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Upper Pleistocene Radiocarbon-Dated Artefacts from the Northern Yukon

Man was in Beringia 27,000 years ago.

W. N. Irving and C. R. Harington

A bone implement and a number of bone artefacts broken or otherwise modified by man were discovered in 1966 by C. R. Harington and P. Lord at Old Crow River locality 14N (Fig. 1), a site that had produced a rich assemblage of Pleistocene fossils. During the summers of 1966 through 1968 Harington and Lord collected approximately 390 fossil vertebrate specimens from locality 14N. Irving visited the site with Harington in 1966 shortly after the artefacts were found, and in 1967 and 1970 recovered additional fossils in the vicinity.

Our initial findings were reported in 1967 and 1968 (*1*) before all of the components of the present fossil collection had been identified, and prior to radiocarbon dating of the artefacts. We now wish to describe and discuss the bone implement and two of the artefacts in the light of (i) their identification as artefacts, (ii) their stratigraphic situation, (iii) their radiocarbon dates, and (iv) the paleoenvironment as suggested by associated mammal remains (*2*). Our studies of fossils from more than 70 sites in the Old Crow Basin, several of which appear to have yielded bone artefacts as well, are continuing.

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Geographical and Geological Setting

The meandering Old Crow River drains an intermontane basin some 64.4 by 128.7 kilometers in extent (Fig. 1), which has never been glaciated but which is filled with unconsolidated fine sediments to an unknown depth. High-level shorelines on the margin of the Old Crow Basin indicate that during the Pleistocene there was in this area a vast lake (*3*). The Old Crow River is incised about 36.6 meters into the basin-fill sediments. Many exposures in the basin show a rather uniform stratigraphic sequence. From the top down, the sequence is as follows: layer a, 1.5 to 3.1 m of peat with wood; layer b, 0 to 3.7 m of fluvial and lacustrine silt with organic layers including wood; layer c, 1.5 to 3.1 m of dark gray silt and clay of probable glaciolacustrine origin, deposited when a late Wisconsin advance of the Laurentide ice sheet diverted meltwater into the basin through the headwaters of the Bell and Eagle rivers; and layer d, 25.9 m or more of fluvial and lacustrine basin-fill sediments (silt, sand, small amounts of gravel) containing lenses of wood and organic detritus and remains of fossil invertebrates and vertebrates. In places layer d is separated by an erosional unconformity from what we have called layer e, sandy clay of unknown thickness; in a few places this unconformity could not be seen. Radiocarbon dates on organic detritus, mostly wood, from layer d range from 31,300 ± 640 years before the present (B.P.) (GSC 1191) to more than 39,000 years B.P. (GSC 1189).

Many exposures of the sequence just described are eroding actively, and at several points along the Old Crow River distinctive "old" wood from layer d is being deposited with modern wood in the sand and gravel accumulating at transgressing meanders (point bar deposits). Evidently this pattern prevailed during deposition of the fossiliferous horizon at locality 14N (see below).

Locality 14N (MjV1-1; 69°51′N, 139°46′W) (Fig. 1) lies on the right (going downstream) bank of the Old Crow River between the mouths of Johnson and Schaeffer creeks, and within the broad, deeply incised valley mentioned previously. The fossiliferous unit of brown, sandy gravel averages about 0.5 m in thickness and is overlain by approximately 4.3 m of brown, sandy clay and by over 0.6 m of jointed, iron-mottled blue clay, which appears to correspond to layer e.

During 1966 and 1967 the bank was eroded to form a nearly vertical face along most of its length, but in the summers of 1968 and 1970 large blocks of clay above the fossil horizon had tumbled down and covered most of the exposure as a result of stream undercutting. The fossil horizon itself is slightly arched in section and is exposed above low water for a length of 21.3 m. From his stratigraphic study at locality 14N, Hamilton (*4*) infers the fossiliferous sediments to be point bar deposits, formed within the last few thousand years, similar in origin to those now forming on the opposite side of the river. Two radiocarbon determinations on wood from the fossiliferous horizon of about 41,000 years B.P. (GSC 730-1) and 14,000 years B.P. (GSC 730-2) (see Table 1) demonstrate the presence of relatively old and young wood (*5*). We infer that any fossils more than a few

thousand years old have been transported to locality 14N from their original place of deposition.

Although approximately two thirds of the vertebrate fossils were excavated from the fossil horizon by troweling, the remainder, including the three artefacts discussed here, were recovered from the surface of the bank just below the fossil horizon. These specimens probably had been washed down from the fossil stratum during subsidence of the river after high water in the spring of the year in which they were collected. No difference was detected between organic remains from the fossil horizon and those found on the bank.

