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Late Pleistocene Fauna of Lost Chicken Creek, Alaska

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ABSTRACT. The fossil remains of one invertebrate and 16 vertebrate genera have been recovered from late Quaternary sediments of a large placer gold mine in east-central Alaska. Forty-six of 1055 fossils were recovered *in situ* from nine stratigraphic units at the Lost Chicken Creek Mine, Alaska. The fossils range in age from approximately 1400 yr BP (*Alces alces*) to greater than 50 400 yr BP (*Equus [Asinus] lambei, Rangifer tarandus*, Ovibovini cf. *Symbos cavifrons*, and *Bison priscus*). The assemblage includes an unusual occurrence of gallinaceous birds (*Lagopus* sp., ptarmigan), wolverine (*Gulo gulo*), the extinct American lion (*Panthera leo atrox*), collared lemmings (*Dicrostonyx torquatus*), and saiga antelope (*Saiga tatarica*).

Sediments at Lost Chicken Creek consist of 37 vertical m of sandy silt, pebbly sand, gravel and peat of fluvial, colluvial and eolian origins. Four episodes of fluvial deposition have alternated sequentially throughout the late Wisconsinan with periods of eolian deposition and erosion. Solifluction has created a disturbed biostratigraphy at the site, yielding a fauna that must be considered a thanatocoenosis. The stratigraphy of Lost Chicken Creek is strikingly similar in major features to that of two coeval Beringian localities: Canyon Creek and Eva Creek, Alaska.

Key words: Beringia, Pleistocene, fauna, ecology, mammals

RÉSUMÉ. Les restes fossilisés d'un invertébré et de 16 vertébrés ont été récupérés dans des sédiments du quaternaire tardif d'un grand placer d'or dans le centre-est de l'Alaska. Quarante-six des 1055 fossiles ont été récupérés *in situ* dans neufs unités stratigraphiques à la mine de Lost Chicken Creek en Alaska. Les fossiles datent d'environ 1400 ans avant notre ère (*Alces alces*) à plus de 50 400 ans avant notre ère (*Equus [Asinus] lambei, Rangifer tarandus*, groupe des *ovibovini* Cf. *Symbos cavifrons* et *Bison priscus*). L'ensemble comprend la présence inhabituelle de gallinacés (esp. *Lagopus*, lagopède), du carcajou (*Gulo gulo*), du lion d'Amérique maintenant disparu (*Panthera leo atrox*), de lemmings à collerette (*Dicrostonyx torquatus*), et de saïga (*Saiga tatarica*).

À Lost Chicken Creek, les sédiments se composent de 37 m verticaux de limon sableux, de sable caillouteux, de gravier et de tourbe d'origine fluviale, colluviale et éolienne. Quatre périodes de déposition fluviale ont eu lieu au cours de l'époque glaciaire tardive du Wisconsin, en alternance avec des périodes de déposition et d'érosion éoliennes. La solifluxion a perturbé la biostratigraphie du site, donnant une faune qui doit être considérée comme une thanatocénose. Par ses caractéristiques majeures, la stratigraphie de Lost Chicken Creek ressemble de façon frappante à celle de deux localités béringiennes contemporaines: Canyon Creek et Eva Creek en Alaska.

Mots clés: Béringie, pléistocène, faune, écologie, mammifères

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INTRODUCTION

Alaska, like northeastern Siberia, has long been famous for its Pleistocene fossil vertebrates recovered in large numbers earlier this century by several well-known expeditions (Maddren, 1905; Gilmore, 1908; Quackenbush, 1909). Since 1930, in fact, as many as 30 tons of these fossils have been freighted to national museums, unaccompanied, however, by much meaningful stratigraphic data recording their provenance (Péwé, 1975a). Pleistocene paleontologists working in Alaska and the Yukon have had, until recently, only the sketches of a small number of contemporary researchers to guide them to an understanding of the taphonomy of the Wisconsinan fauna (Weber *et al.*, 1981; Jopling *et al.*, 1981; Harington and Clulow, 1973; Péwé, 1975a; Guthrie, 1968a).

