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An Early Holocene Bowhead Whale (*Balaena mysticetus*) in Nansen Sound, Canadian Arctic Archipelago

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ABSTRACT. At about 10 000 B.P. northern Axel Heiberg and Ellesmere islands underwent a climatic amelioration that caused the demise of the last glaciation. Generally, by 8000 B.P. accelerated retreat left extensive coastal areas ice free. The occurrence of an early Holocene (7475±220 B.P.) bowhead whale (*Balaena mysticetus* L.) skeleton several hundred kilometres north of its present range concurs with other biological and glaciological evidence to indicate that the early Holocene climate in the High Arctic was less severe than at present.

Key words: bowhead whale, early Holocene, Nansen Sound, Canadian High Arctic

RÉSUMÉ. Une amélioration climatique aux envirns de 10 000 ans B.P. mit fin à la dernière glaciation au nord de l'île Axel Heiberg et dans l'île d'Ellesmere. Une acceleration du retrait glacière 8000 ans B.P. libera de vastes zones côtières. La présence au début de l'Holocène (7475±220 B.P.) de la baleine boréale (*Balaena mysticetus* L.) plusieurs centaines de kilomètres au nord de son extension actuelle confirme avec d'autres évidences que le climat de l'Arctique septentrional était moins rigoureux au début de l'Holocène qu'actuellement.

Mots clés: Baleine boréale, Holocène inférieur, Nansen Sound, Arctique canadien septentrional

INTRODUCTION

Glaciological evidence indicates that the climate in the High Arctic immediately following the last glaciation was warmer than it is today. This postglacial climatic optimum was followed by a climatic deterioration that began in the mid-Holocene and persists to the present. This paper presents new zoological evidence on the early Holocene occurrence of the bowhead whale (*Balaena mysticetus* L.) that further substantiates the early Holocene warm interval.

The culmination of the last glaciation on northern Ellesmere and Axel Heiberg islands (Fig. 1) occurred some time prior to 10 ka B.P. During this time glaciers advanced up to 40 km beyond their present margins (Bednarski, 1986; England, 1978; Evans, 1988; Hodgson, 1985; Lemmen, 1988). Many of these glaciers flowed down fiords and terminated in the sea,

