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Evidence for Human Modification of a Late Pleistocene Bison (*Bison* sp.) Bone from the Klondike District, Yukon Territory, Canada

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ABSTRACT. A 31 000 BP bison limb bone from Nugget Gulch near Dawson City, Yukon, shows a "ring crack" considered to be a human-made impact mark resulting in exposure of marrow. This bone is approximately contemporaneous with wolf, horse, and Dall sheep specimens found on an ancient Mid-Wisconsinan terrain surface at this locality. Similar ring cracks, also interpreted as human-made, have been noted on late-glacial bison bones from Engigstciak, Yukon, and Lost Chicken Creek, Alaska.

Key words: bison, *Bison priscus*, Yukon Territory, Late Pleistocene, bone fracture, humans

RÉSUMÉ. Un os de membre de bison datant de 31 000 ans av. J.-C. et provenant de Nugget Gulch près de Dawson City au Yukon, montre une «fissure circulaire» que l'on considère être la marque d'un impact donné par un être humain pour mettre la moelle à nu. Cet os est à peu près contemporain de spécimens provenant de loups, de chevaux et de mouflons de Dall trouvés au même endroit, à la surface d'un ancien terrain datant du milieu du wisconsinien. On a remarqué des fissures circulaires semblables, que l'on a aussi interprétées comme découlant d'une action humaine, sur des os de bison du tardiglaciaire trouvés à Engigstciak au Yukon et à Lost Chicken Creek en Alaska.

Mots clés: bison, *Bison priscus,* Territoire du Yukon, pléistocène tardif, fracture osseuse, êtres humains

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INTRODUCTION

On 17 August 1988, while carrying out a long-term project of collecting and studying remains of Pleistocene mammal bones from the Yukon (Harington, 1989), the first author found a bison bone on the right limit of Nugget Gulch (Dawson Loc. 63, 63˚53′N, 139˚18′W, Fig. 1), a tributary of Eldorado Creek near Dawson City, Yukon.

During the previous summer, Pleistocene mammal bones had been exposed by placer miners Bernie and Ron Johnson in the same area on an ancient grassy surface approximately 9 m below the present surface. The first author collected those bones and noted that they were close to an extensive volcanic ash layer that presumably underlay the ancient grassy surface. Exact relationships could not be observed at the fossil site, since the tephra was exposed only along the lower third of Nugget Gulch.

This paper describes the geographic setting of the locality, the stratigraphy of the site, and the radiocarbon age of the bison bone; discusses the taphonomic history, noting similarities to some other human-modified late-glacial bison bones from Yukon and Alaska; and reports on bones of other approximately contemporaneous Pleistocene mammal specimens recovered at the site.

STRATIGRAPHY AND DATING

Nearly 9 m of frozen organic silt (locally known as "muck") had overlain the bones at Nugget Gulch. The muck had been removed with heavy jets of water, exposing a buried vegetation surface on a relatively steep slope. The vegetated slope (as seen by the first author on 19 July 1987) measured at least 4 × 14 m, overlying a thin layer of gold-bearing gravel and bedrock. About 100 m downstream from the fossil locality, a volcanic ash was found outcropping approximately 1 m above the gold-bearing gravel and beneath 9.1 m of muck. To give an idea of the stratigraphic relationships at the site, a sample of the volcanic ash was submitted to Dr. G. Osborn (pers. comm. 1989) for analysis and interpretation. It best matched the Dawson tephra, dated to about 50 000 BP (See Appendix).

An articulated steppe bison (*Bison priscus*) hind foot, including dried flesh, skin, and fur, was found on the terrain surface. A sample (CR-87-13) of the terrain, consisting of a slice of turf with grass roots, etc., was removed for study; unfortunately, it was lost during a move of the Canadian Museum of Nature's paleobiology laboratory. Other ancient terrain surfaces have been noted in Eastern Beringia,