Intensive gold placer mining in east-central Alaska throughout the past decade has opened several new opportunities to collect and study Alaska's late Pleistocene fauna *in situ*. At one such locality, Lost Chicken Creek in east-central Alaska, 37 m of late Quaternary sediments have been exposed by gold placer mining. In 1976, an opportunity to collect the fossil vertebrates of Lost Chicken Creek for the U.S. National Museum of Natural History became available to me. I undertook collection of these fossils to record an occurrence of a large and diverse Rancholabrean Alaskan fauna in relation to local site stratigraphy. Data collected during the field seasons of 1976-79 and 1983 provide the basis for this summary report on the mammalian biostratigraphy of Lost Chicken Creek, Alaska.

STUDY AREA

Lost Chicken Creek is a very small, short (approximately 1920 m long) stream that flows south and southeast into the South Fork of the Fortymile River, east-central Alaska (Fig. 1). The stream is located at 64°03.2′N, 141°52.6′E, in T.26N., R.18E., Eagle A-2 Quadrangle, U.S. Geological Survey 1:63 360 Topographic Map Series. Lost Chicken Creek occupies a narrow (200 m wide) valley underlain on either side by greenstone (Foster, 1969). A gold placer mine operates at the southeastern confluence of the creek with the Fortymile River. The mine covers an area of approximately 2 km^2. Placer gravel deposits are irregularly distributed in Lost Chicken Creek valley and are mostly the remnants of extensive Pleistocene fluvial terraces. All data for this report have been compiled from the lower, and younger, of two alluvial terraces recognized at Lost Chicken Creek. An upper terrace is not mined today and is poorly exposed.

Prior to my arrival at the site, the lower terrace at Lost Chicken Creek had yielded several thousand large and small vertebrate fossils, remains of invertebrates and plant macrofossils. *Ex situ* vertebrate remains and a brief mention of floristic relations at the site have been the subjects of three earlier scientific reports (Whitmore and Foster, 1967; Matthews, 1970; Harington, 1980a). I collected 1055 fossils from Lost Chicken Creek between 1976 and 1983. Forty-six of these fossils were recovered *in situ* from nine stratigraphic units recognized at the site. The following report summarizes the stratigraphy, paleontology and Quaternary geologic chronology of Lost Chicken Creek, Alaska.