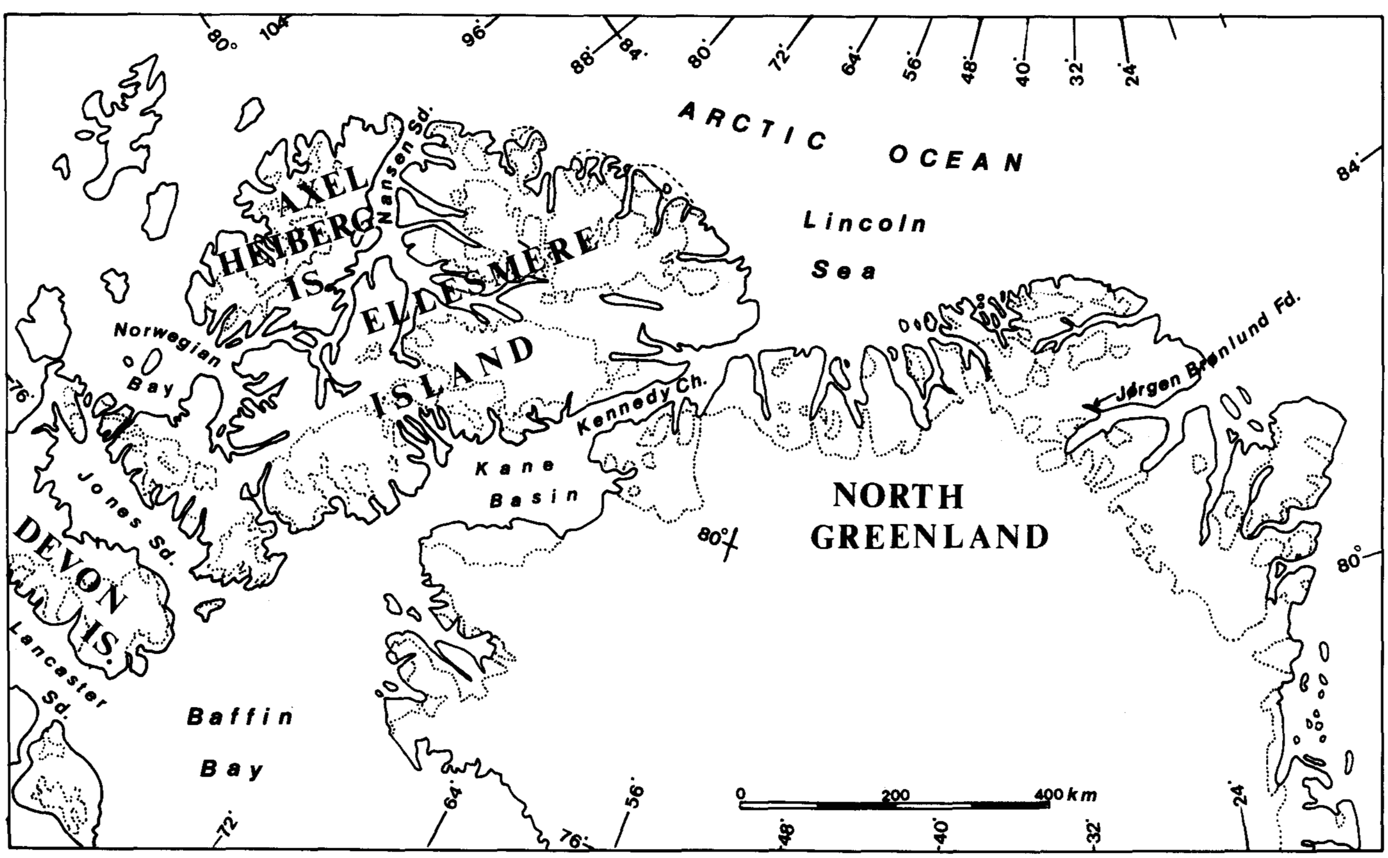

FIG. 1. Canadian Arctic Archipelago and North Greenland.

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probably forming floating glacial ice shelves (cf. Lemmen *et al.*, 1989). The stratigraphic record shows numerous floating glacier tongues, but the actual extent of the ice shelves in the channels of northern Axel Heiberg and Ellesmere islands prior to the Holocene is not known. Nevertheless the period of glacial advance and shelf growth likely coincided with persistent sea ice. A close relationship between the severity of climate and the areal extent and summer persistence of sea ice has long been recognized (e.g., Koch, 1945; Vibe, 1967; Dunbar, 1972; Dickson *et al.*, 1975).

High arctic ice cores indicate that approximately 10.5-10 ka ago the climate warmed considerably and glaciers began to thin and retreat (Fisher *et al.*, 1983; Koerner, 1977; Koerner *et al.*, 1987). However, probably due to response lag, rapid deglaciation of the fiords along the northern coast of Ellesmere Island and Nansen Sound did not begin until just prior to 8 ka B.P. Within 200-300 years of this time most glaciers retreated to near their present margins (Bednarski, 1986, 1987; Evans, 1988; Lemmen, 1988; Stewart and England, 1986).

The early Holocene climatic amelioration coincided with reduced extent of summer sea ice and breakup of ice shelves along the northern coast of Ellesmere Island, which allowed driftwood to penetrate fiords and channels (Blake, 1972; Stewart and England, 1983). Driftwood dating from 8850 to 3000 B.P. behind the Ward Hunt Ice Shelf (Fig. 2) indicates that the shelf did not exist during the early to mid-Holocene (Crary, 1960; Lemmen, 1988; Mielke and Long, 1969). To the west, at Wootton Peninsula (Fig. 2), driftwood dating 4.3 ka B.P. provides a maximum age for the ice shelf there (Evans, 1988). More impressive evidence for open water along the Wootton Peninsula (at 82°N) is a narwhal tusk (*Monodon monoceros* L.) that dated 6830 ± 50 B.P. (Evans, 1989). Currently narwhal range wherever open water is available, from Davis Strait to Disko Bay, west Greenland in winter to Lancaster Sound/Barrow Strait in summer (Stirling *et al.*, 1981). Nevertheless, narwhal are occasionally found far north of their usual range. For example, narwhal were encountered during the drift of the *Fram* in 1895 at about 85°N, 80°E (Nansen, 1897) and Peary sighted narwhal in northernmost Nares Strait in 1905 (Peary, 1907).

