

Muskox Bone of Possible Wisconsin Age from Banks Island, Northwest Territories

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ABSTRACT. Part of a metacarpal of *Ovibos* was found in 1963 on Banks Island, Northwest Territories, Canada, near 121°54'W., 73°23'N. The bone was indistinguishable from *Ovibos moschatus*. A Carbon-14 date in excess of 34,000 years was determined. The possible existence of a Wisconsin refugium on Banks Island is discussed. Evidence suggests that a refugium existed there isolated from Beringia. In addition to plant species, two small mammal species (*Lemmus sibiricus* and *Lepus arcticus*) and possibly muskoxen survived in the Banks Island refugium.

RÉSUMÉ Ossement de bœuf musqué d'âge wisconsin (?) provenant de l'île de Banks, T. du N.-O., Canada. Un morceau de métacarpe d'*Ovibos* a été trouvé en 1963 sur l'île de Banks, T. du N.-O., Canada, près de 121°54'O. et 73°23'N. L'ossement n'était pas distinct de celui d'un *Ovibos moschatus*. L'auteur discute de l'existence possible d'un refuge wisconsinien sur l'île de Banks. En effet, il semble avoir existé là un refuge, isolé de la Béringia. En plus d'espèces botaniques, deux espèces de petits mammifères (*lemmus sibiricus* et *Lepus arcticus*) et, peut-être, le bœuf musqué auraient survécu dans le refuge de Banks.

РЕЗЮМЕ. Кость мускусного быка предположительно Висконсинского возраста с о. Банкс в Северо-западных территориях Канады. Часть пястной кости мускусного быка (*Ovibos*) была найдена в 1963 г. на о. Банкс в районе 121° 54' W, 73° 23' N. Кость была неотличима от *Ovibos moschatus*. Радиоуглеродные измерения с применением углерода C¹⁴ показали, что ее возраст превышал 34000 лет. Обсуждается возможность существования изолированного от Берингии убежища на о. Банкс во время Висконсинского оледенения, в котором кроме растительных видов сохранились два вида мелких млекопитающих (*Lemmus sibiricus* и *Lepus arcticus*), а также, возможно, и мускусный бык.

INTRODUCTION

An investigation of the terrestrial vertebrate fauna was undertaken in the summer of 1963 on Banks Island, Northwest Territories, Canada, near 121°54'W., 73°23'N. The study area was approximately 45 miles inland on the Bernard River at its confluence with a large unnamed tributary from the east (Maher 1968). The gravel bars and uplands on about 10 square miles were persistently searched for vertebrate fossils in the course of the summer's field work. Only one fossil was collected: a bone found on a gravel bar. This report discusses the significance of the find and of the scarcity of fossils in the area.

THE SPECIMEN

The specimen was the right half of a left metacarpal of *Ovibos*. It was 163 mm. long and was indistinguishable from a left metacarpal of *Ovibos moschatus* 156 mm. long from Lake Hazen, Ellesmere Island, Northwest Territories, in the University of Saskatchewan Biology Museum (Fig. 1).

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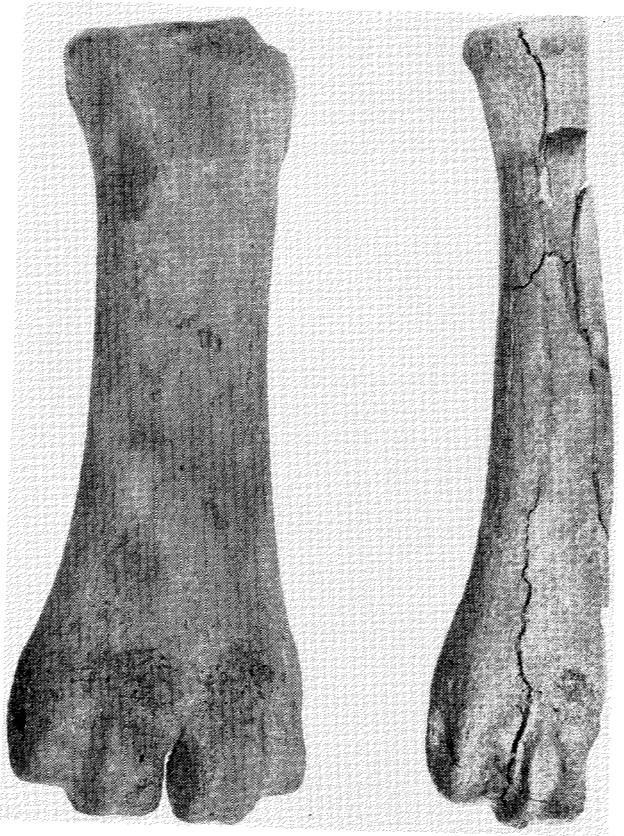