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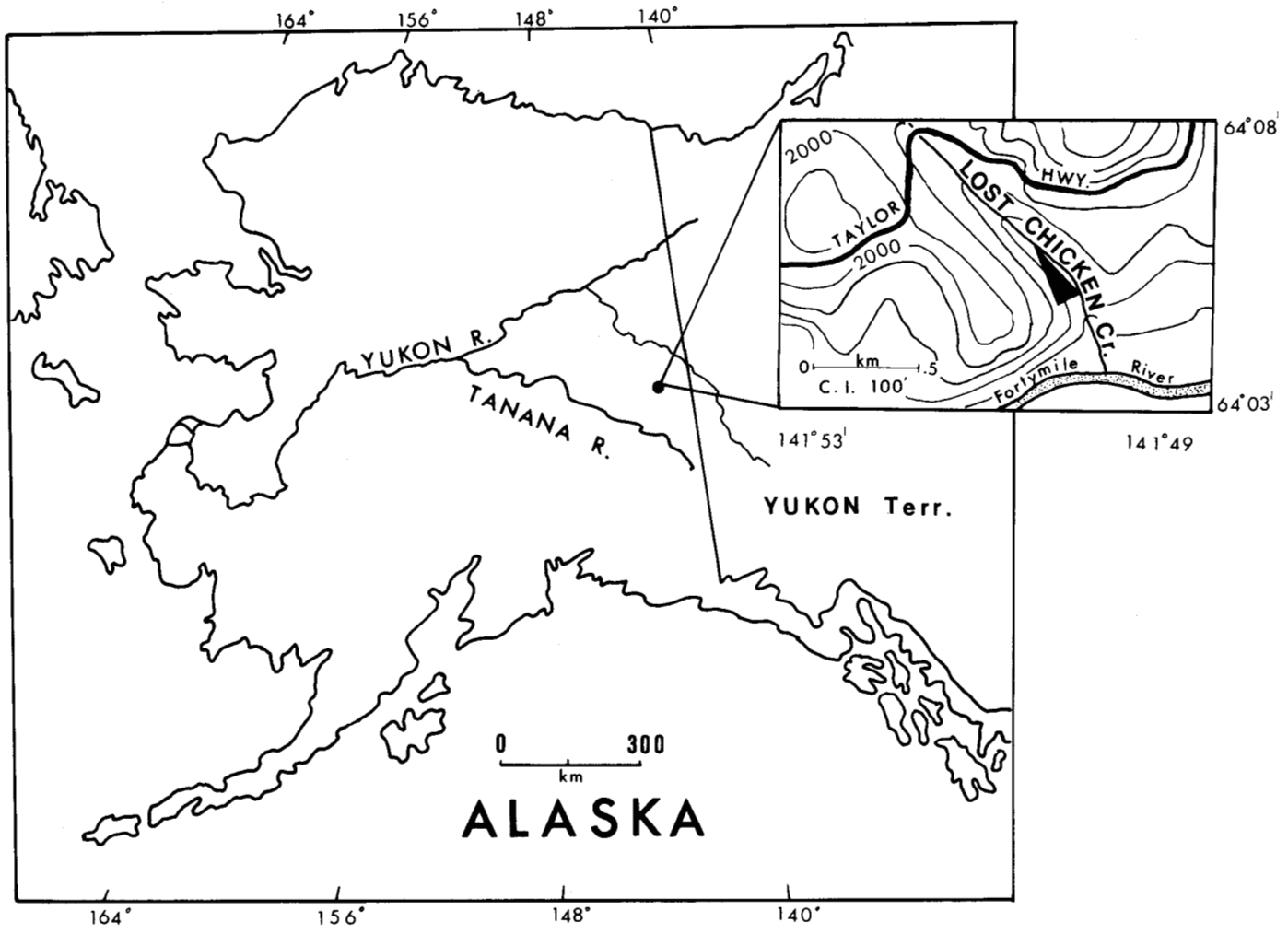

FIG. 1. Map of Alaska showing location of fossil site.

METHODS

Stratigraphic relations at Lost Chicken Creek were determined by field mapping and field sampling. Data taken from six compass-and-clinometer traverses perpendicular to the axis of the placer cut were compiled and transferred to a composite cross section of the vertebrate locality (Fig. 2; Table 1). Four additional types of laboratory sedimentological data also were collected to aid interpretation of the depositional history of Lost Chicken Creek. They were radiometric dating of each sedimentary unit; identification of tephras; mechanical sieving of sediments for particle-size distributions; and petrographic examination of sediments from thin sections.

Radiometric Dating

Nine radiometric samples from Lost Chicken Creek were processed at the U.S. Geological Survey Isotopes Laboratory in Menlo Park, California, by Stephen W. Robinson. The samples were collected and dried, transported and stored in Nasco Whirl-Pak sterile specimen sacks. Care was taken to select only vegetative samples to avoid sources of error common in dating fossil bone (Hassan and Ortner, 1977; Hassan *et al.*, 1977; Hassan and Hare, 1978). Wood, peat and grass rootlets were the only materials submitted (Table 2).

Volcanic Ash Beds

Two volcanic tephras — both white vitric ashes — are recognized at Lost Chicken Creek. The tephras were identified on the basis of trace elements present in their constituent minerals (courtesy of J.A. Westgate, University of Toronto). The uppermost tephra has been identified as the White River Ash (Péwé, 1975b), and the lower ash is the recently named Sheep Creek Tephra (J.A. Westgate, written comm. 1984).

Granulometry

Mechanical sieving of sediments at Lost Chicken Creek was carried out to determine the final agent of transport and the geologic process responsible for deposition (McBride, 1971). Thirty-seven sediment samples were prepared for grain-size analysis following Folk's method (1974). Coarse fraction sediments were sieved in Tyler standard sieves at quarter-phi intervals (Krumbein and Pettijohn, 1938). Fine clastics and clays were separated for pipette analysis (Folk, 1974). Sodium hexametaphosphate was used as a dispersant for wet samples. Data were "fed" into a specifically designed computer program using statistical equations from Folk (1974).