The fact that many fragile fish, bird, and rodent bones survived with little damage and that many of the larger bones (including the artefacts) have well-preserved surface features and few rounded edges due to erosion suggests that either (i) transport was not extensive or (ii) the fossils were protected during transport in clumps of matted vegetation or blocks of frozen matrix. The paucity of coarse gravels in the Old Crow Basin and the likelihood that many of the fossils were in a frozen matrix for long periods of time prior to their arrival at locality 14N are factors that may account for their often extraordinary lack of abrasion and attrition. At the same time, the fact that all of the bones are stained and appear to have undergone chemical alteration is significant in the identification of certain specimens modified by man, some of which cannot be recognized specifically as implements (see below). Because such alteration is never seen in bone lying on the ground surface, and moreover, because bones lying on the surface seldom if ever last more than 50 years, it seems likely that the apparent chemical alteration took place in anaerobic conditions, perhaps under water.

Artefacts and Radiocarbon Dates

The single implement that can be identified with certainty is a flesher made of a caribou tibia [NMC 342 (National Museum of Canada)] (Figs. 2–4). When found, it was in excellent condition, almost as though it were fresh except for its dark brown color which is like that of other fossils from the area. The proximal end of the bone has been chopped or broken and whittled to spatulate form, and a regular series of notches has been carved into the convex working edge to give it a row of subrectangular "teeth." The broad, clearly visible whittling marks show that the tool was shaped by carving with a very sharp instrument that had a strong, nearly straight (*6*) working edge. There is no trace of grinding on the caribou flesher, such as is seen on modern versions of the tool (*7*). Clearly, this specimen was made with an implement designed for carving bone—a fact of some interest in relation to hypotheses regarding the evolution and spread of bone-working technology to which we refer below.

Bone from the flesher has been radiocarbon-dated at about 27,000 + 3000, −2000 years B.P. (GX 1640, Table 1) (*8*). We think it very unlikely that the flesher was made in Recent time from a piece of fossil bone for several reasons: (i) the bone is not strong enough to be useful in its present condition; (ii) as far as can be determined, the depth of staining is similar on the worked and unworked surfaces of the specimen; (iii) by comparison with art or ritual implements, the number of known utilitarian implements made of old or fossil bone that have been recognized is extremely small; and (iv) caribou bone from archeological sites near the Old Crow Basin dating from less than 1000 B.P. is brittle and unsuitable for use as a tool. Although we cannot prove conclusively that this implement was not made, for example, 10,000 years ago from a bone that was then 17,000 years old, we think this a highly im-

Table 1. Radiocarbon dates of bone artefacts, bone fossils, and wood from locality 14N (MjV1-1), Old Crow River, Yukon Territory.

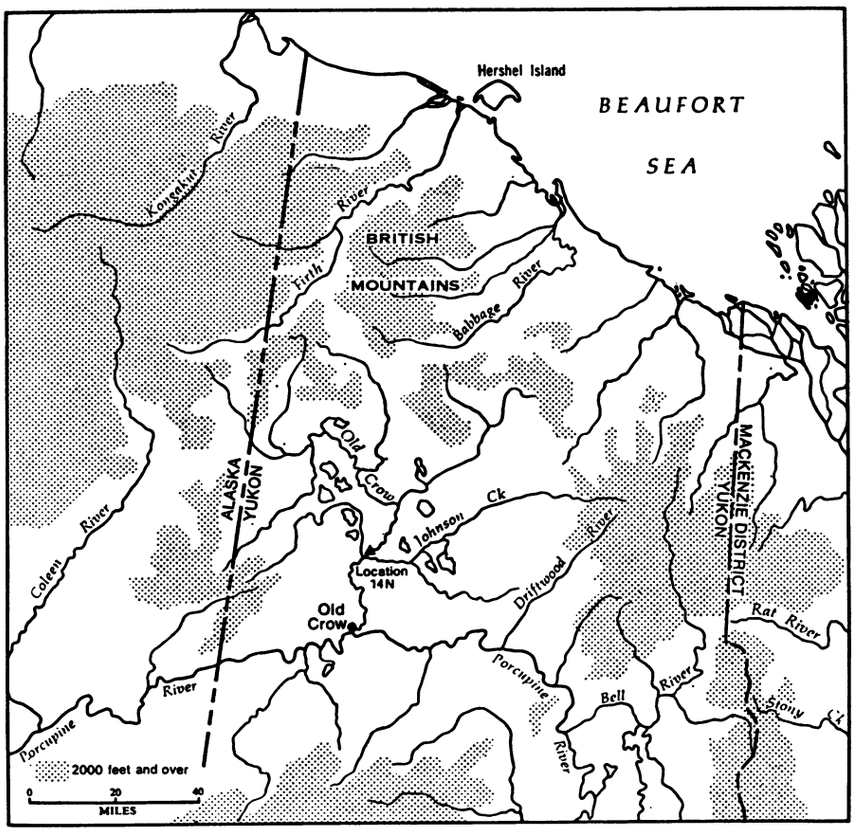
Description of specimen	Radiocarbon age (years B.P., reference date A.D. 1950)	Laboratory number	Remarks
	Bone artefacts		
NMC 330, proximal end of a mammoth radius (*Mammuthus* cf. *primigenius*) (see Figs. 5 and 6)	$29,100 \pm^{3000}_{2000}$	GX 1567	Flakes removed from shaft when fresh. Bone apatite date (*29*).
NMC 331, shaft fragment of a mammoth long bone (*Mammuthus* sp.) (see Figs. 7 and 8)	$25,750 \pm^{1800}_{1500}$	GX 1568	Flakes removed. Fractured by heavy blows when fresh. Bone apatite date (*29*).
NMC 342, flesher with serrated edge; made from a caribou tibia (*Rangifer tarandus*)	$27,000 \pm^{3000}_{2000}$	GX 1640	Worked "blade" preserved. Remainder sacrificed for bone apatite date (*29*).
	Bone fossils		
Proximal end of a mammoth femur (*Mammuthus* sp.)	22,600 ± 600	I 3573	Unworked bone excavated from fossil horizon. Bone collagen date (*26*).
Distal half of a large bison humerus (*Bison* sp.)	33,800 ± 2000	I 4227	Unworked bone excavated from fossil horizon. Bone collagen date (*26*).
	Wood		
Locality 14N, one large piece of wood 24 cm in diameter	41,280 ± 1600	GSC 730-1	Excavated from fossil horizon 13 cm above basal clay unit. Wood date (*5*).
Locality 14N, small twigs and branches	14,390 ± 160	GSC 730-2	Excavated from fossil horizon 13 cm above basal clay unit. Wood date. Wood probably of mixed ages (*5*).
	Shell		
Locality 69 (67°51′N, 139°48′W), *Anodonta beringiana* (mussel)	10,850 ± 160	I 4224	(*24*)

