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Helmeted Muskox (*Bootherium bombifrons*) from Near Fort Saskatchewan, Alberta: Dating Evidence for Redeposition in Late Pleistocene Alluvium

Spécimen d'ovibos casqué (*Bootherium bombifrons*) découvert près de Fort Saskatchewan (Alberta) : attestation par datation d'un remaniement dans des alluvions du Pléistocène supérieur

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Résumé de l'article

La surimposition et l'entrecroisement des réseaux fluviatiles pré- et postglaciaires dans les Prairies indiquent que certains fossiles de vertébrés du Quaternaire pourraient avoir fait l'objet d'un remaniement. Pour tester l'hypothèse, nous avons daté, à l'aide d'un accélérateur de particules (SMA), un os provenant d'un crâne d'ovibos casqué (antérieurement décrit) trouvé près de Fort Saskatchewan. Identifié comme un *Bootherium bombifrons* = *Symbos cavifrons*, le spécimen, qu'on avait daté du Pléistocène supérieur (postglaciaire), portait des traces de transport. La date de 30 570 ± 250 ans ^{14}C BP obtenue par SMA, indique qu'il daterait plutôt du Wisconsinien moyen (avant le dernier maximum glaciaire) et qu'il proviendrait, par conséquent, de la Formation d'Empress (Graviers et Sables de la Saskatchewan), dans la région d'Edmonton. À la lumière de ce résultat, d'autres fossiles de vertébrés devraient être réétudiés et, dans la mesure du possible, faire l'objet d'une datation directe, afin de favoriser les études stratigraphiques et paléontologiques.

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Notes

HELMETED MUSKOX (*Bootherium bombifrons*) FROM NEAR FORT SASKATCHEWAN, ALBERTA: DATING EVIDENCE FOR REDEPOSITION IN LATE PLEISTOCENE ALLUVIUM

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ABSTRACT Superimposition and intersection of preglacial and postglacial valley systems on the Canadian plains indicates that some of the recovered Quaternary vertebrate fossils may be redeposited. To test this proposition, an accelerator mass spectrometer (AMS) date was obtained on bone from a previously described helmeted muskox skull from near Fort Saskatchewan, Alberta. The specimen, identified as *Bootherium bombifrons = Symbos cavifrons* was previously thought to be Late Pleistocene (postglacial) in age but showed evidence of transport. A date of 30 570 $\pm$ 250 ^{14}C yrs BP indicates that it is of Middle Wisconsinan (pre-Last Glacial Maximum) age and therefore was ultimately derived from the Empress Formation (Saskatchewan Gravels and Sands) in the Edmonton area. Other vertebrate fossils must be assessed carefully in this light and direct dating is recommended wherever possible to facilitate both stratigraphic and paleontological studies.

RÉSUMÉ *Spécimen d'ovibos casqué* (Bootherium bombifrons) *découvert près de Fort Saskatchewan (Alberta) : attestation par datation d'un remaniement dans des alluvions du Pléistocène supérieur.* La surimposition et l'entrecroisement des réseaux fluviatiles pré- et postglaciaires dans les Prairies indiquent que certains fossiles de vertébrés du Quaternaire pourraient avoir fait l'objet d'un remaniement. Pour tester l'hypothèse, nous avons daté, à l'aide d'un accélérateur de particules (SMA), un os provenant d'un crâne d'ovibos casqué (antérieurement décrit) trouvé près de Fort Saskatchewan. Identifié comme un *Bootherium bombifrons = Symbos cavifrons*, le spécimen, qu'on avait daté du Pléistocène supérieur (postglaciaire), portait des traces de transport. La date de 30 570 ± 250 ans ^{14}C BP obtenue par SMA, indique qu'il daterait plutôt du Wisconsinien moyen (avant le dernier maximum glaciaire) et qu'il proviendrait, par conséquent, de la Formation d'Empress (Graviers et Sables de la Saskatchewan), dans la région d'Edmonton. À la lumière de ce résultat, d'autres fossiles de vertébrés devraient être réétudiés et, dans la mesure du possible, faire l'objet d'une datation directe, afin de favoriser les études stratigraphiques et paléontologiques.

