New Caribou Fossil Records from Rice Lake, South-Central Ontario: Radiocarbon Evidence and Middle Holocene Climatic Change

Lawrence J. Jackson

This paper discusses three new radiocarbon dates on fossil caribou bones from Rice Lake, Ontario, and their possible environmental implications. Three specimens identified by Howard Savage, of the University of Toronto, and Richard Harington, of the Canadian Museum of Civilization, indicate a middle Holocene caribou presence in this area of south-central Ontario. One specimen, previously reported as a possible Late Pleistocene record (cf. Pavlish and Alcock [1984] on Webb Bay), is radiocarbon-dated several thousand years later in the middle Holocene. Zonal pollen in Rice Lake cores suggests the principal occurrence of these dated Rice Lake caribou during a Hypsithermal warming between about 7,000 and 3,000 years B.P. The lack of fossil material for the late glacial period (terminal Pleistocene) is believed to correlate with the current inaccessibility of depositional environments due to flooding of ancient Rice Lake shorelines. The local presence of Early Palaeo-Indian sites, on the other hand, is highly suggestive of the presence of caribou at this time. The apparent absence of caribou during the early and late Holocene, as well as lack of evidence for their human exploitation throughout the Holocene, requires explanation.

Introduction

Rice Lake is a 26 km long, narrow post-glacial lake basin that connects the Kawartha Lakes with the Trent River and Lake Ontario. It is bounded on the south by the Oak Ridges Interlobate Moraine and on the north by moraine and drumlin features deposited during the final Simcoe Ice Lobe retreat, circa 11,500 years B.P. (Gravenor 1957; Karrow et al. 1975; Kaszycki 1985). In the course of several surveys for Early Palaeo-Indian sites conducted by the author in the Rice Lake basin, fossil cervid bones were recovered from lake-edge mechanical dredgings. Radiocarbon dating of these specimens and analysis of the associated sediments provides significant new data on the presence of caribou during the middle Holocene (Figure 1).

Rice Lake Fossil Caribou Records

Webb Bay

The first caribou fossil site recorded in the Rice Lake basin was near Webb Bay along the high Oak Ridges moraine of the southeast shore (Figure 1). Reported by Pavlish and Alcock (1984), this specimen (a calcaneum) was found by a geologist during hillside cottage excavation. Dr. Howard Savage, of the University of Toronto Faunal Laboratory, identified this specimen as the left calcaneum of an adult caribou (*Rangifer tarandus*). He reported that it occurred in a clay loam matrix four feet (1.2 m) below ground surface in an area of drumlin till. Its context suggested an age contemporaneous with Lake Iroquois in the area (Savage et al. 1981).

A Late Pleistocene age for the Webb Bay caribou bone appeared to be a reasonable assumption since a possible caribou (recorded as a cervine deer) from glacial Lake Iroquois deposits in Toronto had been radiocarbon dated to 11,315±325 B.P. (Churcher and Petersen 1982). Radiocarbon dating of the Webb Bay fossil, reported in this paper for the first time, places it much later – about 5,000 B.P. in the middle Holocene. This was during pollen subzone 3b, a mixed forest with a *Tsuga* decline, documented by pollen cores from Rice Lake (cf. Yu 1992).

The Webb Bay fossil was found in an active drumlin slope environment and had evidence of carnivore modification. Although it appeared to be in a late glacial context, it lacked any adhering sediments to permit pollen sum counts for evidence of associated zonal vegetation. Both circumstances