The postglacial warm interval ended about 4.5 ka ago, when climatic deterioration caused renewed growth of ice shelves along the northern coast of Ellesmere Island (Lyons and Mielke, 1973) and numerous glacial readvances (e.g., Blake, 1981; Evans, 1988; Hattersley-Smith, 1969; Lemmen, 1988; Müller, 1963; Stewart and England, 1983). Ice core records also show progressive cooling from 4.5 to 3 ka B.P. until post-Little Ice Age warming ca. 100 B.P. (Koerner and Paterson, 1974; Koerner, 1977).

SITE DESCRIPTION AND AGE

The bowhead whale skeleton was found adjacent to Nansen Sound on the coast of Axel Heiberg Island (80°42'N, 90°43'W), ~6 km southeast of the mouth of Lightfoot River and ~2.5 km inland (Fig. 2). The skeleton formed the core of a large turf-covered mound from which only a few ribs and mandible fragments protruded. The mound formed the summit of gently rising glaciomarine silts at 40 m above sea level (Fig. 3). Ground ice encapsuled the skeleton beneath the turf; however, it was clear that the bones were partially embedded in the silt substrate. The skeleton was not articulated, but there

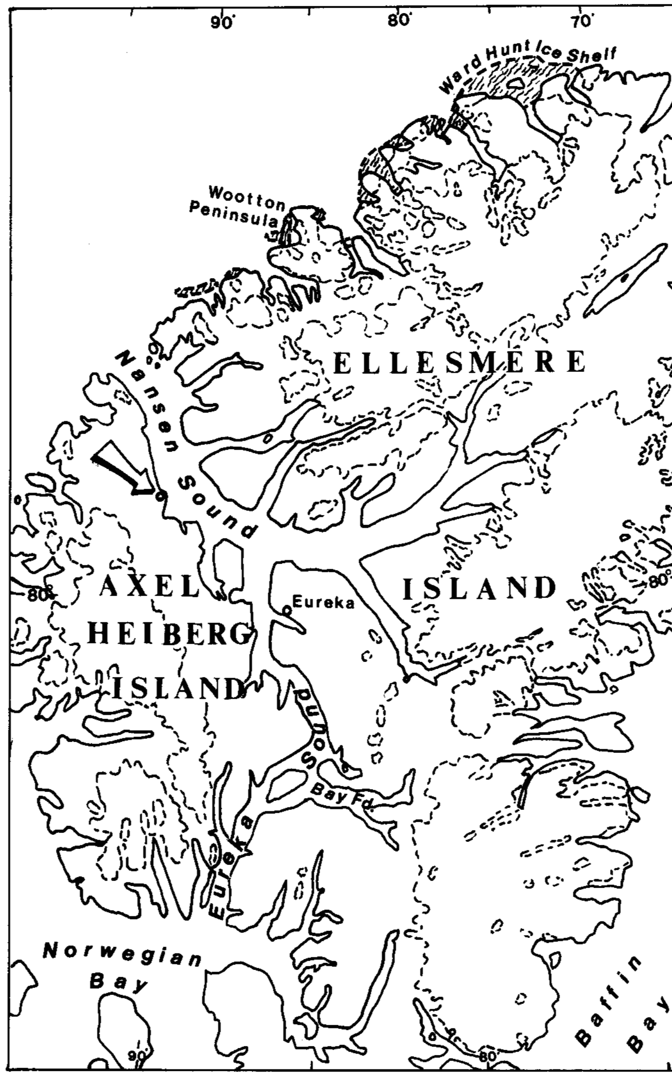

FIG. 2. Axel Heiberg and Ellesmere islands. The arrow locates the whale skeleton in Nansen Sound.

was a rough order in which the vertebrae were scattered out over a distance of ~19 metres. The cranium, minus its protuberances, is 1.5 m wide (Fig. 4) and was found 26 m downslope from the main skeleton on a solifluctating surface. The skeleton could only be partially uncovered because of the frozen substrate. Nonetheless, the characteristic bowhead cranium provided positive identification of the animal.

FIG. 3. Photograph of the site. Glaciomarine silts gently rise to 40 m above sea level.

FIG. 4. Partial cranium and humerus of the bowhead whale. Cranium is approximately 1.5 m wide.

The whale radiocarbon dated at 7475 ± 220 B.P. (S-3035). The date was obtained on part of the ear bone (otic capsule, pers. comm. of A.S. Dyke with C.R. Harington, National Museums of Canada, 1988). The dense nature of this bone minimizes the likelihood of contamination (Dyke, 1980). Thus the whale dates from the time of the postglacial climatic optimum indicated by the glaciological record.

