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Article abstract

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NEW RECORDS AND AMS RADIOCARBON DATES ON QUATERNARY WALRUS (*ODOBENUS ROSMARUS*) FROM NEW BRUNSWICK

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ABSTRACT Walrus fossils are occasionally recovered during scallop dragging in the Bay of Fundy and from sand and gravel deposits along the coastline of New Brunswick in eastern Canada. Six new fossils and four new AMS radiocarbon dates significantly increase the information concerning late-glacial to postglacial walrus in New Brunswick. Dates range from about 12 800 BP to 2900 BP, almost half falling between 9000 and 10 000 BP. Temporal distribution of walrus, compared to estimates of past summer sea surface temperature, suggest that in the Bay of Fundy walrus occurred in waters ranging from 12 to 15°C.

RÉSUMÉ *Nouvelles données et datations à l'accélérateur de particules sur le morse du Quaternaire, au Nouveau-Brunswick.* La pêche aux pétoncles dans la baie de Fundy permet parfois de récupérer des fossiles de morse. Ainsi, six nouveaux fossiles et quatre nouvelles datations viennent enrichir les connaissances sur le morse qui vivait du Tardiglaciaire au Postglaciaire. Les dates se situent entre 12 800 et 2900 BP, la majorité entre 9000 et 10 000 BP. La répartition temporelle du morse, ainsi que les estimations des températures estivales passées de la surface marine indiquent que le morse de la baie de Fundy vivait dans des eaux dont les températures variaient entre 12 et 15 °C.

INTRODUCTION

Late-glacial and postglacial walrus (*Odobenus rosmarus)* remains have been known from the east coast of North America since the middle nineteenth century (Provencher, 1869; Rhoads, 1898). Specimens have been found along the coast of Atlantic Canada and as far south as North Carolina (Gallagher *et al.*, 1989). Fossil walrus from Pleistocene and Holocene deposits in New Brunswick have been known since at least 1871, when a nearly complete skeleton, dated 9700 ± 130 BP (Beta-16161), was collected almost 100 m (?) asl, from a gravel pit near Moncton (Harington and Occhietti, 1988; Harington *et al.*, 1993). Harington and Occhietti (1988) included most New Brunswick specimens in a review of marine mammal fossils from the Champlain Sea and its approaches. Walrus fossils from New Brunswick were reviewed by Miller (1990). Since then, six new fossil walrus have been collected from offshore New Brunswick by dredging. The earlier report by Miller (1990) included an AMS radiocarbon date from one specimen in the New Brunswick Museum. A second date was noted in the CANQUA field guide to southwestern New Brunswick (Seaman *et al.*, 1993). The purpose of this paper is to describe new fossil material, provide a description of the radiocarbon date for the specimen cited in Seaman *et al.* (1993) and to report three new AMS radiocarbon dates.

The biogeography of late-glacial and postglacial walrus populations in Atlantic Canada is all but unknown because fossils are rare. Two subspecies of walrus, *Odobenus rosmarus rosmarus*, the Atlantic walrus and *O. rosmarus divergens*, the Pacific walrus are believed to have originated during the time of Pleistocene glaciation which split a previously single population (Harington, 1966). The two populations developed in isolation and can now be recognized as separate subspecies (Davies, 1958; Fay, 1981). A recent review of the Atlantic walrus has been published by Richard and Campbell (1988). Dated fossil specimens will help shed light on walrus evolution. However, understanding the changes in distribution of walrus during the last deglaciation is relevant to understanding the future of modern walrus. Many climate models predict future increases in mean global temperature to be significantly greater in arctic regions. Projections for climate warming in the Canadian arctic, for a doubling of carbon dioxide, suggest temperature increases above current values of 4 to 6°C in summer and 6 to 10°C in winter (CCPB, 1991). Knowing how walrus responded to past rapid climatic changes, such as the Younger Dryas event, may help predict how present populations may react to future climate change. The information in this paper adds to a small, but growing database on late-glacial and postglacial walrus in Atlantic Canada.

NEW RECORDS OF WALRUS

In addition to records of late-glacial and postglacial walrus from New Brunswick already published (Harington and Occhietti, 1988; Miller, 1990; Harington *et al.*, 1993; Seaman *et al.*, 1993), six new specimens have been recovered during scallop dredging in the Bay of Fundy. Five of the specimens come from the same heavily fished area near Cape Spencer (Fig. 1) where previous specimens were reported (Miller, 1990). Fishermen who donate the fossils report that such finds are not uncommon. Depth and location data are approximate and based on information recalled days to months later when specimens reach the museum. All specimens catalogued as NBMG are reposited in the New Brunswick Museum.