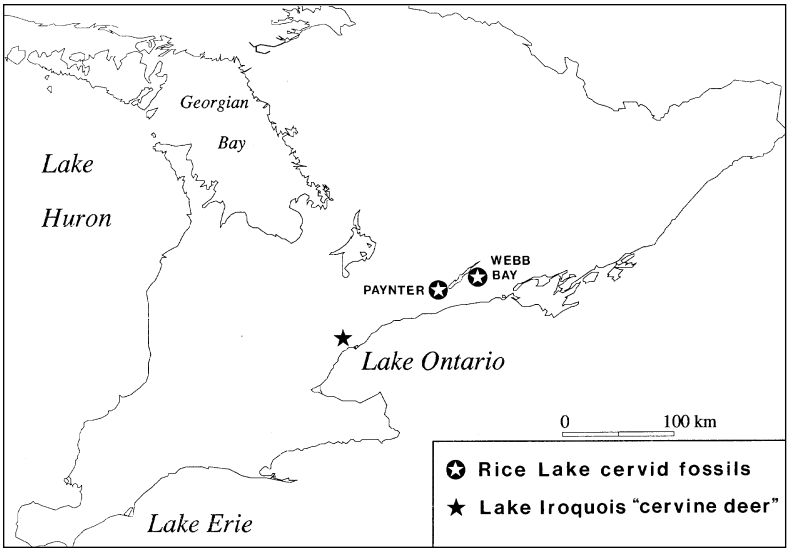

Figure 1. *The location of southern Ontario caribou sites.*

now suggest redeposition of the specimen. This is still an important record of caribou in Ontario and raises key questions of ranging behaviour and habitat. The radiocarbon date is 4,950±85 B.P. (TO-1107) run by accelerator mass spectrometry on bone collagen.

New fossil caribou material recovered by the author from two sites at the west end of Rice Lake augments the Holocene caribou record and supports the middle Holocene dating of the Webb Bay caribou. All of the new fossil material originates in shoreline marsh deposits stretching along a two kilometre section of the western end of Rice Lake. Figure 2 shows an aerial view to the southwest of this shoreline area and historically flooded offshore marsh. Light mixed forest and peat bog covers most of the landward area. Commercial dredging of the peat produced the fossil material. An artificially high water table is maintained by damming of the eastern Rice Lake outlet at Hastings, which began in the nineteenth century. Two separate sites, known as Paynter Marsh and Paynter South, at the west end of the lake, produced fossil caribou bones.

Paynter Marsh

Located near the northwest edge of the Rice Lake basin, Paynter Marsh is part of an extensive wetland and peat bog developed over the past 10,000 years (Figure 3). The age of the bog is precisely indicated by radiocarbon dating of wood from the first peat deposit above glaciolacustrine clay at the site. A stratigraphic sample consisting of 10.5 grams of wood, collected by the author in 1987 from a trout pond excavation, dated to 10,000±130 B.P. (Beta-22874). Analysis of pollen from the glaciolacustrine clay and peat contact (J. McAndrews, personal communication 1991) matched Ontario pollen zone 1 (spruce parkland) typical of the late glacial period. Although slightly young, the date confirms a terminal Pleistocene beginning of peat deposition. A second pollen sample, slightly above the first, matches Ontario pollen zone 2 (jack pine forest) and confirms the stratigraphic integrity of zonal pollen deposits at the site. Any fossil bones found in peat sediments at Paynter Marsh are most likely to post-date the beginning of peat deposition, circa 10,000 B.P.

A near-complete left femur of an adult caribou (*Rangifer tarandus*) was found at Paynter Marsh in a dredging pile (Figure 4). Dr. Heather McKillop, of Louisiana State University, carried out preliminary examination of the bone. Its identification was confirmed by Dr. Howard Savage, University of Toronto and Dr. Richard Harington, of the Canadian Museum of Civilization. Analysis of adhering pollen (Weniger 1989) indicated an association with Ontario pollen subzone 2a, dated circa 10,000 to

Figure 2. *Oblique aerial view to the southwest of the Rice Lake marshlands (Paynter Marsh in the upper right, just to the left of the highway).*

Figure 3. *Aerial view to the south of the dredged ponds at Paynter Marsh, where the caribou femur was found (x marks its location in the dredging piles).*