STRATIGRAPHIC SIGNIFICANCE

Marine mammals, like driftwood, provide a useful method of dating strandlines related to former high sea levels (Dyke, 1980). Once dead, bowhead whales quickly distend and float until they become beached along the shore (T.G. Smith, pers. comm. 1988). Given these conditions, the local sea level was at least 40 m above present at ca. 7475 B.P. However, since the whale was not found on a distinct strandline, the animal may have grounded below contemporary sea level. Conversely, the carcass may have been redeposited to a lower elevation as sea level fell during isostatic rebound. In either case, the whale would date a slightly higher sea level than indicated. The age of the 40 m sea level is currently being verified by other geological data. Maximum postglacial marine inundation at this site is ~110 m above present sea level and a date on marine bivalves at 56 m above sea level indicates that the marine limit is older than 8300 ± 130 B.P. (GSC-4753).

CLIMATIC SIGNIFICANCE AND DISCUSSION

To my knowledge, this is the northernmost subfossil bowhead whale found in the Canadian High Arctic. Undated bones tentatively identified as from *Balaena mysticetus* were also found in Jørgen Brønlund Fjord, North Greenland (Vibe, 1967; Bennike, 1987). Bowhead whales are consistently associated with sea ice edge and broken pack ice habitat (Banfield, 1977; Reeves *et al.*, 1983). This means that bowhead migration and distribution are governed by seasonal variability of sea ice cover, and extensive landfast ice precludes their presence (Vibe, 1967).

In the Canadian High Arctic, the northernmost range of modern bowhead whales extends from Lancaster Sound to the southern end of Kane Basin, outside of recent sightings in western Kennedy Channel (Davis and Koski, 1980), where present-day sea ice conditions are much less extensive due to the ameliorating influence of the West Greenland current (Dunbar and Moore, 1980; Markham, 1984). During historical times occasional sightings were reported in Jones Sound (Davis *et al.*, 1980; Dunbar and Moore, 1980; Reeves *et al.*, 1983). It is likely that whales were more common in Jones Sound prior to intensive whaling and near extermination (Davis and Koski, 1980). Nevertheless, the Nansen Sound site is ~500 km straight north of the present range of bowhead whales (Fig. 2).

Given the current distribution of bowheads, the most likely route for their migration into Nansen Sound must be from Jones Sound to Norwegian Bay and then northward through Eureka Sound (Fig. 2). This proposed paleo-migration route is supported by several old whale skulls found along Eureka Sound. A whale skull of unknown species dated at 1380 ± 130 B.P. (GSC-452; Lowdon and Blake, 1968) was collected by W.O. Kupsch at the junction of Eureka Sound and Bay Fiord (78°54′N, 85°10′W). At least two undated bowhead skulls were also found by station personnel in the vicinity of Eureka weather station in Slidre Fiord (80°00′N, 85°57′W). All of these finds suggest that in the past sea ice conditions must have been less severe than at present, particularly in Norwegian Bay and southern Eureka Sound. Presently these large areas are consistently blocked with pack ice that forms a barrier to the more open conditions in mid-Eureka Sound (Fig. 5; Markham, 1984). The area where the whale was found in Nansen Sound also has extensive sea ice, even at the summer minimum (seven- to nine-tenths old ice for 76-99% of years on record; Markham, 1984).

Vibe (1967) proposed that during climatic warm periods, when pack ice was reduced, whales could migrate from East Greenland to Peary Land and then across Lincoln Sea to the northern coast of Ellesmere Island (Fig. 1). At various times in the Holocene sea ice severity was reduced along the coast of North Greenland and Ellesmere Island (Fredskild, 1969; Stewart and England, 1983). As noted above, ancient bones, probably bowhead, were found in Peary Land (Vibe, 1967; Bennike, 1987). Moreover, several neo-Eskimo sites there contained kayak and umiak remains, which clearly attest to open water conditions in the past (Knuth, 1981, 1983). The 6.8 ka B.P. narwhal tusk found on Wootton Peninsula, northern Ellesmere Island (Evans, 1989), shows that large marine mammals were present on this coast in the early Holocene.