FIG. 1. The Banks Island specimen (right) compared with a left metacarpal of *Ovibos moschatus* from northern Ellesmere Island.

RESULTS AND DISCUSSION

The specimen was submitted to the Department of Chemistry, University of Saskatchewan, Saskatoon, for Carbon-14 dating. The results indicated that it was more than 34,000 years old (K. J. McCallum, personal communication), thus suggesting that muskoxen were present on Banks Island at the height of Wisconsin glaciation or earlier.

Four unglaciated areas are known in North America in which tundra species could have survived the Wisconsin glaciation (Macpherson 1965). A narrow belt of tundra persisted on the mainland south of the ice sheet. Beringia, which included parts of Alaska and Siberia and the exposed continental shelf, persisted in the northwest. There were two unglaciated areas on the northern and western periphery of the arctic islands: one was in northeastern Ellesmere Island and northern Greenland and the other included western and northern Banks Island and some of the western Queen Elizabeth Islands.

Recent workers on the taxonomy of the muskoxen have agreed that there are two forms of the species. Manning and Macpherson (1961) recognized two races: a mainland race *Ovibos moschatus moschatus*, and an island race *O.m. wardi*. Tener (1965) has synonymized the two races, while recognizing that the high arctic and mainland populations do differ significantly. He apparently sub-

scribes to Harington's 1961 hypothesis that the present populations of *Ovibos* are derived from two sources: a population which reoccupied northern mainland Canada from the south as the ice retreated, and a persistent Ellesmere-Greenland population which reoccupied the Canadian arctic islands. Harington did not comment on the fate of the Beringian population of *Ovibos*; presumably he concluded that it did not contribute to the present Canadian populations.

A maximum age cannot be determined for the *Ovibos* specimen reported here; therefore, although the specimen does suggest the persistence of a muskox population on Banks Island into Wisconsin time, it cannot confirm it. Ray and Harington report (unpublished manuscript) a muskox bone found in association with plant debris which has been Carbon-14 dated at $10,660 \pm 170$ years B.P. The bone is from Thesiger Bay on the southern part of Banks Island considered to have been glaciated at the maximum extent of Wisconsin ice. This could simply indicate that *Ovibos* closely followed the retreating ice and reached Banks Island as the ice began to withdraw. Withdrawal of ice in the western archipelago had begun by 13,000 B.P. (Bird 1967).

Unfortunately neither of these data establish that muskoxen persisted on Banks Island during Wisconsin time. Vertebrate fossils were very rare in the part of Banks Island investigated, compared with the number of fossils usually found on gravel bars and on the tundra of northern Alaska. The scarcity of fossils is inconsistent with the view that Banks Island was a refugium. It could mean that the muskox was the only species of large mammal on the island in Wisconsin time and that it survived there in low numbers, or perhaps that it survived into Wisconsin time and became extinct. Conclusions on this point cannot be made until more fossil material becomes available.

The role of the unglaciated islands as a refugium in the northwestern Archipelago is in dispute. Porsild (1955) on the basis of an analysis of the flora of the Archipelago concluded that there was a refugium in the Canadian islands. Savile (1961) reanalysed Porsild's plant distribution data and concluded that there was no evidence for a refugium other than in northeast Greenland.

Mammalogists have differed in their views on this question. Macpherson (1965) found no evidence to suggest survival of a mammalian fauna on Banks Island or in the western Queen Elizabeth Islands. Harington (1964) suggests that glacial refugia in the western Queen Elizabeth Islands were possible although he believes that subspeciation of *Ovibos moschatus wardi* occurred in the northern Ellesmere-Greenland refugium.