Order Carnivora Bowdich, 1821

Family Odobenidae Allen, 1880

Genus *Odobenus* Brisson, 1762

Odobenus rosmarus (Linnaeus, 1758)

NBMG 8621 - mandible lacking teeth, measuring 20 cm long, but missing posterior end of ramus. Identified as a male walrus by F.H. Fay (personal communication, 1992). Collected by D. Lomax in 1990, from the Bay of Fundy 9.5 km south of Quaco Head (Fig. 1) from a depth of about 42 m.

NBMG 8722 - anterior portion of cranium, lacking teeth except for 17 cm right tusk. Cranium measures 19 cm anterior to posterior and includes anterior right zygomatic bone. Identified as a male walrus by F.H. Fay (personal communication, 1992). Collected by M. Lomax in 1992, from the Bay of Fundy 9.5 km south of Quaco Head (Fig. 1) from a depth of about 58 m.

NBMG 9105 - mandible, lacking teeth, measuring 23 cm long. Probably a male walrus. Collected by D. Lomax in 1993 from the Bay of Fundy 8 km south of St. Martins (Fig. 1) on sand bottom, from an unknown depth.

NBMG 10026 - left scapula, measuring 44 cm from the dorsal border at the spine to the coracoid process. Collected by D. Mitchell in 1995, just outside Back Bay (Fig. 1), Bay of Fundy, from a depth of about 73 m.

NBMG 10029 - tusk, measuring 40 cm long. Collected by C. Moore in 1995, from the Bay of Fundy about 4 km south of Cape Spencer (Fig. 1), from an unknown depth.

NBMG 10045 - mandible, lacking teeth, measuring 21 cm long, but missing posterior end of ramus. Probably a male walrus. Collected in 1994 from the Bay of Fundy off Cape Spencer (Fig. 1), from an unknown depth. Donated by S. Brilliant.

AMS RADIOCARBON DATES

AMS radiocarbon analyses have been conducted for two new specimens reported here and for two specimens described previously (Miller, 1990). Specimens from the NBM collection (NBMG 4584; 8621; 9105) were sampled by mechanically removing an outer layer of bone, about 2mm thick, and then recovering a minimum of 3 g of powered bone using a drill. The specimen from the Huntsman collection, recovered about 18 km off Black River, New Brunswick (Miller, 1990) was sampled by recovering bone that had flaked off the surface of the skull. Samples were sent to Beta Analytic or Isotrace for collagen extraction and AMS dating.

NBMG 4584 - A sample of powdered bone from the cranium (Miller, 1990) produced a corrected age of 2890 ± 40 BP (Beta-71157); $\delta^{13}C$ = -16.5 ‰.

NBMG 8621 - A sample of powdered bone from the mandible produced a corrected age of 9980 ± 60 BP (Beta-69386); $\delta^{13}C$ = -16.9 ‰.

NBMG 9105 - A sample of powdered bone from the mandible produced a corrected age of 10 270 ± 70 BP (Beta-89281); $\delta^{13}C$ = -19.2 ‰.

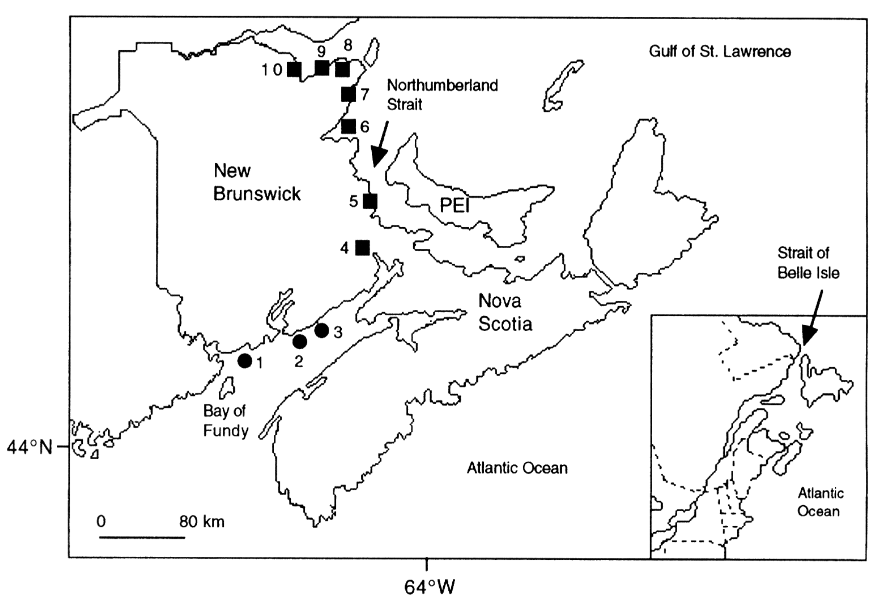

FIGURE 1. Occurrences of Quaternary walrus fossils in New Brunswick, Canada. Circles indicate new finds at 1) Back Bay, 2) off Cape Spencer, and 3) off St. Martins and Quaco Head. Squares indicate previously recorded localities (Miller, 1990) near 4) Moncton, along the Northumberland Strait at 5) Buctouche, 6) Miscou Island, and 7) Tracadie, and along the Bay of Chaleurs near 8) Village St. Paul; 9) Clifton and 10) Beresford.