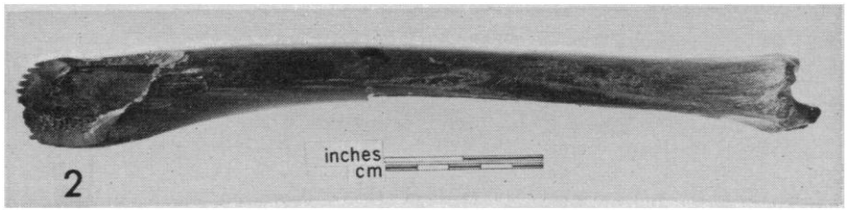
probable explanation; if the radiocarbon date is to be questioned, some other line of reasoning probably will have to be followed.

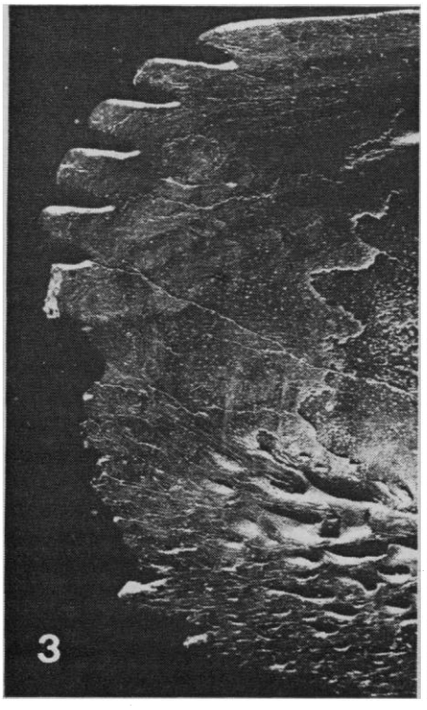
Two large fragments of mammoth radius and long bone (Figs. 5–8) are considered to be artefacts because, like a number of others not considered further here, they show evidence of having been fractured by heavy blows when fresh; such blows, in our judgment, could only have been delivered by man (*9*). Some of the blows resulted in the removal of large flakes, which modified the shapes of the specimens (for example, NMC 330, Figs. 5 and 6). We infer that these bones were broken for some purpose other than the extraction of marrow, because cancellous tissue fills their interiors; however, fat might have been rendered from them by some means not now evident. The specimens cannot at present be identified as tools, for we see no specific function for them (*10*). Bone samples from specimens NMC 330 and NMC 331 have been radiocarbon-dated at about 29,000 (GX 1567) and 26,000 (GX 1568) years B.P., respectively (Table 1).

Attempts to establish the contemporaneity of the three artefacts and several other bones by means of chemical and physical tests other than radiocarbon analysis were inconclusive (*11*). Nevertheless, the generally dark-colored bones from Old Crow River Pleistocene localities such as locality 14N differ greatly from lighter-colored bones in the area known to date from the last 1,000 years, and from bones estimated to be 6,000 to 10,000 years old. These criteria are admittedly very coarse.