Banfield (1961) concluded that Peary caribou survived Wisconsin glaciation in a refugium in the western Queen Elizabeth Islands and perhaps northern Greenland. Although he does not mention Banks Island, his map of Wisconsin ice shows the western half of the island unglaciated and presumably it would be part of the refuge. Manning (1960), however, supposes that Peary caribou evolved in a high arctic refugium and that parts of the Queen Elizabeth Islands, Banks Island and later Victoria Island were colonized in late Wisconsin time as the ice retreated. I would like to discuss briefly the evidence for a refugium on Banks Island and argue for its complete separateness from Beringia.

Geologists have agreed that western and northern Banks Island was not

glaciated in Wisconsin time (Craig and Fyles, 1960) although there is some evidence that western Banks Island was glaciated before that time. The depth of soil weathering led Tedrow and Douglas (1964) to conclude that the northern part of the island may have escaped glaciation entirely. There seems little doubt that part of Banks Island was unglaciated in Wisconsin time. The point in dispute is whether it was a refugium for plants or animals.

Phytogeographic evidence for a refugium is tenuous. I will not review the botanical evidence in detail, but the following facts seem pertinent. The known flora of Banks Island, 172 species (Porsild 1955), is richer than that of any other western Canadian island except Victoria Island, which has a known flora of 201 species. Only Baffin Island with 260 has more vascular plant species. Comparison of the number of species in Porsild's (1955) phytogeographic categories on Banks and Victoria islands reveals striking differences.

Of the 143 circumpolar plants, Banks Island has approximately the same number of high-arctic species as Victoria Island (29 v. 28), fewer arctic-alpine species (33 v. 40) and fewer low-arctic species (21 v. 34). Considering the 62 North American endemic species, Banks Island has fewer North American radiants than Victoria Island (30 v. 39), more arctic-archipelago endemics (20 v. 17) and approximately the same number of cordilleran endemics (6 v. 7), western arctic endemics (7 v. 8) and eastern arctic endemics (0 v. 1). Of the 15 species which Porsild considered amphi-Beringian, 11 are known on Banks Island and 13 on Victoria Island. Both islands have about equal numbers of the 48 amphi-atlantic species (15 v. 14).

The arctic-archipelago endemics (20) that occur on Banks Island are greater in number than those that are known from any Canadian island or from north-east Greenland. The known ranges of 4 of these species (*Puccinellia agrostidea*, *Parrya arctica*, *Astragalus Richardsonii*, and *Oxytropis arctobia*) are entirely within the Archipelago and on the adjacent formerly-glaciated mainland. None occurs in the Greenland refugium or in Beringia.

Savile rejects Porsild's conclusion regarding a refugium in the archipelago. He suggests a refugium on the mainland in the Mackenzie River area and interprets the absence of many arctic species from that area as the result of their having been "largely excluded from the Mackenzie lowlands by increasing temperature" (Savile 1961, p. 938).

The Mackenzie River valley was only sporadically glaciated during the pleistocene and could have been an important refugium (G. W. Argus, personal communication). The area is poorly known botanically, and the absence of species from the area may result from ecologic exclusion following climatic change, as Savile suggests, or may simply reflect present lack of information.

Both Porsild's and Savile's points of view seem supportable on present information. It is admittedly dangerous to draw conclusions about geographic origins of plant species from their present distribution, especially in a region which has undergone great ecologic changes in the recent past, and is not yet fully explored. In my opinion the evidence does slightly favour a Banks Island refugium in Wisconsin time. The richness of the Island flora can be accounted for by survival of a small group of species on the island (including the Arctic Archipelago

endemics), reinvasion by many North American species from a mainland refuge, perhaps in the Mackenzie area, and invasion of high arctic species either from the Queen Elizabeth Islands or from the Greenland refugium. The greater richness of the Victoria Island flora compared with the Banks Island flora suggests that the reinvasion from the south and east may still be going on.