Sites de recouvrement de morses du Quaternaire au Nouveau-Brunswick. Les cercles identifient les nouvelles découvertes : 1) Back Bay, 2) au large du Cape Spencer et 3) au large de St. Martins et Quaco Head. Les carrés identifient les sites déjà confirmés (Miller, 1990) : 4) près de Moncton, le long du détroit de Northumberland, 5) Buctouche, 6) Miscou Island, et 7) Tracadie, et le long de la baie des Chaleurs 8) près du Village Saint- Paul; 9) Clifton et 10) Beresford.

Huntsman specimen - A sample of bone from this relatively complete cranium (Miller, 1990) yielded a corrected age of 12 760 ± 90 BP (TO-1927) (Seaman *et al.*, 1993).

DISCUSSION

Beginning about 14 000 years ago glacier ice retreated from New Brunswick, leaving most of the province ice-free by 11 000 BP. Most marine sediments fringing the coastline were likely deposited before 12 300 BP (Rampton *et al.*, 1984). The oldest radiocarbon date, establishing the opening of the Bay of Fundy by 14 400 ± 530 BP (GSC-2573), comes from *Hiatella arctica* found near Mispec, Saint John (Lowden and Blake, 1979). Nicks (1991) reported a date of 13 900 ± 620 BP (GSC-3354) on *Hiatella arctica* from Sheldon Point in Saint John, in a deposit described as a glaciomarine end moraine. The oldest dated walrus fossil (12 760 BP) indicates that these animals inhabited the Bay of Fundy no more than one thousand years afterward. Almost half the ages determined so far, fall between 9000 and 10 000 BP (Fig. 2) suggesting the largest populations of walrus may have developed in that period. However, only a small sample set is available.

Bousfield and Thomas (1975) speculated on late-glacial and postglacial changes in near surface ocean temperatures based on the present distribution of littoral marine invertebrates in the Maritimes. They suggested that between 13 000 and 12 000 BP, as ice retreated from most of New Brunswick, water temperatures adjusted to changing currents and sea levels (Fig. 2). During this time the Strait of Belle Isle (Fig. 1) opened to allow cold subarctic (< 12°C summer) waters to penetrate along the St. Lawrence River valley and into the Champlain Sea. Harington *et al.* (1993) recorded an 11 490 ± 160 (Beta-16518) year old walrus from the Strait of Belle Isle, while the first walrus fossil from Champlain Sea deposits, dated 10 090 ± 60 BP (TO-2224), was described by Bouchard *et al.* (1993). According to Bousfield and Thomas (1975), areas of subarctic surface temperatures (< 12°C summer) at 12 500 BP would have included sites where walrus (Fig. 1), beluga and seal fossils are recorded from New Brunswick. An area of cold water persisted along