INTRODUCTION

Harington (1975) recorded the first occurrence of helmeted muskoxen from Alberta (Fig. 1), the specimen considered and dated here, referring to it as *Symbos cavifrons* (Leidy) and assigned it a common name of helmeted muskoxen. This partial cranium was collected by Mr. F. Jacknicki from sands in the Steele Brothers of Canada gravel pit along the North Saskatchewan River (53° 39' 40" N, 113° 17' W), 4.8 km SW of Fort Saskatchewan, northeast of Edmonton (Fig. 2). It is in the collections of the Department of Biological Sciences, University of Alberta. In their taxonomic review of fossil and recent muskoxen, McDonald and Ray (1989) synonymized *S. cavifrons* with *Bootherium bombifrons* (Harlan, 1825). This nomenclature is followed here. *Bootherium* originated in the middle part of the Pleistocene, possibly as early as 1 Ma, but most specimens are from the Late Pleistocene. Few have been dated by the radiocarbon method (Clay and Neusius, 1985; McDonald and Ray, 1989; McDonald and Echols, 1990; McDonald *et al.*, 1991; McDonald *et al.,* 2000)

The Fort Saskatchewan specimen was not observed *in situ* but was reportedly derived from a heavily iron and manganese oxide-stained sand bed near the base of a 6.1 m unit of quartzite-rich gravels and sands with angular shield erratics and woody detritus (Fig. 3). The character and abundance of quartzite clasts and woody material closely resembles the basal member of the Empress Formation (Saskatchewan Gravels and Sands), the last cycle of alluvial deposition in valley floors prior to the onset of glaciation and well represented in the Edmonton-Fort Saskatchewan area (Westgate, 1969; Rutter *et al.*, 1998). The presence of shield-derived clasts, however, led to the conclusion that the deposits at Fort Saskatchewan were "obviously deposited following the initial glaciation of the region, and it cannot belong to the Saskatchewan Gravels" and that the specimen was probably of Late Pleistocene age (Harington, 1975, based on information from Westgate, 1969). The specimen does, however, show abrasion from transport, being a frontlet (posterior cranium with occipitals, frontals and incomplete horn cores). A quartzite pebble is lodged in the foramen magnum. The gravel and sand unit from which the specimen probably came was itself overlain by up to 4.6 m of silt and sand, the lower part of which displayed mechanical rhythmites and was thought to be in part equivalent to glacial Lake Edmonton sediments (Harington, 1975).

Recent discovery of a paleontological site in southern Alberta also containing the Helmeted muskox (*B. bombifrons*)

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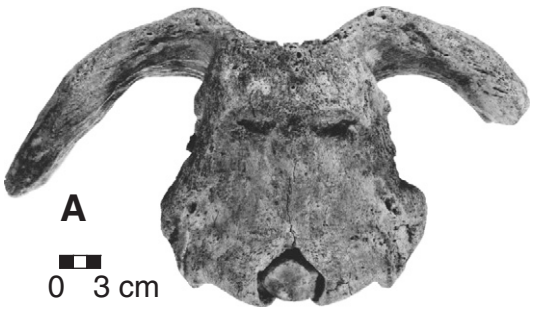

FIGURE 1. A) Posterior view and B) anterior view of *Bootherium bombifrons* (photographs: courtesy of C.R. Harington).

A) Vue postérieure et B) vue antérieure de la vertèbre de Bootherium bombifrons *(photographies : courtoisie de C.R. Harington).*

and dated to the Late Pleistocene, *ca.* 11 000 yrs BP (Hills *et al.*, 1999; Kooyman *et al.*, 2001) renewed interest in the Fort Saskatchewan specimen as to its comparative value and hence its radiometric age. Therefore a sample was obtained and submitted for an AMS date, which resulted in a radiometric age of 30 570 ± 250 ^{14}C yrs BP (Isotrace TO-8973).

DISCUSSION AND CONCLUSIONS

The new date indicates that the Fort Saskatchewan specimen is Middle Wisconsinan (pre-Last Glacial Maximum) rather than latest Pleistocene in age, corresponding to other dates on vertebrate fossils from pre-Late Glacial Maximum (LGM) Empress Foundation gravels and sands in the Edmonton area (Burns and Young, 1994). It also supports the contention of the late Dr. L.A. Bayrock (personal communication to L.V. Hills, 1963) that some of the gravels along the North Saskatchewan River were Saskatchewan Gravels that have been reworked during incision of the North Saskatchewan River.