Thus, we believe that at least three human artefacts from the Old Crow region are between 25,000 and 29,000 radiocarbon years old and are associated with at least a part of the vertebrate fauna to be described below. We do not discuss here a number of other bone artefacts from locality 14N and other sites; these artefacts have no chronological significance at present.







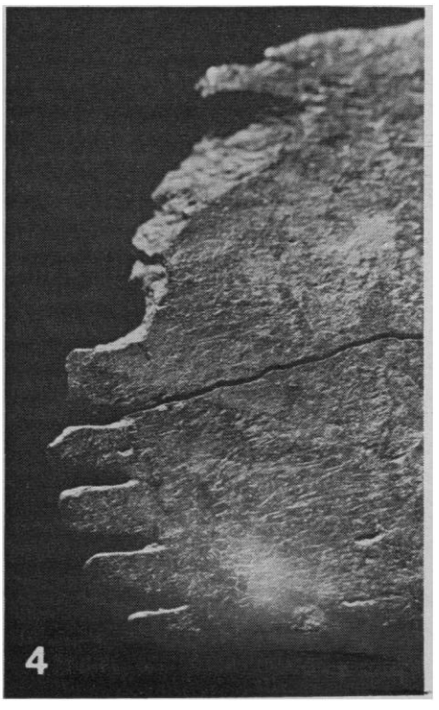


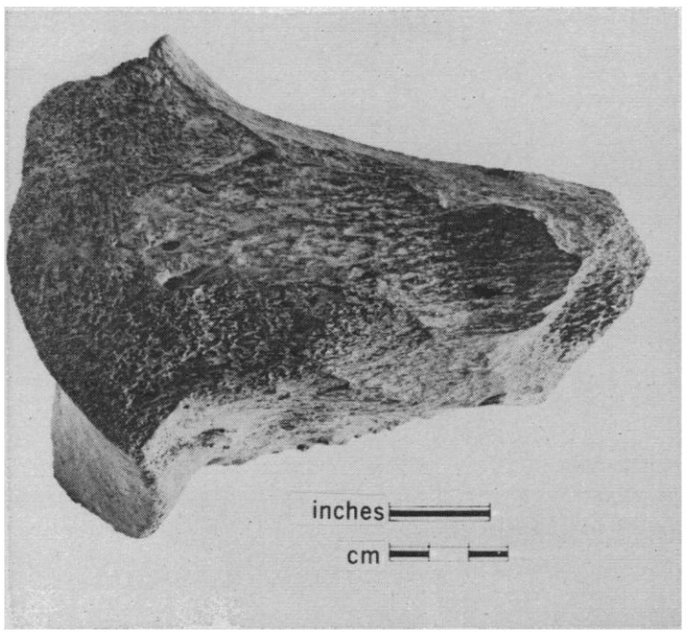
Fig. 1 (top). Map showing locality 14N and Old Crow Flats in relation to the surrounding uplands. Fig. 2 (middle). Flesher (GX 1640, Table 1) probably used for removing fascia from skins to prepare them for use as clothing. Fig. 3 (bottom left). Obverse of Fig. 2 showing details of workmanship. Fig. 4 (bottom right). Reverse of Fig. 2 showing details of workmanship.

Associated Fauna and Paleoenvironment

The faunal material from locality 14N provides clues to the environment that prevailed during the Upper Pleistocene in the Old Crow Basin (*12*) and probably to that of the period during which the artefacts were made. Limb bone samples of mammoth and bison have been radiocarbon-dated at about 23,000 (I 3573) and 34,000 (I 4227) years B.P., respectively (Table 1); however, bones younger or older than these also may be present at the site.

In addition to plant, mollusk, fish, and bird remains, 18 species of mammals have been identified at locality 14N (Table 2). Of the 18 species listed, 9, including the horse, are extinct in the Yukon Territory. With the possible exceptions of the giant pika and the dhole, none of these mammals would be out of place in a faunal list of Wisconsin age. The five radiocarbon dates on bone from locality 14N (Table 1) suggest that caribou, mammoth, bison, and man lived in the northern Yukon during the period from 22,600 to 33,800 years B.P. This period correlates well with the Karginsky interglacial (interstadial?) of Siberia [21,700 to 32,500 years B.P. (*13*)]. It correlates less well with the Farmdalian substage of Illinois [22,000 to 28,000 years B.P. (*14*)] and the Olympia glaciation of southwestern British Columbia and northwestern Washington [15,000 to 36,000 years B.P. (*15*)].