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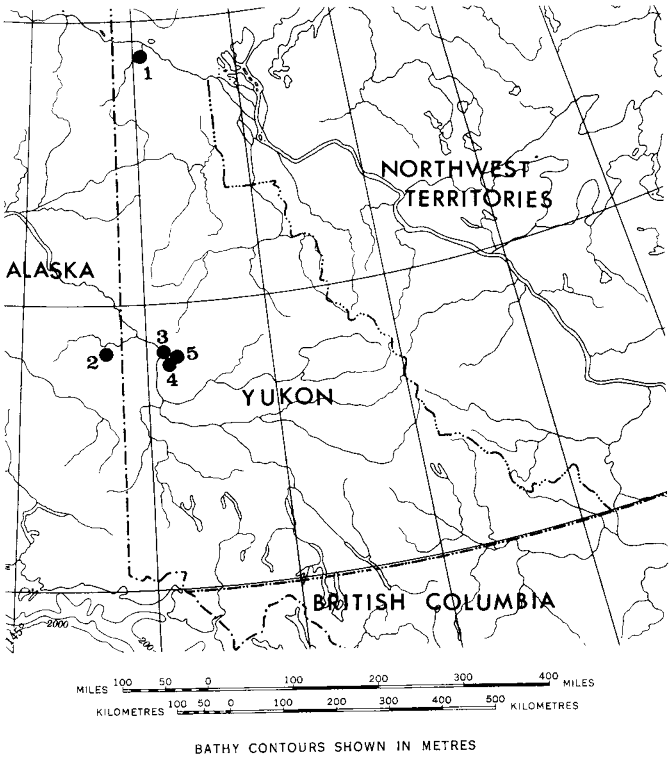

FIG. 1. Map of parts of Yukon and Alaska, showing localities mentioned in the text: 1: Engigstciak, Yukon; 2: Lost Chicken Creek, Alaska; 3: Dawson City, Yukon; 4: Nugget Gulch, Yukon; 5: Hunker Creek, Yukon (UA 68, Dawson tephra site).

e.g., Goetcheus and Hopkins (1997), from Alaska, and Fraser and Burn (1997), from the Dawson area, Yukon.

Although Bernie and Ron Johnson tried to preserve the surface under a sheet of plastic until a paleopedologist could examine it, lobes of melting muck sliding down from above soon buried it. Other remains were also collected from the terrain surface with the bison hind foot. These included a nearly complete wolf (*Canis lupus*) skull with associated axis vertebra; part of a Yukon horse (*Equus lambei*) cranium in several pieces, with heavily worn teeth indicating old age; and some excellent horse palates with teeth and stringy soft tissue. Near the wolf skull, Ron also found a Dall sheep (*Ovis dalli*) cranium (lacking the right tooth row and third left premolar) with mandible. The bison (*Bison* sp.) radio-ulna was found nearby the following year, partly buried in the surface of apparently disturbed organic silt.

The wolf skull yielded a bone collagen radiocarbon date of 27 920 ± 650 BP (Beta-33191 ETH-3899, determined by accelerator mass spectrometry [AMS]). This date is reasonably close to that of the bison radio-ulna. For the latter specimen, 8.3 grams of bone were cored from the interior of the radius to provide an AMS date on bone collagen of 30 810 ± 975 BP (Beta-33192, ETH 5900). Therefore, we suspect that the radio-ulna may have been associated with the grassy terrain surface on which the other bones were found, and that all of the fossils overlay the tephra layer, gold-bearing gravel, and bedrock.

DESCRIPTION OF THE BISON SPECIMEN

The bison bone (CMN 46320; now CMC KlVj-13:1) is the proximal end of a right radio-ulna near the semilunar notch. Presumably it represents a steppe bison (*Bison priscus*), a species that was relatively common in the Yukon and Alaska during the Mid-Wisconsinan interstadial.

This bone has had a complex taphonomic history. We believe that it was broken by dynamic loading, because it exhibits an oval ring crack on the anterior surface of the radius adjacent to the proximal epiphysis (Figs. 2, 3). Helical fractures radiating distally from the ring crack travelled for 14 cm along the radius shaft and also passed through the ulna that is firmly fused to the radius. Despite the proximity of the ring crack to the proximal end, the fracture did not initially pass through the epiphysis, as the cancellous tissue absorbed the shock. The fracture surfaces form acute and obtuse angles with the outer surface of the bone, and they exhibit no perturbations caused by split lines. The fracture surfaces are the same colour (pale brown, 10YR6/3) as the outer surface of the bone. These characteristics indicate that the bone was fresh when this fracture occurred (see Bonnichsen, 1979; Morlan, 1984; Johnson, 1985).