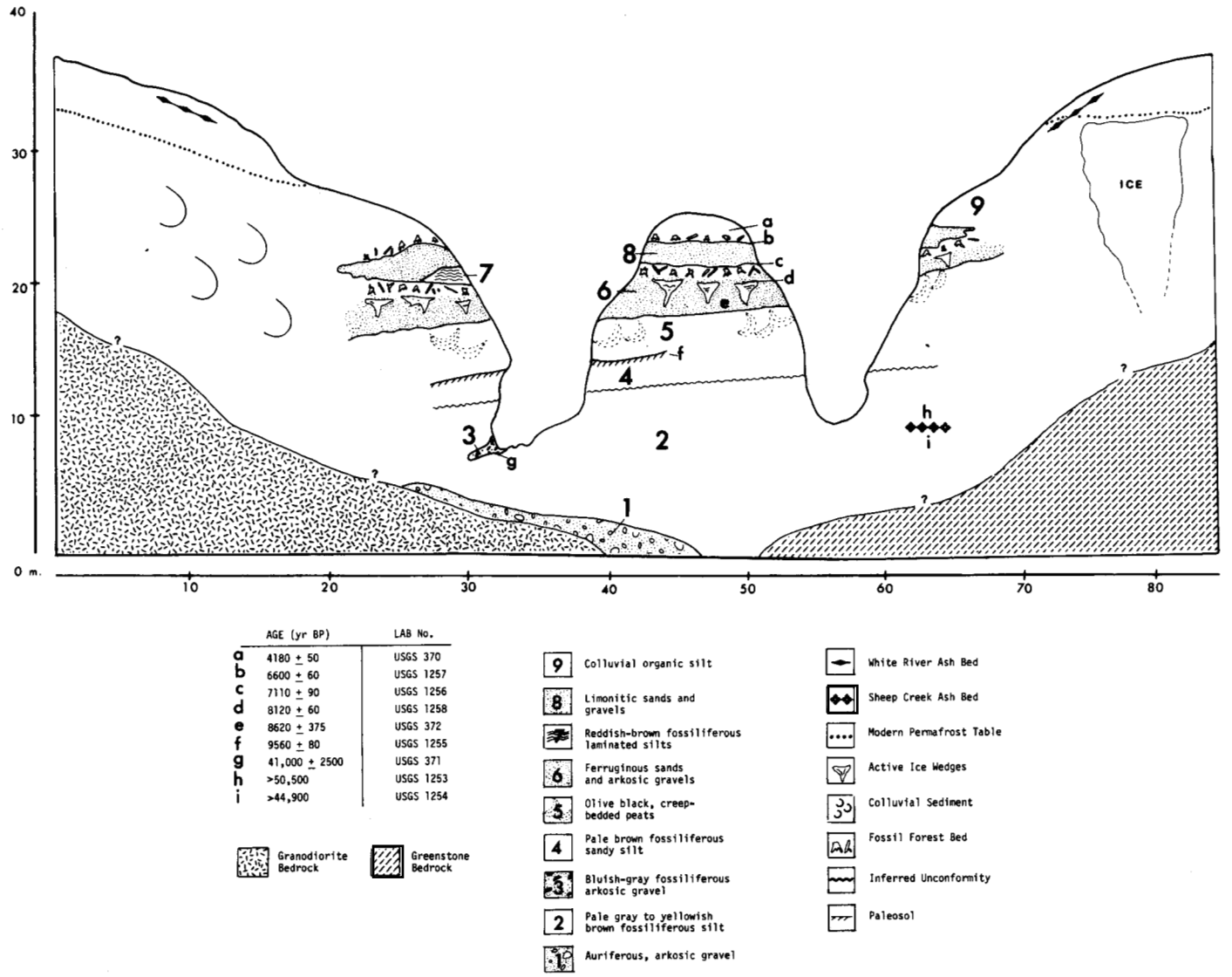

FIG. 2. Stratigraphic relationships at Lost Chicken Creek. Letters designate radiocarbon samples. Numbers represent discrete stratigraphic units.

