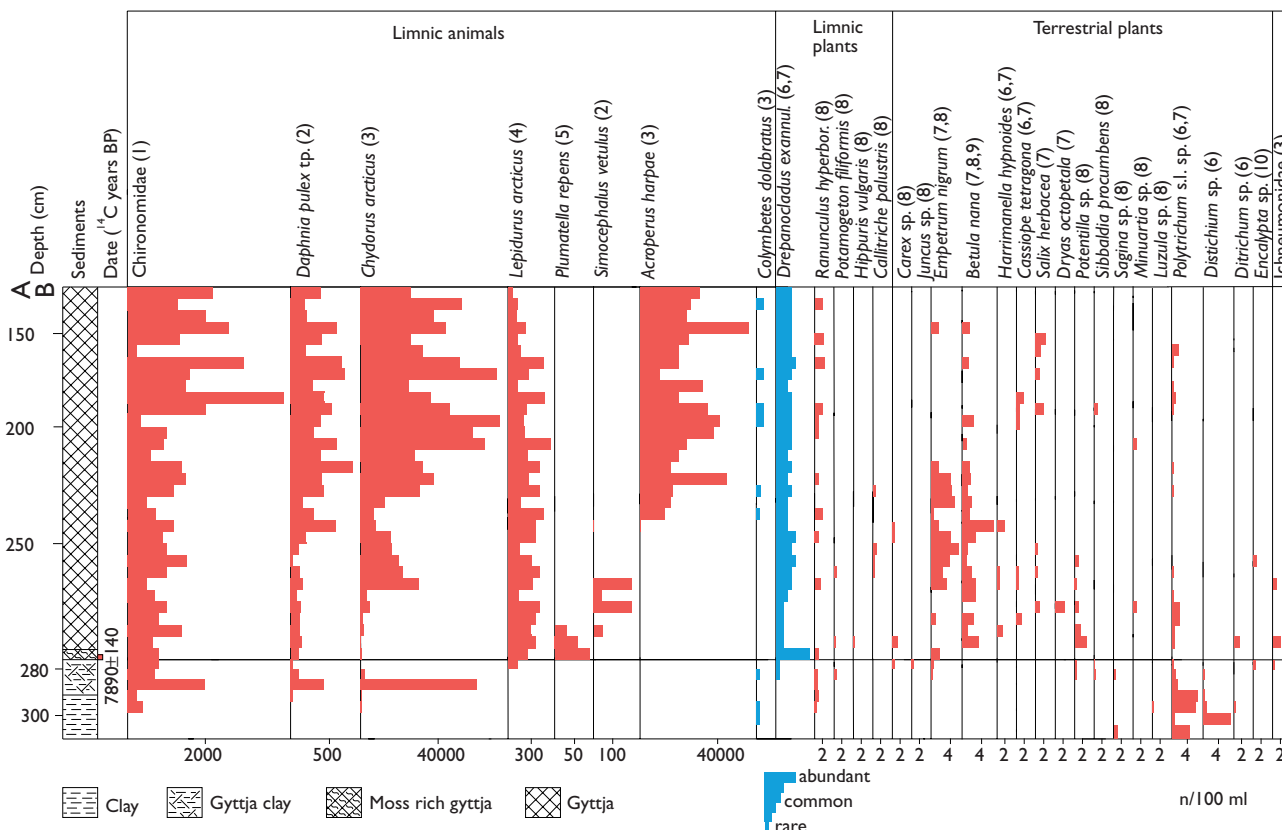


Fig. 2. Composite macrofossil concentration diagram from coring sites A and B, Jameson Land. Coring site B is closer to the shore than A, and the bryophyte layer in core B is found at 275–276 cm below lake level. See Table 1 for description of sediment types. The two cores are correlated by means of the bryophyte layer. (1) larval head capsules, (2) ephippia, (3) exoskeleton fragments, (4) mandibles, (5) statoblasts, (6) stem fragments, (7) leaves, (8) seeds, fruits, (9) catkin scales, (10) calyptreae.

The *P. repens* phase was succeeded by a short-lived phase recorded by common ephippia of the cladoceran *Simocephalus vetulus*, before an abrupt increase in *C. arcticus* is observed. *Acroperus harpae* was a late immigrant to the lake, but its remains are abundant in the upper part of the cored section. The range of this cladoceran in Greenland is low arctic, with the northernmost record in East Greenland near latitude 72°N (Røen, 1962). It was not found in Lower Holocene sediments in the 'Boksehandsken' lake, and it is suggested that it was a late immigrant to central East Greenland, in contrast to southernmost Greenland where it has been found in Lower Holocene sediments (Fredskild *et al.*, 1975).

Only three species of submerged vascular plants are present: *Potamogeton filiformis*, *Hippuris vulgaris* and *Callitriche palustris*. These were early immigrants to the region (Funder, 1978; Björck *et al.*, 1994), but none of them were observed growing in the lake at the present time; since their fruits were not found in the upper part of the sequence, they probably became extinct in the

lake due to oligotrophication, as has been documented for many other Greenland lakes (Fredskild, 1992). *Ranunculus hyperboreus* probably grew in shallow water along the lake margins or in wet places close to the lake.

Vegetation around the lake

The clay at the base of the core contains remains of the terrestrial bryophytes *Distichium* sp., *Ditrichum* sp. and *Polytrichum s.l.* sp.; these forms are either rare or absent in the organic sediments above. These taxa grew in Jameson Land at the very beginning of the Holocene (O. Bennike, unpublished data) and were probably among the first plants to invade the ground around the lake, together with herbaceous plants such as *Sagina* sp. and *Luzula* sp.

Empetrum nigrum is the first member of the dwarf shrubs to appear in the core; this species was probably the first dwarf shrub to colonise Jameson Land after the last glacial stage. According to pollen analyses and

bulk sediment dating, *Betula nana* immigrated to Jameson Land from Iceland around 8000 BP (Funder, 1978), but no macrofossils of this shrub were recorded from deltaic sediments north of Lollandselv dated to 7920±100 years BP (Böcher & Bennike, 1996). In the lake sediments reported here, macrofossil remains of *B. nana* suggest slightly later colonisation than 7890±140 BP by this species in the immediate area, and it is possible that the bulk sediment date of 8000 BP is somewhat too old. *Empetrum nigrum* shows a marked peak in concentration at 220–270 cm, and the concentration of *B. nana* decreases at 215 cm. These changes indicate that the dwarf shrub heaths surrounding the lake became areally reduced as the relatively warm climatic conditions in the Early Holocene came to an end. The Early Holocene warm period has been demonstrated in the area by Funder (1978) and in many other parts of the Arctic by various proxies. We suggest that the mean summer temperature was *c.* 1–2°C higher than today.

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