Also when the bone was fresh, the proximal border of the olecranon process was removed, leaving a continuous row of short chipping scars and a scooped-out area of cancellous tissue. Thereafter, the bone was buried in the active layer for some period, during which plant roots etched the surface in a few scattered locations. Once deeply buried, the bone became permineralized, probably through the absorption of manganese and iron. After it was exhumed, the now desiccated and rather fragile specimen rapidly developed weathering cracks that penetrated through the cortex, but the surface shows none of the flaking or exfoliation that occurs during normal weathering (Behrensmeyer, 1978:151). All of the observable weathering cracks expose surfaces that are slightly darker brown (10YR5/3) than the outer surfaces, and the latter may have been bleached by exposure to sunlight.

Our interpretation of this taphonomic history focuses on the modifications that occurred while the bone was fresh. It seems obvious that the chipping and scooping of the olecranon process was caused by carnivore gnawing (see Haynes, 1980:346), although the bone lacks the evidence of tooth scoring that is often associated with such damage. It might seem parsimonious to attribute the ring crack and primary fracture of the shaft to biting by a large carnivore, but several factors suggest some other process. The ring crack represents dynamic loading, whereas the application of force by a carnivore is a relatively static loading. Furthermore, the gape of the animal would need to accommodate the 8 cm span of the radius and ulna and would surely cause damage to the ulna shaft that is not observed on the specimen. It is unlikely that even the very large short-faced bear (*Arctodus simus*) could have caused the observed modifications.

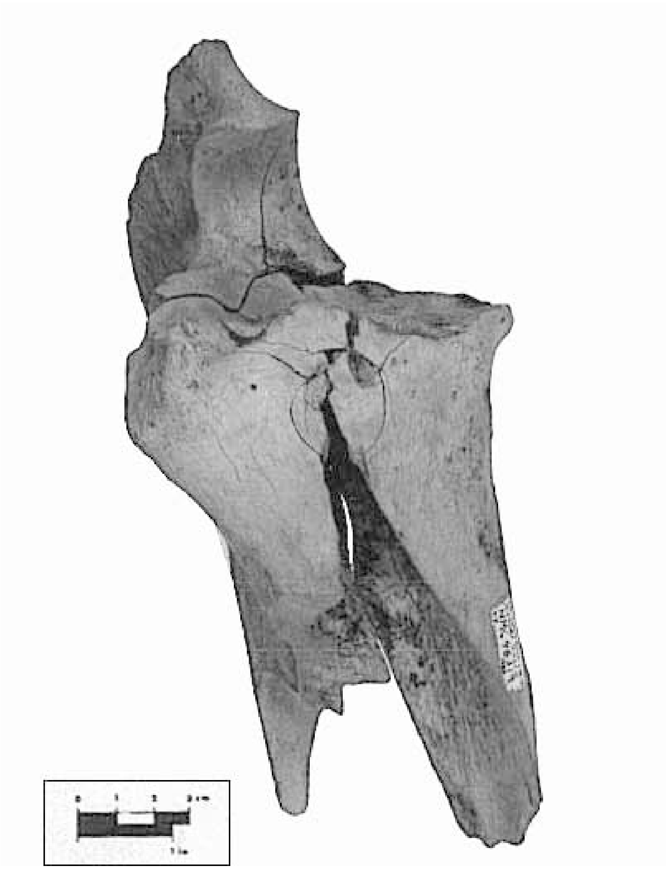

FIG. 2. Anterior view of proximal end of a bison [probably referable to steppe bison (*Bison priscus*)] right radio-ulna from Nugget Gulch, Yukon, showing a ring crack just below the proximal articular surface of the radius. Note the smooth spiral fracture extending below and across both radius and ulna. This bone yielded an AMS radiocarbon date of 30 810 ± 975 BP (Beta-33192 ETH 5900).