Petrography

Identification of sedimentary minerals at Lost Chicken Creek was carried out by thin-section analysis under a standard Zeiss petrographic microscope. Thin sections were made from each of Lost Chicken Creek's nine stratigraphic units, from each volcanic ash and from the principal cobble types of gravel units 1, 3, basal 6 and basal 8. Minerals were identified in reflected, transmitted and cross-polarized light. Magnifications of 10x and 40x were most frequently used. The Michel Levy Color Chart of mineral birefringence indices was used to identify minerals (Scholle, 1979). The Terry and Chilingar (1955) comparison chart for Visual-Percentage-Estimation was used to estimate sediment proportions. Mineralogic analyses of Lost Chicken Creek sediments are given in order of decreasing abundance in Table 1.

SEDIMENTOLOGICAL RESULTS AND CONCLUSIONS

Sediments at Lost Chicken Creek were found to consist of 37 m of sandy silt, pebbly sand, gravel and peat of fluvial, colluvial and eolian origins. These sediments are assignable to nine stratigraphic units (Table 1; Fig. 2). Nine radiocarbon dates have established a chronology for sedimentation (Table 2). Summarizing relationships, four fluvial episodes (units 1, 3, 6 and 8) alternate sequentially with periods of eolian deposition and erosion (units 2, 4, 7 and 9) during the late Pleistocene and early Holocene. Unit 5 represents a brief interval of peat accumulation. Solifluction is particularly detectable in unit 9, and to a lesser extent in unit 2, through evidence of coarse, tabular schist inclusions in otherwise fine eolian silts and by highly contorted volcanic ash beds.

The base of the Lost Chicken Creek section consists of angular, arkosic, auriferous gravels of unknown age, but estimated to be greater than 50 400 years old. This basal, fluvial gravel is overlain by a thick (1-6 m) sequence of eolian fossilferous silts that contain redeposited concentrations of Sheep Creek Tephra near the top of the unit. The Sheep Creek Tephra is loosely dated at greater than 40 000 yr BP (USGS 1254, 1253). Animals buried in this ash at Lost Chicken Creek are *Equus (Asinus) lambei* (Yukon wild ass), *Rangifer tarandus* (caribou),

TABLE 1. Stratigraphic section of Lost Chicken Creek, Alaska (64°03.2'N, 141°52.6'W, composite)