The faunal material consists of two components: (i) a cold-adapted component including a number of species derived from Eurasia (for example, woolly mammoth, Barren Ground caribou, bison, moose, and Arctic fox); and (ii) a warm-adapted component derived from southern North America [for example, camelid, giant beaver, and mastodon (*16*)]. Probably the cold-adapted component spread northward into the Alaska-Yukon region toward the end of the last (Sangamon) interglacial or during a Wisconsin interstadial. Pending further evidence, we think it possible that the two components are of roughly the same age, a finding



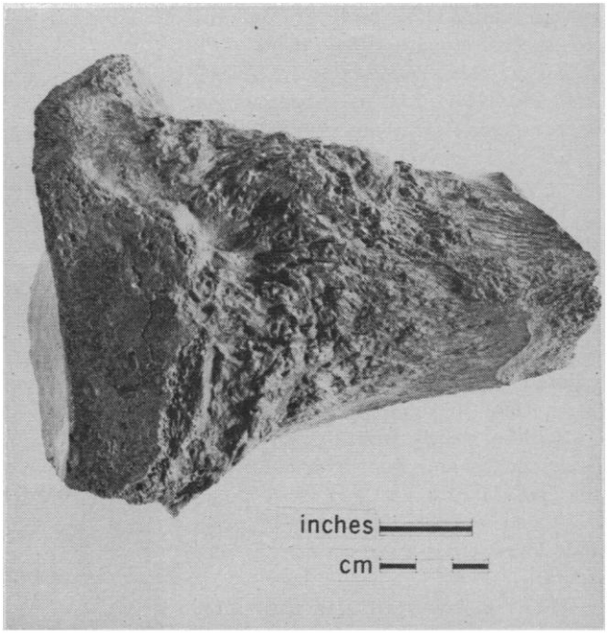
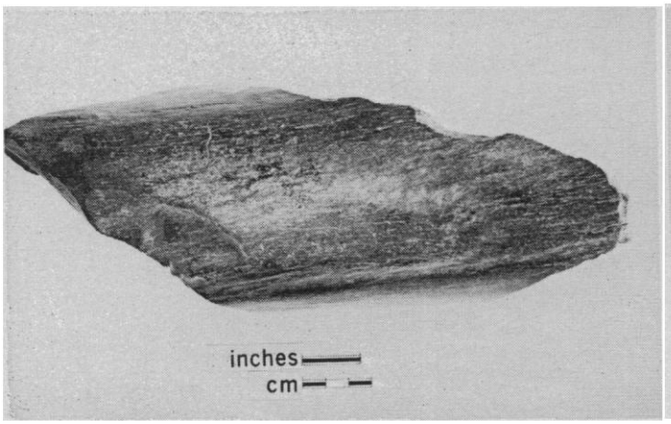


Fig. 5 (left). Proximal end of mammoth radius (*Mammuthus* cf. *primigenius*) (GX 1567, Table 1). Flakes were removed while the bone was fresh. Fig. 6 (right). Side of mammoth radius opposite to that shown in Fig. 5.



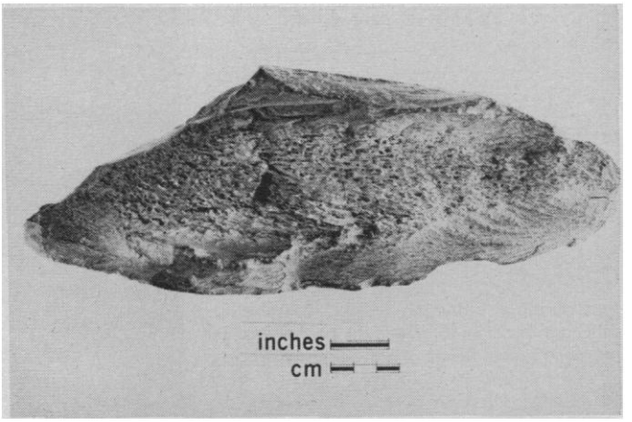


Fig. 7 (left). Shaft fragment of a mammoth long bone (*Mammuthus* sp.) (GX 1568, Table 1), fractured by heavy blows. Fig. 8 (right). Side of mammoth long bone opposite to that shown in Fig. 7. Note cancellous tissue in marrow cavity and a probable point of impact indicated by ripple marks concentric on the lower end of the fragment.

which suggests a period of transition from a warm climate to a cool one.

Horses, woolly mammoths, and bison are by far the most commonly represented among the fauna of locality 14N. They are fundamentally grazers, and this suggests the presence during the Pleistocene of large tracts of productive grassland within the Old Crow Basin, a feature missing from the area now (*17*). The presence of cold-adapted species like the Arctic fox, woolly mammoth, Barren Ground caribou, and musk-ox (*18*) implies that, at one phase at least, the grasslands were of a cool, loess-steppe nature. The presence of camelids and singing voles suggests areas of well-drained grassland.