Irrespective of the route used, the presence of the whale indicates that sea ice conditions must have been more open at ca. 7.5 ka B.P. than now, implying significantly warmer conditions. However, this is not to say that the marine conditions ca. 7475 B.P. were not severe. The early Holocene was a time of rapid glacial retreat and extensive calving in the fiords (Bednarski, 1986, 1987; England, 1978; Evans, 1988; Hodgson, 1985; Lemmen, 1988). The Nansen Sound whale was partially embedded in sediments containing many dropstones (ice-rafted debris), indicating that numerous debris-laden icebergs choked fiords and channels. These icebergs scoured the sea floor, as they do today, and must have been formidable barriers to whales.

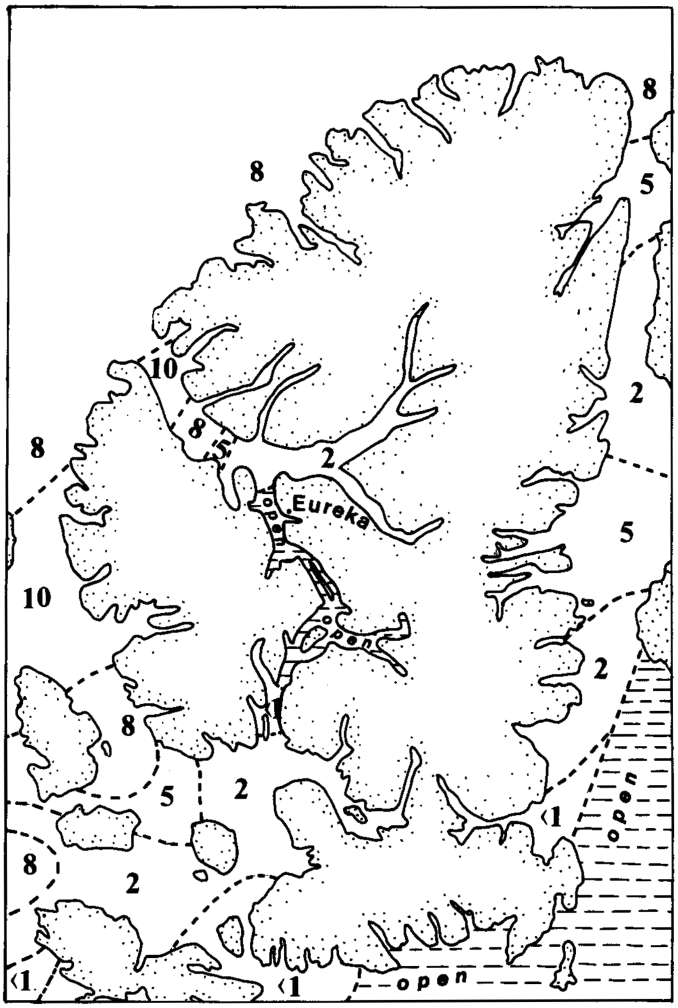

FIG. 5. Minimum sea ice conditions around Axel Heiberg and Ellesmere islands. Numbers indicate median amount of old ice in tenths occurring 13 August (after Markham, 1984).

CONCLUSION

Several lines of data from the High Arctic indicate that the climate during the first half of the Holocene was milder than today. The end of the last glaciation on northern Ellesmere and Axel Heiberg islands was brought on by a climatic warming about 10 ka B.P. (Koerner *et al.*, 1987). The early Holocene was a time of accelerated deglaciation, with extensive calving of fiord glaciers and breakup of ice shelves along the northern coast of Ellesmere Island (Bednarski, 1986; Evans, 1988; Hodgson, 1985; Lemmen, 1988). Abundant driftwood was able to penetrate fiords and channels as the sea ice cover diminished (Blake, 1972; Stewart and England, 1983) and deglaciation was so extensive that some glaciers retreated up valley of their present-day margins (e.g., Blake, 1981; England, 1978; Hattersley-Smith, 1969; Lemmen, 1988).

Appearance of a bowhead whale in northern Nansen Sound at 7475 B.P. provides further evidence that relatively warm conditions prevailed in the High Arctic during early postglacial time. Additional whalebone found at several sites along Eureka Sound suggest that bowhead whales may have regularly migrated north from Norwegian Bay during times of climatic warmth. Systematic radiocarbon dating of the numerous fossil whale remains in the Canadian Arctic would more conclusively document these periods of climatic amelioration and the patterns of Holocene whale distribution.

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