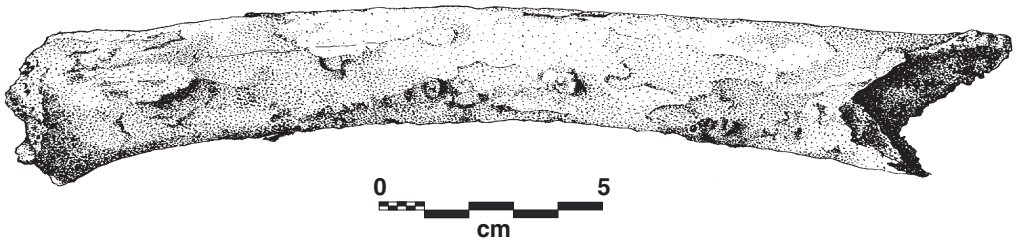

Figure 4. *Left femur of the caribou found at Paynter Marsh. The femur is lacking its epiphyses.*

8,500 B.P. (Table 1). AMS dating of the femur produced a later date of 2530±70 B.P. (TO-1092) consistent with pollen subzone 3c (mixed forest). This is the same age as the Early Woodland Dawson Creek site one kilometre to the northeast (Jackson 1979:16).

The nature of the marsh deposits at the west end of Rice Lake suggests a probable explanation for the date of the Paynter Marsh bone being younger than the associated sediments. As noted by Haynes (1974:380): "It is common for the sediments in active spring ponds to consist of sand fluidized by ascending water.... Under these conditions it is easy for bones ... to penetrate the fluidized sediments and settle out in the bottom." The location of Paynter Marsh is directly between a high and sandy segment of the Oak Ridges Interlobate Moraine and the west end of Rice Lake, with abundant small creeks and spring seeps nearby. It is highly likely that the Paynter Marsh caribou femur sank in seasonally fluidized sediments and came to rest in the deeper subzone 2a deposits. In excavating wet site deposits elsewhere along the moraine, the author has direct experience of wood objects of comparable size actually sinking to the level of glacial clays and becoming embedded. Radiocarbon dating proved them to be much more recent in age than suggested by their apparent stratigraphic context.

Table 1. *Sediment pollen counts from fossil caribou bones.*

	Femur	Tibia
Tree Species	**Paynter Marsh**	**Paynter South**
Picea	1	–
Abies	2	–
Larix	9	–
Cupressaceae	–	1
Pinus	80	40
Betula	2	2
Quercus	2	12
Ulmus	1	3
Fraxinus	–	1
Ostrya	–	1
Salix	–	3
Acer saccharum	–	12
Tilia	–	7
Carya	–	1
Tsuga	–	6
Fagus	–	1
Alnus	–	1
Gramineae	2	–
Tubuliflorae	1	–
Standard Pollen Count	100	100
Pteridium	11	–
Dryopteris type	4	–
indeterminable	1	6
Pollen Zone Indicated:	2a	3b
Age in Years B.P.:	10,000-8,500	7,500-5,000

Paynter South

Less than one kilometre south of the Paynter Marsh site, a second caribou fossil was found, in 1988, by Lawrence Jackson Sr. It consisted of a partial left tibia shaft (Figure 5) from an adult caribou (*Rangifer tarandus*). This bone was exposed by the dredging of a stream channel near its entry into Rice Lake. Identification of the specimen was confirmed by Savage and Harington, with preliminary work by McKillop. A pollen count was possible from adhering sediments (see Table 1) and suggested a subzone 3b association circa 7,500 to 5,000 B.P.

AMS dating of a small section of the caribou tibia yielded a date of 3415±85 B.P. (Beta-26660). This places the bone in the period of subzone 3c – mixed oak-hickory nut forest after the *Tsuga* decline of subzone 3b. Again, it appears likely that the bone sank into deeper and