Redeposition of vertebrate specimens is a significant concern on the Canadian plains because of the presence of faunas of immediately pre-Late Glacial Maximum and post-Late Glacial Maximum ages, separated by a hiatus of about 8 millennia representing presence or influence of glacial ice. Detailed maps of preglacial channels show that the pre-Late Glacial Maximum and post-Late Glacial Maximum drainage patterns were different, with earlier rivers integrated into a dendritic pattern trending northeastward whereas post-Late Glacial Maximum rivers trend northeastward to eastward but often "jump" laterally (southeastward) as a result of damming along former ice-front positions (Stalker, 1961; Farvolden, 1963). The last pre-Late Glacial Maximum fluvial cycle gave rise to widespread valley fills assigned to the Empress Formation (Saskatchewan Gravels and Sands), dating before about 20 ^{14}C ka (Rutherford, 1937; Stalker, 1968a; Burns and Young, 1994; Rutter *et al.*, 1998). Widespread terminal Pleistocene valley fills are assigned to the Bighill Creek Formation and equivalents, dated between about 12 000 and 10 000 ^{14}C yrs BP (Churcher, 1968, 1972, 1975; Stalker, 1968b; Jackson *et al.*, 1982; Wilson, 1983; Wilson and Churcher, 1984; Hills and Harington, 2003).

Upstream from eastern Edmonton, the North Saskatchewan Valley is narrow and steep-walled with Cretaceous bedrock exposures, marking postglacial incision through a preglacial upland. Downstream from Edmonton, through the Fort Saskatchewan area, the valley widens abruptly and has less steep walls as it follows the trend of the preglacial Beverly Valley (Farvolden, 1963; Rutter *et al.*, 1998). Farther downstream, near Waskatenau, the river turns southeastward and leaves the Beverly Valley. In the Beverly reach of the river valley, postglacial gravel fills are inset into and superimposed upon preglacial deposits. Empress Formation deposits are dominated by clasts of quartzite, or quartzose sandstone, and black chert, with lesser amounts of arkosic sandstone, jasper, and locally derived coal fragments, wood, and clay ironstone. Their relatively high compositional maturity likely reflects multiple cycling of resistant materials from the Rocky Mountains through Tertiary upland conglomerates to the Quaternary fills (Westgate, 1969). Early postglacial North Saskatchewan River alluvium, on the other hand, is poorly sorted and compositionally less mature, with abundant Shield-derived clasts reworked from till. Vertebrate fossils are known from both deposits.

A diverse Pleistocene fauna was reported from pits in the Beverly (east Edmonton) area by Fuller and Bayrock (1965), who argued that it dated from post-Late Glacial Maximum times. Yet it included not only bison referred to *Bison occidentalis* and *B. crassicornis*, but also a horn core of *B. latifrons*, understood on the basis of finds from the Canadian plains to Mexico to be of earlier Pleistocene (pre-Late Glacial Maximum) age (Kurtén and Anderson, 1980). From photographs in Fuller and Bayrock (1965) and Wilson's observations of the *B. latifrons* specimen, it appears that the *B. latifrons* horn core and at least one of the *B. crassicornis* crania exhibit more abrasion and damage than does the *B. occidentalis* material; therefore, redeposition of the larger forms is a strong possibility (Wilson, 1975). A similar conclusion was reached by Guthrie (1970) and Harington (1978). Burns and Young (1994, p. 393) stated that terrace gravels at the Beverly Pits "contain both postglacial and mid-Wisconsinan fossils, having been reworked and left as lag deposits during postglacial incision of the North Saskatchewan River". These findings remain in need of further testing through direct dating of specimens.

Westgate (1969) described the terrace sequence along the North Saskatchewan in the Edmonton area. Of four postglacial

FIGURE 2. Location (X) of *Bootherium bombifrons* between Edmonton and Fort Saskatchewan.