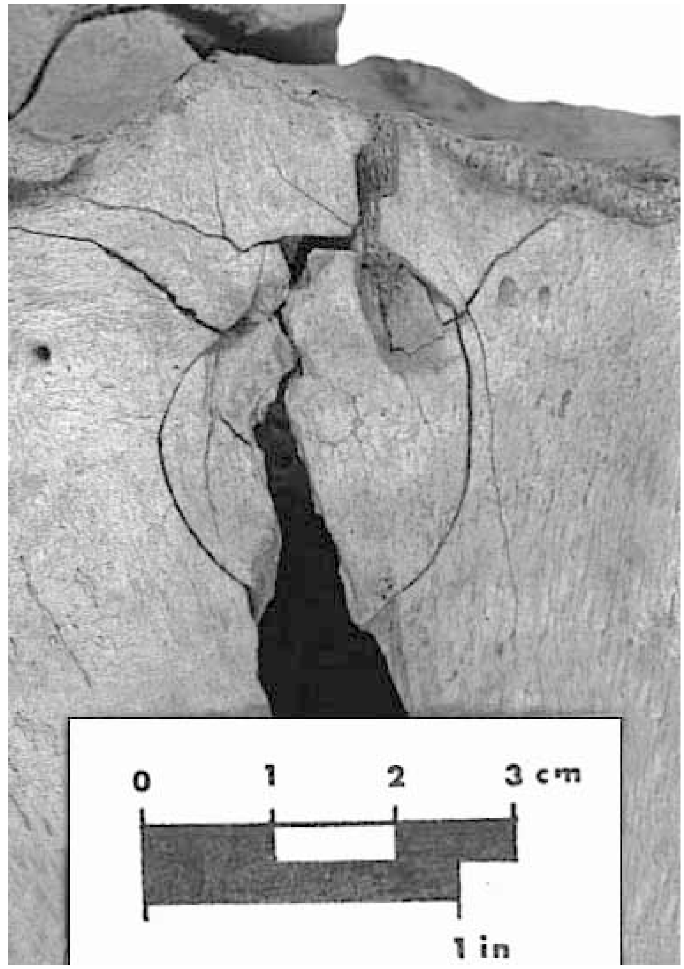

FIG. 3. Anterior view of the ring crack on the bison radio-ulna (CMN 46320; now CMC KlVj-13:1).

The size of the ring crack, 32 × 25 mm, is informative of the potential list of impacters that could have produced the fracture. Since the ring crack formed as a tension fracture just outside the contact area of the impacter, we can eliminate carnivore teeth and animals hooves as potential causes. No carnivore tooth is large enough and no animal hoof is small enough to have created the ring crack. A ring crack of similar size has been documented on a bison femur from Shield Trap Cave in Montana (Oliver, 1989:83, Fig. 12). At that site, the most likely cause is roof-fall, a process that probably does not explain the Nugget Gulch specimen for two reasons. There is no evidence that a rock overhang ever existed in the drainage during the last 30 000 years, and the natural position of repose, influenced by the ulna, causes either the medial surface or the antero-lateral edge to face upward.

To receive an impact to its anterior surface, the radio-ulna would have to be held in an appropriate position, and we believe that a person wielding a cobble-size hammerstone is the most likely cause of the ring crack and its associated fracture. The purpose, presumably, would be exposure of the marrow, and the missing distal end of this bone may also have been struck to achieve this objective.

DISCUSSION

Ring cracks similar to that seen in the Nugget Gulch radio-ulna have been described on other limb bones referred to steppe bison (*Bison priscus*) elsewhere in Eastern Beringia. Two examples are known from the Engigstciak archaeological site (NiVk-1) in northern Yukon, one near the distal end of a right tibia dated at 9870 ± 180 BP (RIDDL-362) and one near the distal end of a left metatarsal dated at 9400 ± 230 BP (RIDDL-319; Cinq-Mars et al., 1991: Figs. 2, 4). A third example is the left tibia of a bison (*Bison* sp.; CMN 25845) from Lost Chicken Creek, Alaska, dated at 10 370 ± 160 BP (I-8582; Harington, 1980:170–171, Fig. 2). All of these fractures have been attributed to human agency and interpreted as the results of marrow retrieval. The arguments advanced in this report suggest that the Nugget Gulch radio-ulna is yet another example of this process. We believe that this evidence, albeit slim and divorced from any proper archaeological context, supports the hypothesis that people lived in Eastern Beringia during Mid-Wisconsinan time (Cinq-Mars and Morlan, 1999).