Savile's main argument against a refugium in the northwestern archipelago is his opinion that the unglaciated area must have been buried under a permanent blanket of snow. He suggests that the snow reached a depth of 100 to 500 feet and that it was probably compressed to ice in its lower levels. He argues that this snowfield remained static and melted when the climate ameliorated without leaving evidence discernible to geologists.

This suggestion is not convincing. Such a layer of snow and ice would presumably vary in thickness depending on the configuration of the underlying landscape. As a result of movement by wind, it would be thicker in drainageways and lowlands than on uplands and would inevitably be subject to internal stresses which would result in plastic deformation. Resulting movements should probably affect the landscape in some recognizable way. At the least, when so much snow and ice melted, it should leave obvious erosion features. Savile's suggestion is highly speculative and must await further evidence before it can be evaluated.

Part of Savile's argument for a permanent snow cover on Banks Island stems from an assumption of increased precipitation rates as the climate cooled. There is now strong evidence, however, for the uninterrupted existence of sea ice on the Arctic Ocean for the last 70,000 years (Hunkins and Kutschale 1965; Ku and Broecker 1965). Also, Colinvaux (1964) has concluded, on the basis of pollen profiles, that the Arctic Ocean near Beringia was frozen over during Wisconsin glaciation. Both of these conclusions suggest that one major requirement for increased precipitation, a relatively ice-free Arctic Ocean, has not been met at least since before Wisconsin time. Savile accepts the presence of a snow-free refugium in northeast Greenland and suggests that it could have been maintained in part by winds warmed by latent heat of condensation and freezing as they descended from the Greenland glacier. I see no reason why this mechanism could not be suggested with equal validity to explain in part the maintenance of a snow-free refugium in the northwest Canadian islands. *

Macpherson (1965) in his analysis of the present distribution of Canadian arctic mammals found no evidence for the survival of mammalian faunas on Banks Island or the western Queen Elizabeth Islands. He postulated dispersal over the ice of a narrowed Beaufort Sea from eastern Beringia to Banks Island to account for the present distribution pattern of some tundra mammals. I believe that the assumption of an isolated refugium on Banks Island more satisfactorily accounts for this distribution.

The northern boundary of Beringia is usually shown extending west from Point Barrow to Siberia where the continental shelf is broad (see for example Haag 1962). The continental shelf east of Barrow is very narrow and the Beaufort Sea between Banks Island and Alaska is between 500 and 2,000 fathoms deep. It seems improbable that a connection developed between the two lands in the Pleistocene. Connection between Banks Island and the mainland directly

south is more possible; but Amundsen Gulf is approximately 100 miles wide and between 100 and 500 fathoms deep (U.S. Navy Hydrographic Office 1958) and it seems unlikely that a relative displacement of land and sea levels of this magnitude occurred. The fact that the islands are known to have been depressed in Wisconsin time when sea levels were also lower reinforces the argument against a connection between Banks Island and the mainland having been established.

The alternative way in which mammals could reach Banks Island is by dispersal across sea ice. Long distance movements by large herbivores such as caribou and muskoxen are well known (Banfield 1961 and Harington 1964), as are extensive movements on sea ice by carnivores such as the polar bear (*Ursus maritimus*) and arctic fox (*Alopex lagopus*). However, dispersal by a small herbivore, such as a lemming or hare, while possible, seems very improbable over the approximately 100 miles involved.

The zoogeography of several small mammal taxa in the Canadian Arctic as analysed by Macpherson (1965) can be interpreted to support the view that they survived in a Wisconsin refugium isolated from Beringia and including Banks Island. *Lepus arcticus banksicola*, which is restricted to Banks Island, and *Lemmus sibiricus phaiocephalus*, which occurs on Banks and Victoria islands, could have differentiated in this refugium. There is also evidence (Manning and Macpherson 1958) that the original wolf population on Banks Island in 1914-16 was strikingly different from those on the Queen Elizabeth Islands to the north and the mainland to the south. The absence of several small mammal species which could be expected to survive on Banks Island is further support for the Wisconsin isolation of the island. Isolation of Banks Island would explain the absence of the masked shrew (*Sorex cinereus*), the arctic ground squirrel (*Spermophilus undulatus*), the tundra vole (*Microtus oeconomus*) and the red-backed vole (*Clethrionomys rutilus*) from both Banks and Victoria islands.