Lakes, ponds, and streams with available aquatic vegetation and nearby wooded areas (*19*) were probably necessary for the survival of beavers, giant beavers, muskrats, and moose. Open spruce woodlands or forests seem to have been the preferred habitats of the American mastodon (*12*).

We believe that the mammalian faunal evidence indicates a period of transition to a cool climate from a warmer one in a parkland (*20*) type of environment; however, other interpretations are possible. At present, we are unable to reconstruct a more detailed picture of the environment of the human population represented by the artefacts.

Discussion

Certain questions remain to which only partial or speculative answers can be given. The scarcity of recognizable stone tools and stone-chipping debris in our collections from along the Old Crow River is perplexing because the bone flesher was made with a stone tool and the mammoth bones probably were cracked with stone hammers. Perhaps stone tools were uncommon, and such stones as were used had patterns of redeposition different from that of the bones. The discovery of worked bone of Pleistocene age with no associated stone implements is unusual but not unique. For example, Larsen (*21*) has described bone artefacts and an extinct fauna of Pleistocene age occurring without tools at the bottom of Trail Creek cave 9, Seward Peninsula, and in the Fairbanks district (*22*).

Because the caribou bone flesher (NMC 342) closely resembles late prehistoric and modern implements, and because implements of this specific description have never been reported as ancient, we were reluctant at first to view this example as being 27,000 years old. However, because there appears to be no substantial basis for questioning the laboratory age determination, our evidence apparently requires reconsideration of some recent views on the development of prehistoric technology in the New World. The flesher is evidence for a sophisticated bone-working technology in the New World considerably older than the 15,000 years postulated by Müller-Beck (*23*), and older than any previous evidence from the New World, eastern Siberia, or the Far East has indicated. The worked mammoth bone fragments appear anomalous, perhaps because such artefacts have been overlooked previously, or because the preservation of such detailed evidence is seldom as good as it is on these specimens, which probably have been enclosed by permafrost for much of the time since they were abandoned.

So far, evidence of human modification of animal bone has been recognized only on elements of the cool holarctic fauna, for example, caribou and woolly mammoth. This raises the interesting possibility that man moved from Eurasia to North America with portions of the cold-adapted fauna, particularly caribou —a species on which most modern human populations of the boreal forest and tundra have depended heavily for food and clothing.

One problem that we have been unable to resolve thus far is why, so far, no organic materials other than bone from the basin-fill sediments have yielded dates between about 11,000 and 31,000 years B.P. (*24*). Only radiocarbon dates on bone fill this seeming gap at present. Clearly, more radiocarbon dates and more detailed stratigraphic work are needed at this and other sites in the area.

Haynes (*25*) has remarked that, because of incomplete preliminary treatment, many so-called collagen dates may be suspect, generally leading to dates that are too young. Our collagen-dated specimens (Table 1, I 3573, I 4227) were treated to remove the possibility of humic acid contamination (*26*). Regarding apatite dates (Table 1, GX 1568 and GX 1640), Haynes *et al.* (*27*) have stated that this method yields more accurate results than any other bone-dating method but that in some cases, although the apatite contains the oldest carbon fraction in the sample, the date obtained is still 1,000 years or so too young for some samples in excess of 10,000 years old. Therefore, if the radiocarbon dates on bone given in Table 1 err, they would tend to be on the young side.

Table 2. Identification of Pleistocene mammal specimens evidently associated with human artefacts from locality 14N, Old Crow River, Yukon Territory.

Species	Common name
Ochotonidae cf. *Ochotona* new species*	Giant pika
Lepus sp.	Hare
Castor canadensis	Beaver
Castoroides cf. *ohioensis**	Giant beaver
Ondatra zibethica	Muskrat
Microtus (*Stenouranius*) *miurus*†	Singing vole
Cuon sp.‡	Dhole (short-snouted dog)
Alopex lagopus	Arctic fox
Gulo sp.	Wolverine
*Panthera atrox**	Lion-like cat
Homotherium sp.*	Scimitar cat
*Mammut americanum**	American mastodon
*Mammuthus primigenius**	Woolly mammoth
Equus sp.§	Large horse
*Camelops hesternus**	Western camel
Alces alces	Moose
Rangifer tarandus	Barren Ground caribou, rarely woodland caribou
*Bison crassicornis**	Large-horned bison

* Extinct. † Fedyk's (*30*) cytogenetic evidence indicates that it is incorrect to consider *Microtus miurus* as synonymous with *M. gregalis*, as Rausch (*31*) has suggested. ‡ Extinct in America; survives in eastern Asia. § Extinct in the Yukon Territory; reintroduced in historic times.