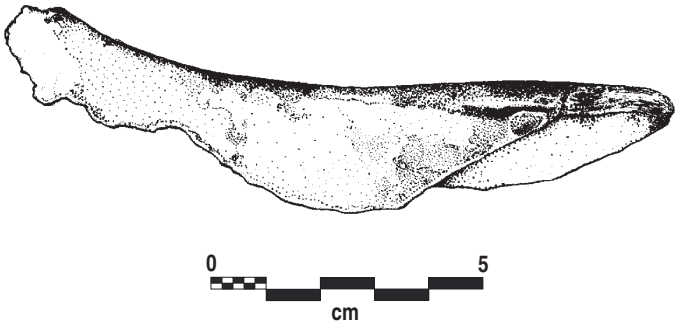

Figure 5. *Left tibia shaft of the caribou found at Paynter South.*

older subzone 3b deposits due to fluidization of sediments. There is some uncertainty with the 100 sum pollen count carried out on sediment found in the tibia marrow cavity. This sample lacks *Tsuga* dominance and has strong counts for *Quercus* (oak) and *Acer saccharum* (sugar maple) which could indicate either a subzone 3b or 3c association. This could correspond well with the radiocarbon date which places the bone in later subzone 3c.

Bone Sample Effects

The radiocarbon dating of bone can present unusual problems for interpretation, most commonly due to humate contamination of small collagen residues that produce dates which are too young. The most frequent source of humate contamination is from groundwater – a major consideration at the Paynter Marsh and Paynter South sites, which are seasonally water-saturated, but a minor consideration at Webb Bay which is a well-drained till location. All three samples were run using Accelerator Mass Spectrometry techniques (AMS) requiring only small collagen samples. The Paynter South date, run by Beta Analytic in July of 1988, was adjusted for isotope effects ^{13}C analysis and is in general agreement with adhering pollen which places it only slightly earlier than the radiocarbon date. Sample pretreatment included a series of acid washes to remove the carbonate/mineral fraction of the bone, leaching of the extracted bone collagen in alkali to remove humic acids, acidification again and then drying.

The Paynter Marsh date, run by the University of Toronto Isotrace Laboratory in December of 1988, is not in agreement with adhering pollen which suggests a much older age. The greater depth and total age of marsh deposits in this locality, as compared to Paynter South (which is much closer to the modern lakeshore), however, strongly argues that fluidization of deposits may have allowed settling of the bone into older and deeper layers. The Isotrace Laboratory also reports that the purified collagen yield for this sample (TO-1092) was quite good at three percent (R. Beukens, personal communication 2000), which tends to add support to interpretation of this date as more secure than the adhering sediments might suggest.

The Webb Bay bone, also dated by the University of Toronto Isotrace laboratory in December of 1988, had no adhering pollen that could be analyzed and the radiocarbon date was at variance with the presumed context. However, it was noted in the original faunal analysis by Savage (Savage et al. 1981) that the specimen has been subject to carnivore modification, strongly suggesting its redeposition. The steep hillside location may also argue for secondary transport. The Isotrace Laboratory reports that the purified collagen extract for this sample (TO-1107) was much less, at around 0.7 percent (R. Beukens, personal communication 2000). It is unclear whether the resulting date for the Webb Bay caribou bone reflects its true age as accurately as the Paynter Marsh sample run by the same laboratory.

All three radiocarbon dates for Rice Lake caribou bones are accepted for the purposes of this paper and are regarded as acceptable minimum

age estimates. The consistency in association between adhering Zone 3 pollen sediments and AMS dating at Paynter South (Beta-26660) confirms that bone collagen dating accurately places Rice Lake caribou in the middle Holocene.