Unit	Thickness (m)	Description
9	2.5-8.0+	Moderately well-sorted, subangular to subrounded, leptokurtic, organic micaceous sandy silt (62% coarse silt; 25% fine sand). Dusky brown (5 YR 2/2 to 10 YR 2/2). Rodent burrows at 1.0-1.3 m depth. Modern permafrost table at 1.0 m. Massive ground ice in northern exposures; colluvial aprons form when sediment thaws. Sand mineral constituents: quartz (undulose extinction), muscovite and tourmaline. White River volcanic ash (white, vitric, straight extinction, shards) present at 0.8-1.0 m depth in single, double and sometimes triple strands. Frost-shattered *in situ* forest bed (*Picea* sp.; other unidentified wood) at basal contact. Fossiliferous: *Alces alces*. Age of unit: White River Ash = 1400 yr BP; ^{14}C from basal forest bed: 4180±50 yr BP.
8	1.0-1.5	Poorly sorted, bimodal, platykurtic, subangular to angular, coarse sands and gravels. Pale yellowish brown (10 YR 6/2 dry; 10 YR 5/4 wet). Sand mineral constituents: >50% quartz (undulose and composite extinctions), muscovite, epidote, biotite, chlorite, olivine, chert, plagioclase feldspar, anorthoclase, limonite-stained chert and 5% hematite opaques. Gravel clasts: epidote schist, granodiorite, chert and conglomerate. Fossiliferous: *Bison priscus* and *Bison* sp. (small). Age ^{14}C at upper contact 6600±60 yr BP.
7	1.0-1.5	Moderately well-sorted, subangular to angular, leptokurtic, sandy organic silt. Positively skewed, mean particle size 4.73 Phi; pale reddish brown (5 YR 5/2 dry; 5 YR 5/6 wet). Laminated when frozen in near-horizontal beds with small (0.2 cm) undulatory peat seams. Sand mineral constituents: quartz (undulose extinction), hematite-stained quartz, muscovite, olivine, tourmaline and <5% iron opaques. Fossiliferous: pulmonate gastropod snails, *Succinea avara*. Estimated age: 6800 yr BP.
6	1.0-2.0	Poorly sorted, mesokurtic to leptokurtic, subrounded to rounded, ferruginous coarse sands and pebbly gravels. Pale reddish brown (5 YR 5/2 dry; 5 YR 5/6 wet). Sand mineral constituents: >50% quartz (strongly undulose and composite extinctions), chert sand, plagioclase feldspar, olivine, biotite, muscovite and detrital rock fragments of schist, quartzite and hematite-cemented sandstone. Peaty and highly fossiliferous. Prominent ice wedge horizon in mid-unit. Uppermost 1.0 m bears a frost-shattered *in situ* forest bed. Tree species: *Picea glauca* (cone), *Betula* sp. (bark), *Betula nana* (leaf), *Populus balsamifera* (leaf), *Salix planifolia* (leaf), Gramineae (blade). Class Mammalia: *Equus lambei*, *Rangifer tarandus*, *?Ovibos* or *?Symbos* and *Bison priscus*. Age of unit: forest bed ^{14}C 7110±90 yr BP, ice wedge horizon 8120±60 yr BP; and base of unit 8620±375 yr BP.
5	1.0-4.0	Crescentically bedded olive black (5 YR 2/1) peat; tightly felted, ice and sand penetrated. Peat festoons at disjunctive angles; also creep-bedded and channel-bedded peats. Fossiliferous: Mammalia, species unknown, rib, USNM 262442, ?Bison. Age of unit: ≈9000 yr BP.
4	2.0-3.0	Moderately well-sorted, subangular to subrounded, leptokurtic, sandy micaceous silt. Pale brown (5 YR 5/2 dry) to light bluish gray (5 B 7/1 wet). Sand mineral constituents: quartz (undulose extinction), muscovite and tourmaline. Subrounded grains of coarse silt 63% and fine sand 32%. Faint undulatory laminations in near-horizontal beds (when frozen). Oxidized red silty sand paleosol (10 R 5/4) 0.8 m from upper contact. B horizon penetrated by fossil grass rootlets. Inferred unconformity at mid-section. Fossiliferous: *Betula* sp. (bark), Gramineae (roots). Class Mammalia, species unknown, bone fragments. Age ^{14}C Paleosol 9560±80 yr BP; basal date ?40 000 yr BP.
3	1.0-2.0	Poorly sorted, coarse, mesokurtic, subrounded, arkosic pebbles in coarse sandy matrix. Light to medium bluish gray (5 B 7/1 to 5 B 5/1). Vivianite-stained, quartz-rich detrital sands. Pebbles of granodiorite, phyllite, chert, schist and gray marble. Fossiliferous: woody twigs, *Rangifer tarandus*, *Bison priscus*; vivianite-stained. Age ^{14}C 41 000±2500 yr BP.
2	1.0-6.0	Well-sorted, micaceous, quartz-rich, leptokurtic sandy silt with redeposited concentrations of white, vitric volcanic ash (shards, straight extinction, no inclusions). Pale yellowish brown (10 YR 6/2). Sand constituents: subangular to angular quartz sand (undulose extinction), hematite-stained quartz, muscovite, biotite, olivine and traces of tourmaline and iron opaques. Rare occurrences of tabular shist cobbles (3.9-5.0 cm) and weathered granodiorite. Peat composed of twigs and grass rootlets in thin (0.5 cm) subhorizontal beds. Fossiliferous: Class Aves, *Lagopus* sp.; Class Mammalia, *Equus lambei*, *Rangifer tarandus*, *Symbos cavifrons*, *Bison priscus*, *Mammuthus primigenius*. Age of unit: ^{14}C >44 900 yr BP and >50 400 yr BP.
1	2.0+	Poorly sorted, arkosic, auriferous, coarse pebbly sands and gravels. Mesokurtic, subangular to subrounded pebbles and small cobbles of diverse igneous and metamorphic lithologies. Light olive gray (5 YR 5/2). Beds dipping 3°SE. Yellowish gray (5 YR 7/2) sandy matrix composed of 50% quartz sand (strongly undulose extinction), epidote, chlorite, biotite, muscovite metamorphic rock fragments (MRFs) and volcanic rock fragments (VRFs). Idiomorphic yellow tourmaline crystals in MRFs. Cobbles of granite and granodioite (quartz, biotite and plagioclase feldspar; hornblende replaced by epidote and pennine) and greenstone (fine-grained, strained quartz; large and conspicuously zoned, twinned and euhedral plagioclase crystals; epidote, chlorite and iron opaques. Fossiliferous: *Rangifer tarandus*, *Mammuthus primigenius*. Estimated age of unit: >50 000 yr BP.