Site d'origine du spécimen de Bootherium bombifrons *(indiqué par un X), entre Edmonton et Fort Saskatchewan.*

terraces, the second lowest was ~20 m above river level with a fill of sands and poorly sorted cobble gravels. Vertebrate fossils from this unit included postcranial bones of extinct bison and horse ("*Camelus* sp.", in error; Westgate (1969), listed *Titanotylopus* sp., but Harington (1978), cited *Camelops hesternus*, and mammoth (*Mammuthus* sp.) were from a buried gravel fillstrath in a terrace 7.5 to 10.5 m above river level, capped by younger fine alluvium. They suggested an age of about 8000 ^{14}C yrs BP for these fossiliferous gravels; but Westgate showed that the fill on a terrace of comparable elevation was made up of fine sediments with Mazama tephra (6730 ± 40 ^{14}C yrs BP by Hallett *et al.*, 1997; 7627 ± 150 cal yrs BP from Greenland core GISP2, Zdanowicz *et al.*, 1999). Westgate suggested that the gravels of the ~20 m terrace were similar to the Bighill Creek gravels and therefore of terminal Pleistocene age. The pits sampled by Fuller and Bayrock (1965) likely included superimposed or inset gravel deposits of more than one age (Harington, 1978), or the gravels are postglacial but elements of the fauna have been redeposited. Burns and Young (1994) found that in the Consolidated Concrete Pit, in the Beverly Valley at Edmonton, 3-5 m of gravels and sands without shield stones (Empress Formation) were unconformably overlain by another 3 m of gravels and sands "reworked during incision of the postglacial North Saskatchewan". Most of the nearly 800 bones from that pit were from the lower gravel, but older bones from the early gravels were also found in the younger deposits.

Deposits and relationships reported by Westgate (1969) allow for three possible pathways of redisposition in these situations: (i) Empress Formation to post-Late Glacial Maximum, Bighill Creek-equivalent gravels; (ii) Bighill Creek-equivalent gravels to Holocene terrace fills; and (iii) Empress Formation directly to Holocene terrace fills. Given that the gravels associated with the *Bootherium bombifrons* specimen were described as containing shield stones, together with Westgate's statement to Harington that the gravels were Late Pleistocene, alternative (i) seems indicated in this instance. The same could also be true for the *Bison latifrons* specimen, if not the *B. crassicornis* material as well. It is clear from this that direct dating of important vertebrate specimens, together with examination for evidence of redeposition, is advisable for both stratigraphic and paleontological studies in this area. Diagenetic changes during fossilization may also provide chemical means for the differentiation of pre-Late Glacial Maximum and post-Late Glacial Maximum faunas. Intersections of modern drainage with filled preglacial channels emerge as probable "hotspots" for redeposition, much as they are also key areas for sampling of the earlier alluvial fills. In contrast, fossiliferous early post-Late Glacial Maximum gravels in the Cochrane-Calgary area have yielded no redeposited pre-Late Glacial Maximum material (Churcher, 1968, 1975; Wilson, 1983; Wilson and Churcher, 1984).

The specimen from the St. Mary Reservoir now stands as the first terminal Pleistocene occurrence of *Bootherium bombifrons* in Alberta (Hills *et al.*, 1999; Kooyman *et al.*, 2001). Helmeted muskox was certainly a member of both the pre- and post-Late Glacial Maximum vertebrate faunas on the Alberta plains and proper chronometric control will allow direct morphological comparisons to assess evolutionary changes between *ca.* 30 000 and 11 000 ^{14}C yrs BP. Radiometric control will also aid in better definition of palaeofaunal associations, their distribution and duration.