Rice Lake Caribou Date Implications

Storck and Spiess (1994) documented a late glacial Gainey phase Early Palaeo-Indian hearth containing fragmentary caribou bone at the Udora site just east of Lake Simcoe. Jackson (1998) recorded the Gainey phase Sandy Ridge site on the northwest shore of Rice Lake, with the predominant use of the same exotic raw material for tools (Fossil Hill Formation/Collingwood chert) as found at Udora, and inferred exploitation of caribou on the basis of the site's position overlooking Rice Lake, the prevalence of diagnostic end scrapers, and the presence of hearth and pit features. The Sandy Ridge site offers circumstantial evidence for the presence of caribou at Rice Lake in the Late Pleistocene period. As already noted, a shed caribou antler is associated with glacial Lake Iroquois deposits near Toronto and a possible caribou skeleton dated to 11,315 B.P. was found in Lake Iroquois deposits in the same general area. The occurrence of both palaeontological and archaeological records of caribou dating to the Late Pleistocene in southern Ontario argues strongly for the contemporaneous presence of caribou at Rice Lake. A shed caribou antler from northwestern Ontario is also radiocarbon dated to 9,940 B.P. ±120 B.P. (AA-3285), documenting the persistence of the species into the early Holocene in northern regions (Jackson 1989). Savage et al. (1981) note that caribou are recorded at the Small Point Archaic Knechtel and Inverhuron archaeological sites along the Lake Huron shore of southwestern Ontario. These sites date between 3,500 and 2,800 B.P. There are no other middle Holocene records of caribou in Ontario, either from fossil or archaeological sites. In the late Holocene, there are isolated records on Iroquoian sites, but it is not known whether these specimens may have been acquired in northern hunting trips or through trade. There is, consequently, only a small data base for palaeontological or archaeological knowledge about caribou in southern Ontario.

AMS radiocarbon dates for the Webb Bay, Paynter Marsh, and Paynter South fossils indicate a caribou presence in the Rice Lake region over a 2,500 year span of the middle Holocene (from about 5,000 to 2,500 years B.P.). Calibrated dates suggest that Webb Bay dates to about 5,700 B.P., Paynter South about 3,700 B.P., and Paynter Marsh about 2,700 B.P. A span of about 3,000 years is suggested (Table 2). All three fossils are associated by date with Ontario pollen zone 3 or mixed forest. Pollen subzones identified in cores from nearby Rice Lake suggest specific associations for each dated fossil: Webb Bay with subzone 3b, mixed forest with *Tsuga* minimum or decline (4,500 to 4,000 B.P.); Paynter South with early subzone 3c, mixed forest with *Tsuga* resurgence and minor fluctuations in other species; and Paynter Marsh with subzone 3c. Actual adhering sediments, subjected to pollen analysis, are most useful as reference points in suggesting maximum ages for the Paynter Marsh and Paynter South fossils, which are believed, due to fluidization of sediments, to have sunk into older deposits.

As previously noted, caribou bones are recorded from an Early Palaeo-Indian feature at the Udora site in south-central Ontario (Storck and

Table 2. *Radiocarbon intercepts with dendro-calibration dates*[1].

Site Name	Lab. No.	Calibrated Age	1 sigma (68.3%)	2 sigma (95.5%)
Paynter Marsh	TO-1092	778 B.C.	801-775 B.C.	824-406 B.C.
Webb Bay	TO-1107	3,777 B.C.	3,813-3,690 B.C.	3,829-3,624 B.C.
		3,745 B.C.	3,813-3,690 B.C.	3,829-3,624 B.C.
		3,708 B.C.	3,813-3,690 B.C.	3,829-3,624 B.C.
Paynter South	BETA-26660	1,700 B.C.	1,860-1,845 B.C.	1,910-1,510 B.C.
			1,775-1,615 B.C.	

[1]All calculations as provided by laboratories.

Spiess 1994). Coleman (1933) recorded a shed antler of caribou in glacial Lake Iroquois deposits near Toronto. Churcher and Petersen (1982) also reported a cervine deer (which some researchers believe is a caribou) from Lake Iroquois deposits. This specimen is radiocarbon dated to 11,400 B.P. Clearly, caribou were present in southern Ontario during the Late Pleistocene at the same time as Early Palaeo-Indian peoples. The absence of Late Pleistocene caribou records for Rice Lake is most likely due to the fact that the early shorelines of Rice Lake have been inundated by Holocene rises in lake levels and that anaerobic environments for bone preservation since the Late Pleistocene are simply inaccessible (Jackson 1997; 1998). early Holocene records of caribou present other complications since, not only are deposits inaccessible, but it is believed that a significant range shift to northern Ontario may have occurred due to the incursion of closed jack pine forests. There are presently no data available to assess the presence or absence of Rice Lake caribou in the early Holocene.