Conclusions

The evidence presented here indicates that man lived in the eastern part of the Beringian refugium before the peak of the late Wisconsin glaciation (*27*). He had sharp, stone tools intended for working bone and means of breaking large mammoth bones. Probably he hunted mammoth and caribou, and prepared the skins of the caribou for use as clothing and perhaps shelter. It is possible that he migrated to southern North America, although evidence for the presence of man there prior to the peak of the Wisconsin glaciation is at present in dispute (*28*). We do not know whether his culture should be classified as Mousteroid or Aurignacoid

in Müller-Beck's scheme (*23*), whose criteria are taken from stone implements of which we have none, although we infer their presence. Our data suggest that in Beringia, and therefore probably in Siberia and the Far East, the transition from Middle Paleolithic to Upper Paleolithic levels of technology occurred at a relatively early date. This raises the larger question: Did the transition from Middle to Upper Paleolithic occur simultaneously in many parts of the world, or did it begin in and spread from one area (*23*)?

References and Notes

1. C. R. Harington and W. N. Irving, paper presented at the annual meeting of the Society of American Archeology, Ann Arbor, Mich., 1967; W. N. Irving, *Arctic Circ.* **12** (No. 2), 18 (1968).
2. The sections on artefacts and archeological implications were written by Irving; the sections on fossils and paleoenvironment were written by Harington.
3. O. L. Hughes, *Geol. Surv. Can. Pap. 69-1* (part A) (1968), p. 209. The stratigraphic sequence given is based on his field work in the Old Crow Basin.
4. T. D. Hamilton, personal communication.
5. W. Blake, Jr. (personal communication) has advised us that, in view of the discrepancy between these two dates (GSC 730-1 and GSC 730-2), new, small pieces of wood were taken from the same sample, burned to liberate the carbon dioxide, and then the radioactivity of the resulting gas was counted for just a few hours. When it became apparent that the radioactivity was equivalent to a date of about 4000 years, the counting was stopped, because by this time it was clear that the samples were mixed, containing some old wood and some young wood (a mixture of which had produced the 14,390-year date).
6. Close examination of the whittle marks shows that the carving implement had only very small nicks and angles on its working edge. This indicates the absence of edge retouch and raises the possibility that the lateral edge of a burin was used.
7. J. Steinbring [*Amer. Antiquity* **31**, 575 (1966)] has described the manufacture of moose bone "defleshers" by Manitoba Ojibwa. Similar implements were made by the Kutchin of Old Crow in the present century. This type of tool has been reported sporadically in the archeological literature and in most cases is relatively recent. It appears to have a predominantly, if not exclusively, New World distribution.
8. The worked portion of the flesher has been kept intact in the National Museum of Man, Ottawa.
9. Our reasoning is that, whereas bone from the Old Crow region more than a few hundred years old tends to break along lines parallel to or perpendicular to the cellular structure [see : Tappen and Peske, *Amer. Antiquity* **35**, 383 (1970), who report that split line patterns parallel weathering cracks on relatively young archeological bone from Wisconsin], fresh bone tends to sustain diagonal, curving fractures, the shapes of which are determined primarily by the force and direction of the fracturing blow and the shape and thickness of the bone itself. In gross terms, fresh bone fractures somewhat like flint but ancient bone breaks like rotten wood. All of the fractures on the two dated mammoth bones are of the diagonal, curving kind; therefore, they were made when the bones were fresh. No carnivore can break a mammoth leg bone. Large stones are extremely rare in the Old Crow Basin, and phenomena such as frost action and "earth pressure" are not likely to have effected multiple fractures on a few bones, without having caused the same effect on thousands of others; thus, by default, man, wielding a stone hammer, is implicated. These criteria may be applicable in other parts of the world, but allowance must be made for variation in weathering and fossilizing processes which affect the physical properties of bone. Our experiments and observations comparing modern bone with that from archeological collections several hundred years old (W. N. Irving and C. R. Harington, in preparation) show that the criteria are useful in dealing with Upper Pleistocene and Recent bone from the Old Crow area. Casts of the dated mammoth bone specimens, NMC 330 and NMC 331, are in the National Museum of Man, Ottawa.
10. Other flaked mammoth bone fragments of similar size have been recognized from locality 14N and additional sites along the Old Crow River. Several large flakes of bone and mammoth ivory were recovered at locality 14N and are tentatively classified as chipping detritus.