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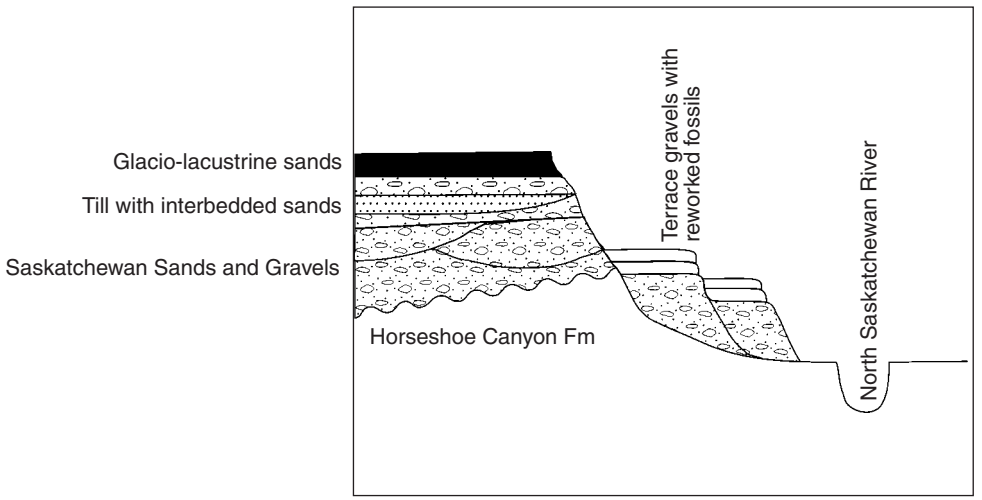

FIGURE 3. Schematic cross-section illustrating origin of reworked *Bootherium bombifrons* (modified from Rutter *et al.*, 1989).

Coupe schématique du site d'origine de Bootherium bombifrons *(modifié de Rutter* et al.*, 1989).*

arranged the same sample for ^{14}C dating. Dr. C.R. Harington made many helpful suggestions as to improvement of an earlier draft of the manuscript.

REFERENCES

Burns, J.A. and Young, R.R., 1994. Pleistocene mammals of the Edmonton area, Alberta. Part 1: The Carnivores. Canadian Journal of Earth Sciences, 31: 393-400.

Churcher, C.S., 1968. Pleistocene ungulates from the Bow River gravels at Cochrane, Alberta. Canadian Journal of Earth Sciences, 5: 1467-1488.

_____ 1972. Imperial mammoth and Mexican half-ass from near Bindloss, Alberta. Canadian Journal of Earth Sciences, 9: 1562-1576.

_____ 1975. Additional evidence of Pleistocene ungulates from the Bow River gravels at Cochrane, Alberta. Canadian Journal of Earth Sciences, 12: 68-76.

Clay, V.L. and Neusius, S.W., 1985. A partial muskox skeleton from eolian deposits, southwest Colorado. Current Research in the Pleistocene, 2: 95-96.

Farvolden, R.N., 1963. Bedrock channels of southern Alberta. Research Council of Alberta, Edmonton, Early Contributions to the Groundwater Hydrology of Alberta, Bulletin 12: 63-75.

Fuller, W.A. and Bayrock, L.A., 1965. Late Pleistocene mammals from central Alberta, Canada, p. 53-63. *In* R.E. Folinsbee and D.M. Ross, eds., Vertebrate Paleontology in Alberta. Report of a Conference (Department of Geology, University of Alberta, Aug. 29-Sept. 3, 1963), Bulletin 2, 76 p.

Guthrie, R.D., 1970. Bison evolution and zoogeography in North America during the Pleistocene. Quarterly Review of Biology, 45: 1-15.

Hallett, D.J., Hills, L.V. and Clague, C.D., 1997. New accelerator mass spectrometry ages for the Mazama tephra from Kootenay National Park, British Columbia, Canada. Canadian Journal of Earth Sciences, 34: 1202-1209.

Harington, C.R., 1975. Pleistocene muskoxen (*Symbos*) from Alberta and British Columbia. Canadian Journal of Earth Sciences, 12: 903-919.

_____ 1978. Quaternary vertebrate faunas of Canada and Alaska and their suggested chronological sequence. National Museums of Canada, National Museum of Natural Sciences, Ottawa, Syllogeus 15, 115 p.

Harlan, R, 1825. Fauna Americana: Being a Description of the Mammiferous Animals Inhabiting North America. Anthony Finley, Philadelphia, 318 p.

Hills, L.V. and Harington, C.R., 2003. New radiocarbon dates for Columbian mammoth and Mexican horse from southern Alberta and the Lateglacial regional fauna. Quaternary Science Reviews, 22: 1521-1523.