Data presented in this paper bear directly on the question of middle Holocene presence of caribou at Rice Lake. Assuming that extant fossils are truly representative of a limited, 3,000 year middle Holocene caribou presence (between 5,700 and 2,700 B.P.), some suggestions may be offered. Firstly, it appears that Holocene Rice Lake caribou are associated only with Zone 3 mixed forest after the *Tsuga* decline. Yu et al. (1996) confirm a middle Holocene warm and dry period, as originally proposed by Terasmae (1973), to explain a major decline in *Tsuga* pollen (a cool climate tree). Beginning about 7,500 B.P. with a local transition from marsh to swamp, this warming trend resulted in a dry period with significant lowering of Rice Lake water levels (circa 6,400 to 3,200 B.P. uncalibrated). The three Rice Lake caribou fossils fall neatly within this period. Although it is not possible to address the question of whether Rice Lake caribou were migratory or woodland from available fossil evidence, it appears most logical that a warm period incursion into the area would coincide with a southward range shift of either subspecies. Vertebrate fossils from Michigan confirm a widespread middle Holocene Great Lakes warming trend (Holman 1990). Southern Michigan, circa 5,800 B.P., was significantly milder than in the Late Pleistocene or early Holocene. Early Holocene closed canopy pine forests (Zone 2) may have offered unsuitable caribou habitat (cf. Heard 1997). Northward range displacement likely occurred, with newly exposed lake plains of the Upper Great Lakes (caused by isostatic rebound) attracting caribou for forage. This may be one reason why a majority of Ontario's Late Palaeo-Indian sites cluster along the north shores of Lakes Superior and Huron. A shed caribou antler from northwestern Ontario is dated to 9,940±120 B.P. (cf. Jackson 1989), coeval with early Holocene human occupations.

As noted by Kelsall (1968), the presence of suitable lichens and other forage determines the capacity of an area to support caribou. Calef (1981) remarks that caribou on the barrens select sedges and horsetails – which grow in wet environments – and will wade deeply to obtain them. Middle Holocene Rice Lake shoreline habitats, in spite of a warmer and drier climate, hosted such plants. Yu (1992) records sedges at Paynter Marsh coincident with western basin flooding.

One argument against a significant presence of caribou in the Rice Lake region during a middle Holocene hypsithermal is the apparent absence of this species from archaeological sites in the region. Although a large number of precontact sites, ranging from Late Archaic to Late Woodland in age, have produced deer remains (often in abundance), no caribou have been identified. Some of these sites are shown in Figure 6 and include: Sandy Ridge, an Early Palaeo-Indian site on the north shore; Halstead, a similar site on the south shore; McIntyre, a Late Archaic site on the north shore; Dawson Creek, an Early Woodland site on the northwest shore; Serpent Mounds, a Middle Woodland site on the north shore; and Willow Point, a submerged Middle Woodland site on the south shore. Factors of preservation and expertise in identification may contribute to the archaeological invisibility of Rice Lake caribou.

Caribou may not have been present in south-

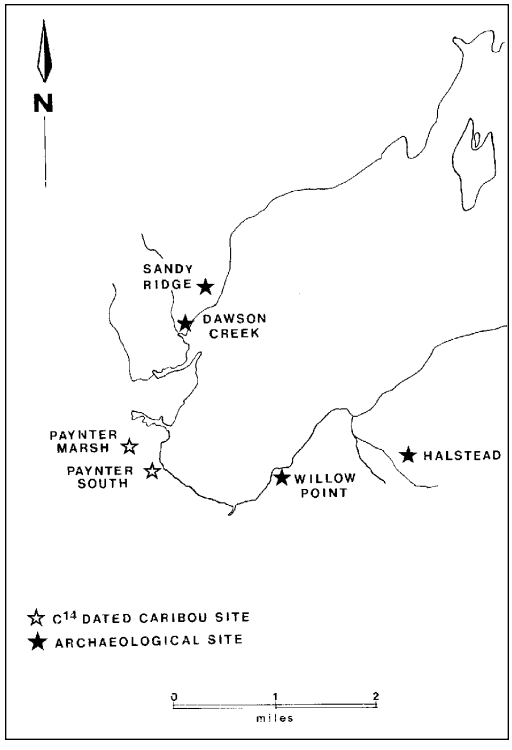

Figure 6. *Caribou fossil and archaeological sites of the western Rice Lake basin.*