TABLE 1. Comparison of glass composition in Nugget Gulch tephra and Dawson tephra.

	Glass Composition								
	SiO_2	TiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	Total
Nugget Gulch, Klondike District, Yukon (CR-87-12)									
First run (31 readings) Average	72.67	0.27	13.14	2.05	0.21	1.22	5.06	3.55	98.18
Standard Deviation	0.92	0.04	0.39	0.08	0.02	0.03	0.11	0.08	1.31
Second run (31 readings - Average, normalized to 100%)	74.02	0.28	13.38	2.09	0.21	1.24	5.15	3.62	100.0
Standard Deviation	0.26	0.04	0.29	0.07	0.02	0.02	0.10	0.09	–
Dawson tephra, Hunker Creek, Klondike District, Yukon (UA68)									
Glass shards (normalized, H_2O-free)	74.13	0.30	13.53	2.20	0.22	1.23	4.43	3.55	–

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The first author is particularly grateful to placer miners Bernie and Ron Johnson (Dawson City) for bringing to his attention the significant finds at their 1987–1988 operation on Nugget Gulch, and for donating important Pleistocene bones from this and other sites on Eldorado Creek to the Canadian Museum of Nature, as well as for their great hospitality. We thank Gerry Osborn (Department of Geology and Geophysics, University of Calgary) for his analysis and interpretation of a tephra sample from Nugget Gulch; Jerry Fitzgerald (Canadian Museum of Nature) for taking the radiocarbon sample and for the photographs; and Gail Harington for word-processing the manuscript. The second author's contribution was supported by the Canadian Museum of Civilization. The radio-ulna described here was originally catalogued at the Canadian Museum of Nature (CMN 46320). It has been transferred to the Canadian Museum of Civilization under catalogue number KlVj-13:1.

APPENDIX: VOLCANIC ASH

Two thick patches of volcanic ash were noted on the right limit of Nugget Gulch (Dawson Loc. 63), Yukon, about 400 m upstream from its mouth at Bernie and Ron Johnson's placer operation, on 19 July 1987. The ash lay about 1 m above the gold-bearing gravel (which in turn overlay siliceous schist bedrock with blocky weathering, and underlay about 9.1 m of organic silt ["muck" in mining terms]) in patches nearly 2 m long with a maximum depth of 25 mm. A relatively dry sample (CR-87-12) was taken in an attempt to determine its approximate geological age. Dr. Gerald Osborn of the University of Calgary analyzed the sample (Table 1). He noted (pers. comm. to C. Harington, 28 March 1989) that it "consisted almost entirely of bubble-wall glass…being neither of the two well-studied Yukon ashes, White River and Old Crow…but is in the same stratigraphic setting as, and is likely to be 'Dawson tephra'…with the rather nebulous date of ≤ 52 000 BP" (see Naeser et al., 1982).

Dr. John Westgate (University of Toronto), in a letter to Dr. Osborn dated 5 April 1989, cautioned that it is best to have a comprehensive documentation of the physicochemical attributes of the tephra, rather than basing the identification solely on glass chemistry. Osborn (pers. comm. 17 April 1989) commented: "These are respectable match-ups except for sodium, which is notoriously flaky anyway. The composition and the field relations strongly suggest your sample is Dawson tephra. But note Westgate's caution that glass chemistry isn't necessarily enough (although in your sample that's all there is!)."

ADDENDUM

The first author has received a more precise date of 24 000 B.P. for the Dawson tephra (John Westgate and Duane Froese, pers. comm. 4 April 2002). Therefore, instead of the volcanic ash at Nugget Gulch being below the exhumed ancient terrain surface, it would be just above it in the stratigraphic sequence.

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