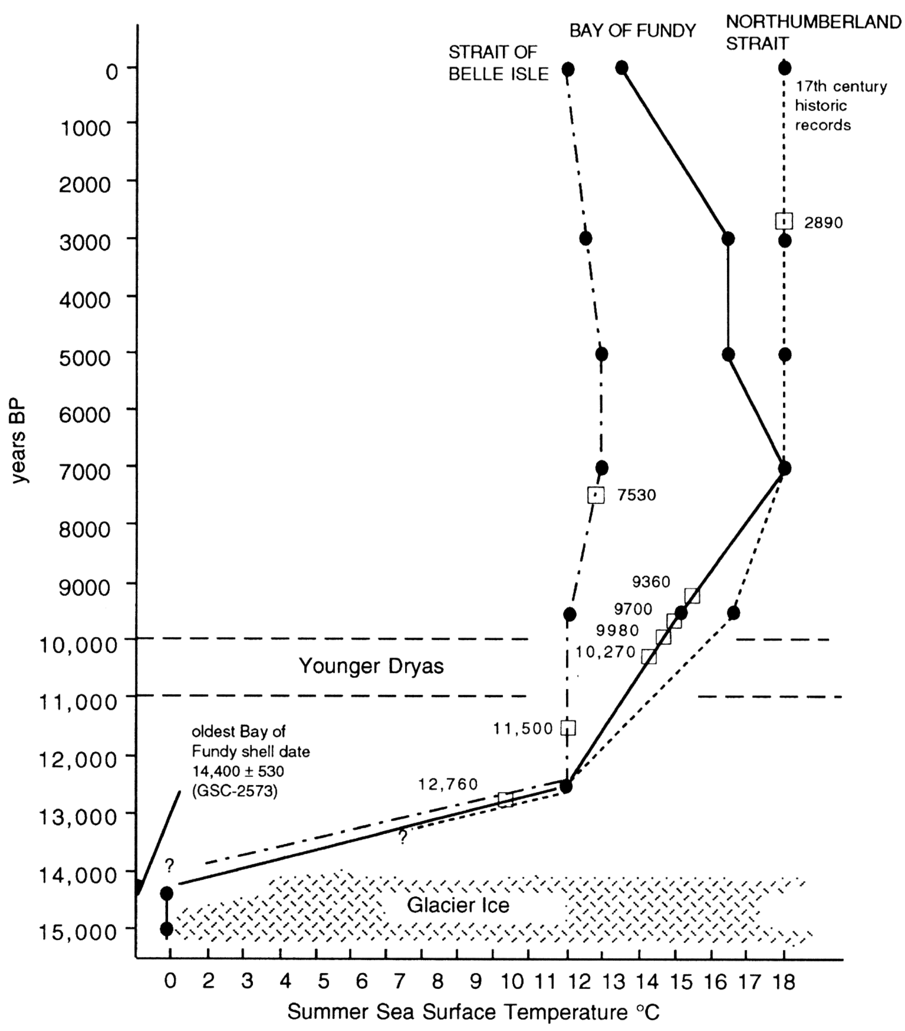

FIGURE 2. Hypothetical summer sea surface temperatures (°C) over the past 15,000 years in the Bay of Fundy, Northumberland Strait and the Strait of Belle Isle (data complied from Bousfield and Thomas, 1975) . Open squares indicate radiocarbon dates (yr BP) for walrus fossils from each of these regions.

Estimations des températures marines de surface depuis 15 000 ans, dans la baie de Fundy, le détroit de Northumberland et le détroit de Belle-Isle (données compilées à partir de Bousfield et Thomas, 1975). Les carrés vides identifient les datations au radiocarbone sur morse fossile de chacune des régions.

the north shore of the Bay of Fundy, eventually warming by 9500 BP. Similar surface water temperatures occur today in the St. Lawrence estuary where a relict beluga population survives and also near mouth of the Bay of Fundy where beluga have been recorded recently.

Although environmental effects on marine mammal distribution are not completely understood, sea-surface temperature is used as a parameter in studies of cetacean zoogeography (Gaskin, 1982). Comparison of surface water temperatures postulated by Bousfield and Thomas (1975) with occurrences of dated walrus show that most fossils in the Bay of Fundy date from times when summer sea surface temperatures were about 12 to 15°C (Fig. 2).

In postglacial times, walrus are known to have occupied the Strait of Belle Isle until about 7500 years ago (7530 ± 140 BP (I-8099); Tuck, 1976). The youngest walrus fossil from New Brunswick, dated here at 2890 BP, occurs on Miscou Island (Miller, 1990) on the Northumberland Strait coast (Fig. 1). Historic records from the 17th century exist for walrus in the Northumberland Strait (Ganong, 1904, 1906) and probable strays have been recorded off the western end of Nova Scotia in this century (Wright, 1951).

This paper continues to document the late-glacial and postglacial distribution of walrus in Atlantic Canada and it's response to climate change. One early observation is that most walrus dates fall outside the Younger Dryas interval, about 11 000 to 10 000 years ago (Fig. 2). Additional dates may prove this to be a sampling bias. However, studies of North Atlantic sea surface temperatures suggest conditions during the Younger Dryas resembled ocean temperatures at 18 000 BP when the North Atlantic Polar Front readvanced to near full glacial conditions (Ruddiman and McIntyre, 1981; Rind *et al.*, 1986; Lowe *et al.*, 1994). Walrus usually live on moving pack ice over the shallow waters of the continental shelf. Perhaps sea ice conditions reduced walrus populations in the Bay of Fundy during part of the Younger Dryas interval. Terrestrial data in the Maritimes indicate that during the Younger Dryas event local ice caps in Nova Scotia expanded (Stea and Mott, 1989). Clear indications of cooling are seen in the pollen record of New Brunswick and Nova Scotia (Cwynar *et al.*, 1994; Mott, 1994) and the terrestrial insect record also shows evidence of Younger Dryas cooling (Wilson *et al.*, 1993; Miller, 1996). Walrus feed on benthic invertebrates, mostly molluscs, at depths of 10-50 m and up to 80 m (Fay, 1981). However, molluscs are not likely to have been a limiting factor as they are known to have inhabited the Bay of Fundy during the Younger Dryas (Dyke *et al.*, 1996).

More information on walrus, with respect to their tolerances of sea-surface temperatures, sea-ice, water depth and food resources and a larger set of dated specimens will have to be compiled to more fully examine the effects of climate change on walrus.

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