central Ontario during certain periods, such as Zone 2 pine dominance (10,000 to 7,500 B.P.) and succeeding Zone 3a early mixed forest (7,500 to 5,000 B.P.). The present study suggests caribou presence during Zones 3b and 3c (mixed forest) at a time of climatic warming. Paradoxically, caribou might favour a warmer and drier environment if there was greater availability of water plants for forage. Flooding of lake basin margins by progressive isostatic rebound enhanced such conditions circa 5,700 to 2,700 years B.P.

Summary

New radiocarbon evidence from three fossil caribou sites in the Rice Lake region of south-central Ontario indicates a middle Holocene presence of this species (*Rangifer tarandus*) during a hypsithermal (warming) period. AMS dating of bones documents an age span of about 3000 years (from 5,700 to 2,700 B.P.) and supports their association with mixed forest pollen subzones 3b and 3c. Caribou may have been locally absent during the earlier Zone 2 (pine forest) and Zone 1 (spruce parkland) periods, as well as during subsequent Zone 4. Since caribou are present elsewhere in southern Ontario during Zone 1 (both archaeologically and palaeontologically), the lack of Rice Lake fossils of this period is believed to be connected to sampling, particularly since natural areas of fossil bone deposition along old shorelines of Rice Lake are flooded by higher Holocene lake levels. The absence of caribou throughout *southern* Ontario during zone 2 and presence of a dated specimen in *northern* Ontario at this time suggests a possible northward range shift. This tends to be supported by an abundance of Late Palaeo-Indian sites in northern Ontario in the early Holocene. During the middle Holocene climatic warming, caribou are documented by dated fossils at Rice Lake. Accelerated northern glacial melt, accompanied by isostatic rebound and flooding of the western Rice Lake basin, may have created attractive local aquatic environments for caribou forage during this period. The local absence of caribou remains on all archaeological sites remains unexplained. The dated Rice Lake fossils support a lengthy period of middle Holocene caribou presence in the region and answer at least some questions raised by the early work of Howard Savage.

Acknowledgements. This paper has benefited from the assistance of many people, including crew members who worked on several archaeological projects through the 1980s and 1990s. I would like to thank Jane Weniger and John McAndrews for pollen analyses, Heather McKillop, Scott Gibbs, Lawrence Jackson Sr., Donna Morrison and Don Simons for their help in searching for fossils, and the late Howard Savage and Dick Harington for generous assistance with identifications. Dr. Savage also graciously made the Webb Bay fossil available for radiocarbon dating. Thanks also to the anonymous reviewers who provided helpful comments and to Phil Woodley for his comments on an early draft of this paper. Research into the Rice Lake fossil record was funded by the Ontario

Heritage Foundation (research grant ARG-136) and by Social Sciences and Humanities Research Council of Canada survey grants in 1984 and 1985.

References Cited

Calef, G.
1981 *Caribou and the Barren Lands*. Firefly Books, Scarborough, Ontario.

Churcher, C.S., and R.L. Peterson
1982 Chronologic and Environmental Implications of a New Genus of Fossil Deer from Late Wisconsin Deposits at Toronto, Canada. *Quaternary Research* 18:184-195.

Coleman, A.P.
1933 *The Pleistocene of the Toronto Region*. Annual Report of the Ontario Department of Mines 41, Part 7. Ontario Department of Mines, Toronto.

Gravenor, C.P.
1957 *Surficial Geology of the Lindsay-Peterborough Area, Ontario, Victoria, Peterborough, Durham, and Northumberland Counties, Ontario*. Memoir 288. Geological Survey of Canada, Ottawa.