11. K. P. Oakley (personal communication) analyzed samples from the artefacts and other bones for us. On the basis of the tests for fluorine and ^{235}U, it is not possible to discriminate between Pleistocene bone from locality 14N and caribou bone less than 1000 years old excavated from an Athabaskan site (Klokut MjV1-1) nearby, on the Porcupine River.
12. The basic assumption is that species represented by fossils had ecological requirements similar to those of the same or closely allied living species. In some reported cases clues to habitats of extinct species are provided by preserved stomach contents and plant remains associated with skeletal remains. W. R. Farrand [*Science* **133**, 729 (1961)] and A. Dreimanis [*Ohio J. Sci.* **68**, 257 (1968)] have discussed such evidence for the woolly mammoth (*Mammuthus primigenius*) and the American mastodon (*Mammut americanum*).
13. N. V. Kind [in *The Bering Land Bridge*, D. M. Hopkins, Ed. (Stanford Univ. Press, Stanford, Calif., 1967)] classifies the Karginsky interglacial (interstadial?) as "moderately cold (similar to Recent)." This interglacial was preceded and followed by cold glacials.
14. J. C. Frye, H. B. Willman, R. F. Back [in *The Quaternary of the United States*, H. E. Wright, Jr., and D. G. Frey, Eds. (Princeton Univ. Press, Princeton, N.J., 1965)] state that the Farmdalian substage was an interval of major glacial withdrawal, but, because the sediments and fauna indicate cool, moist conditions, Frye *et al.* consider that continental deglaciation did not occur.
15. J. E. Armstrong, D. R. Crandell, D. J. Easterbrook, J. R. Noble, *Geol. Soc. Amer. Bull.* **76**, 321 (1965).
16. Specimens from other sites nearby which also represent this southern component are *Megalonyx* sp. (ground sloth) and *Arctodus simus* (short-faced bear). Both species are extinct. No examples of the warm-adapted fauna have yet been dated.
17. A similar conclusion has been reached by R. D. Guthrie [*Amer. Midl. Natur.* **79**, 346 (1968)] following a study of Upper Pleistocene mammal assemblages in central Alaska.
18. The occurrence of the musk-ox (*Ovibos moschatus*) at other Old Crow fossil localities which are stratigraphically similar to locality 14N strengthens the evidence for a cool grassland. W. Soergel's [*Beitr. Geol. Thuringen* **7**, 75 (1942)] data on numerous fossil *Ovibos* locations in Central Europe indicate that about 20 percent of the animals lived on the loess-steppes while the remainder lived on tundra. With respect to the Upper Pleistocene environment of Beringia, D. M. Hopkins [in *The Bering Land Bridge*, D. D. Hopkins, Ed. (Stanford Univ. Press, Stanford, Calif., 1967)] remarks: "Some fossil assemblages of animals and plants that lived during the Illinoian and Wisconsin Glaciations represent mixtures of tundra and steppe elements that cannot be matched in any present-day landscape; they seem to record a wider distribution of xeric climates and more extensive grasslands during certain phases of the glacial cycles."
19. The existence of these environmental features in the region some 32,000 years ago is supported by floral and faunal evidence from a fossil locality on the nearby Porcupine River [D. E. McAllister and C. R. Harington, *Can. J. Earth Sci.* **6**, 1185 (1969)].
20. We envisage this parkland as consisting of extensive grassy uplands broken by spruce and other kinds of woodland, with lakes, ponds, and sluggish streams in lower areas.
21. H. Larsen, *Acta Arctica* (1968), fascicle 4, pp. 1–80.
22. Bones broken by man have also been found in Jaguar Cave, Idaho, unaccompanied by stone implements (H. Sadek-Kooros, personal communication).
23. H. J. Müller-Beck, *Science* **152**, 1191 (1966).
24. Well-preserved valves from the freshwater *Anodonta beringiana* at Old Crow River locality 69 (67°51′N, 139°48′W) yielded a radiocarbon date of 10,850 ± 160 years B.P. (I 4224). O. L. Hughes (personal communication) has obtained a date of 31,300 ± 640 years B.P. (GSC 1191) from wood beneath glaciolacustrine clays from a section in the Old Crow Basin.
25. C. V. Haynes, *Science* **161**, 687 (1968).
26. J. Buckley (personal communication) states: "The bone and horn-core material were processed according to the method of R. Berger, A. G. Horney, and W. F. Libby as published in *Science* [**144**, 999 (1964)] and subsequently modified by C. V. Haynes. The modification involved treating the collagen with a dilute sodium hydroxide solution to remove the possibility of humic acid contamination."
27. C. V. Haynes, Jr., M. J. Holdaway, A. Long, progress report on the radiocarbon dating of bone apatite to A. Van Valkenburg, National Science Foundation, 21 May 1969.
28. C. V. Haynes, Jr., *Science* **166**, 709 (1969); R. S. MacNeish, *Sci. Amer.* **224**, 36 (April 1971); W. N. Irving, *Arctic Anthropol.* **8** (No. 2), 68 (1971).
29. Bone artefacts were dated by Geochron Laboratories, Inc. Bone mineral apatite was extracted from which carbon dioxide was released by treatment with hydrochloric acid. The yields of carbon dioxide from apatite were smaller than had been expected.
30. S. Fedyk, *Acta Theriologica* **15**, 143 (1970).
31. R. Rausch, *Z. Saugetierk.* **29**, 343 (1964).

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