Hills, L.V., Kooyman, B., Tolman, S. and McNeil, P., 1999. The St. Mary Reservoir late Pleistocene paleontological and archaeological site, p. 28. *In* Program and Abstracts. Canadian Quaternary Association-Canadian Geomorphological Research Group 1999 Joint Meeting (University of Calgary, Aug. 23-27), 88 p.

Jackson, L.E., Jr., MacDonald, G.M. and Wilson, M.C., 1982. Paraglacial origin for terraced river sediments in Bow Valley, Alberta. Canadian Journal of Earth Sciences, 19: 2219-2231.

Kooyman, B., Newman, M., Cluney, C., Lobb, M., Tolman, S., McNeil, P. and Hills, L.V., 2001. Identification of horse exploitation by Clovis hunters based on protein analysis. American Antiquity, 66: 686-691.

Kurtén, B. and Anderson, E., 1980. Pleistocene Mammals of North America. Columbia University Press, New York, 442 p.

McDonald, J.N. and Echols, J., 1990. A record of *Bootherium bombifrons* (Artiodactyla: Bovidae from Hunt County, Texas. Texas Journal of Science, 42: 143-149.

McDonald, J.N. and Ray, C.E., 1989. The autochthonous North American Muskoxen *Bootherium, Symbos* and *Gidleya* (Mammalia: Artiodactyla: Bovidae). Smithsonian Contributions to Paleobiology, 66: 1-77.

McDonald, J.N., Ray, C.E. and Harington, C.R., 1991. Taxonomy and zoogeography of the musk ox genus *Praeovibos* Staudinger, 1908, p. 285-314. *In* J.R. Purdue, W.E. Klippel and B.W. Styles, eds., Beamers, Bobwhites, and Blue-points: Tributes to the career of Paul W. Parmalee. Illinois State Museum Scientific Papers, 23: 285-314.

McDonald, J.N., Ray, C.E. and Ruddell, M.W., 2000. New records and range extensions of *Cervalces, Rangifer*, and *Bootherium* in the southeastern United States. Current Research in the Pleistocene, 17: 131-133.

Rutherford, R.L., 1937. Saskatchewan gravels and sands in central Alberta. Transactions of the Royal Society of Canada, 31: 81-95.

Rutter, N.W., Andriashek, L.D., Stein, R. and Fenton, M.M., 1998. Engineering geology of the Edmonton area, p. 71-92. *In* P.F. Karrow and O.L. White, eds., Urban Geology of Canadian Cities. Geological Association of Canada, St. John's, Special Paper 42, 500 p.

Stalker, A. MacS., 1961. Buried Valleys in Central and Southern Alberta. Geological Survey of Canada, Ottawa, Paper 60-32, 13 p.

_____ 1968a. Identification of Saskatchewan gravels and sands. Canadian Journal of Earth Sciences, 5: 15-163.

_____ 1968b. Geology of the terraces at Cochrane, Alberta. Canadian Journal of Earth Sciences, 5: 1445-1466.

Westgate, J.A., 1969. The Quaternary geology of the Edmonton area, Alberta, p. 129-151. *In* S. Pawluk, ed., Pedology and Quaternary Research. University of Alberta, Edmonton, 218 p.

Wilson, M.C., 1975. Holocene Fossil *Bison* from Wyoming and Adjacent Areas. M.Sc. thesis, University of Wyoming, 276 p.

_____ 1983. Once Upon a River: Archaeology and Geology of the Bow River Valley at Calgary, Alberta, Canada. National Museums of Canada, Archaeological Survey of Canada, Ottawa, National Museum of Man Mercury Series, Paper 114, 465 p.

Wilson, M.C. and Churcher, C.S., 1984. The Late Pleistocene Bighill Creek Formation and its equivalents in Alberta: Correlative potential and vertebrate palaeofauna, p. 159-175. *In* W.C. Mahaney, ed., Correlation of Quaternary Chronologies. GeoBooks, Norwich, 517 p.

Zdanowicz, C.M., Zielinski, G.A. and Germani, M.S., 1999. Mount Mazama eruption: Calendrical age verified and atmospheric impact assessed. Geology, 27: 621-624.