Haynes, C.V., Jr.
1974 Paleoenvironments and Cultural Diversity in Late Pleistocene South America: A Reply to A.L. Bryan. *Quaternary Research* 4:378-382.

Heard, D.C.
1997 Causes of Barren Ground Caribou Migrations and Implications to Hunters. In *Caribou and Reindeer Hunters of the Northern Hemisphere*, edited by L.J. Jackson and P. Thacker, pp. 27-31. Avebury, Glasgow, U.K.

Holman, J.A.
1990 Vertebrates from the Harper Site and Rapid Climatic Warming in Mid-Holocene Michigan. *Michigan Academician* 22:205-217.

Jackson, L.J.
1979 Dawson Creek: An Early Woodland Site in South-Central Ontario. *Ontario Archaeology* 33:13-36.
1989 Late Pleistocene Caribou from Northern Ontario. *Current Research in the Pleistocene* 6:72-74.
1997 Caribou Range and Early Palaeo-Indian Settlement Disposition in Southern Canada. In *Caribou and Reindeer Hunters of the Northern Hemisphere*, edited by L.J. Jackson and P. Thacker, pp. 127-159. Avebury, Glasgow, U.K.
1998 *The Sandy Ridge and Halstead Paleo-Indian Sites: Unifacial Tool Use and Gainey Phase Definition in South-Central Ontario*. Memoir 32. Museum of Anthropology, University of Michigan, Ann Arbor, Michigan.

Karrow, P.F., T.W. Anderson, A.H. Clarke, L.D. Delorme, and M.R. Sreenivasa
1975 Stratigraphy, Palaeontology, and Age of Lake Algonquin Sediments in Southwestern Ontario, Canada. *Quaternary Research* 5:49-87.

Kaszycki, C.A.
1985 History of Glacial Lake Algonquin in the Haliburton Region, South-Central Ontario. In *Quaternary Evolution of the Great Lakes*, edited by P.F. Karrow and P.E. Calkin, pp. 109-123. Special Paper 30. Geological Association of Canada, St. John's, Nfld.

Kelsall, J.P.
1968 *The Migratory Barren-Ground Caribou of Canada*. Canadian Wildlife Service, Ottawa, Ontario.

Pavlish, L.A. and P.W. Alcock
1984 The Case of the Itinerant Bone: the Role of Sedimentological and Geochemical Evidence. *Journal of Field Archaeology* 11:323-330.

Savage, H.G., L.J. Jackson, and H. McKillop
1981 *Post-glacial Caribou in Southern Ontario*. Paper presented at 8th Annual Ontario Archaeological Society Symposium, Toronto. Ms. on file, Northeastern Archaeological Associates, Port Hope, Ontario.

Storck, P.L., and A. Spiess
1994 The Significance of New Faunal Identifications Attributed to an Early Palaeo-Indian (Gainey Complex) Occupation at the Udora Site, Ontario, Canada. *American Antiquity* 59:121-142.

Terasmae, J.
1973 Notes on Late Wisconsin and Early Holocene History of Vegetation in Canada. *Arctic and Alpine Research* 5(3):201-222.

Weniger, J.
1989 *Pollen Count Data for Paynter Marsh and Paynter South Fossil Sediments*. Ms. on file, Northeastern Archaeological Associates, Port Hope, Ontario.

Yu, Z.
1992 *Postglacial Water Levels at Rice Lake, Ontario: Sediment, Pollen, and Plant Macrofossil Evidence*. Unpublished MSc thesis, Department of Botany, University of Toronto, Toronto.

Yu, Z., J.H. McAndrews, and D. Siddiqi
1996 Influences of Holocene Climate and Water Levels on Vegetation Dynamics of a Lakeside Wetland. *Canadian Journal of Botany* 74:1602-1615.

Lawrence J. Jackson,
Northeastern Archaeological Associates,
P.O. Box 493, Port Hope, Ontario, Canada L1A 3Z4
ljnortheast@sympatico.ca