Banks Island is separated from the islands to the north by M'Clure Strait which, like Amundsen Gulf, is approximately 100 miles wide and 100 to 500 fathoms deep (U.S. Navy Hydrographic Office, 1958). The relatively depauperate flora of these northern islands (Savile 1961) and the absence of *Lemmus* from anywhere north of M'Clure Strait indicates that Banks Island may have been isolated not only from Beringia, but from the ice-free islands to the north as well. Thus it is possible that there were at least two refugia in the northwestern archipelago in Wisconsin time.

CONCLUSIONS

The available evidence suggests that Banks Island was an important Wisconsin refugium isolated from Beringia and from the islands to the north. Several plant species endemic to the western Arctic Archipelago may have originated there and dispersed in post-Pleistocene time. It was possibly a refugium for two small mammal species (*Lemmus sibiricus* and *Lepus arcticus*) which subspeciated there. The *Ovibos* bone reported in this paper suggests that it was also a possible refugium for muskoxen. More definite conclusions on the last point await further information.

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REFERENCES

- BANFIELD, A. W. F. 1961. A revision of the reindeer and caribou, genus Rangifer. *Canadian National Museum Bulletin*, No. 177, 137 pp.
- BIRD, J. B. 1967. *The physiography of Arctic Canada*. Baltimore: The Johns Hopkins Press. 336 pp.
- COLINVAUX, P. A. 1964. The environment of the Bering Land Bridge. *Ecological Monographs*, Vol. 34, No. 3, pp. 297-329.
- CRAIG, B. G. and J. G. FYLES. 1960. Pleistocene geology of arctic Canada. *Geological Survey of Canada Paper*, 60-10, 21 pp.
- HAAG, W. G. 1962. The Bering Strait Land Bridge. *Scientific American*, 206: 112-23.
- HARINGTON, C. R. 1961. History, distribution and ecology of the muskoxen. M.Sc. Thesis, McGill University. 489 pp.
- . 1964. Remarks on Devon Island Muskoxen. *Canadian Journal of Zoology*, 42: 79-86.
- HUNKINS, K. and H. KUTSCHALE. 1965. Quaternary sedimentation in the Arctic Ocean. *Progress in Oceanography*, 4: 89-94.
- KU, T. L. and W. S. BROECKER. 1965. Rates of sedimentation in the Arctic Ocean. *Progress in Oceanography*, 4: 95-104.
- MACPHERSON, A. H. 1965. The origin of diversity in mammals of the Canadian arctic tundra. *Systematic Zoology*, 14: 153-73.
- MAHER, W. J. 1968. Predation by weasels on a winter population of lemmings, Banks Island, Northwest Territories. *Canadian Field-Naturalist*, 81: 248-50.
- MANNING, T. H. 1960. The relationship of the peary and barren ground caribou. *Arctic Institute of North America Technical Paper*, No. 4. 52 pp.
- MANNING, T. H. and A. H. MACPHERSON. 1958. The mammals of Banks Island. *Arctic Institute of North America Technical Paper*, No. 2, 74 pp.
- . 1961. A biological investigation of Prince of Wales Island, N.W.T. *Transactions of the Royal Canadian Institute*, 33, pt. 2, pp. 116-239.
- PORSILD, A. E. 1955. The vascular plants of the western Canadian Arctic Archipelago. *National Museum of Canada Bulletin*, 135, 226 pp.
- SAVILE, D. B. O. 1961. The botany of the northwestern Queen Elizabeth Islands. *Canadian Journal of Botany*, 39: 909-942.
- TEDROW, J. C. F. and L. A. DOUGLAS. 1964. Soil investigations on Banks Island. *Soil Science*, 98: 53-65.
- TENER, J. S. 1965. Muskoxen in Canada. Ottawa: Queen's Printer. 166 pp.
- U.S. NAVY HYDROGRAPHIC OFFICE. 1958. Oceanographic Atlas of the Polar Seas, Part II, Arctic. *Hydrographic Office Publication*, No. 705, 150 pp.