?Symbos cavifrons (muskox), *Bison priscus* (steppe bison) and *Mammuthus primigenius* (woolly mammoth).

Silt of probable mid-Wisconsinan age (unit 2) is overlain by another arkosic fluvial gravel deposited about 41 000 yr BP. These stream gravels are covered by 3.0+ m of *in situ* tan eolian silt containing at least one, and probably several, unconformities. The uppermost 0.5 m of tan silt bears a prominent early-Holocene paleosol, with fossil plant roots and an oxidized B-horizon, which has been dated at 9560 ± 80 yr BP (USGS 1255).

A large peat deposit approximately at mid-section indicates flourishing vegetation at the site, and perhaps a temporary impoundment of surface water in the valley between 9000 and 8600 yr BP. This thick peat deposit is overlain by the first of two Holocene buried forests (USGS 372 and 1256). A reinvasion of spruce into the northeastern quarter of the Yukon-Tanana Upland, between 9000 and 8500 yr BP, is suggested by both accumulations of wood. Climatic warming appears to have continued up to a maximum of 8120 ± 60 yr BP (USGS 372), a date marked by a prominent ice-wedge horizon that truncates all older ice deposits. By approximately 8000 yr BP, the Birch Interval (Hopkins, 1982) had concluded in extreme eastern Beringia.

Loess deposition (unit 7) resumed between 7100 and 6600 yr BP at Lost Chicken Creek, suggesting perhaps a return to cooler climates in the middle Holocene. A continental-type, loess-associated, pulmonate snail fauna (*Succinea avara*) is found in these middle Holocene sediments.

At about 6600 yr BP, another fluvial cycle disturbed middle-Holocene sedimentation at the site, possibly removing part of unit 7, and depositing the coarse fluvial sands of unit 6. These sands were quickly occupied by another spruce forest between 7700 and 4200 yr BP. Since 4200 yr BP, this spruce forest has been buried beneath at least 8 m of colluvial silt, originally of loess origin, and recently carried downslope by warm climate solifluction.

TABLE 2. Radiocarbon dates from Lost Chicken Creek, Alaska

USGS sample number	Description	Age (^{14}C yr)
370	Spruce twigs from upper forest bed, lower boundary of unit 9	4180 ± 50
1257	Woody twigs from upper forest bed, lower boundary of unit 9	6600 ± 60
1256	Spruce wood from lower forest bed, upper boundary of unit 6	7110 ± 90
1258	Peat from gray alluvium overlying a prominent ice-wedge horizon, unit 6	8120 ± 60
372	Large spruce stem in red gravel, basal unit 6	8620 ± 375
1255	Grass rootlets associated with oxidized B horizon of buried paleosol, unit 4	9560 ± 80
371	Wood. Associated with USNM 372804, *Rangifer tarandus* antler, unit 3	41 000 ± 2500
1253	Wood overlying Sheep Creek Ash bed, unit 2	>50 500
1254	Wood underlying Sheep Creek Ash bed, unit 2	>44 900*

*USGS 1254 originally was reported as a finite date of 44 900 ± 3200 yr BP by S.W. Robinson. A conservative assessment of the date is better placed at >44 900 yr (D.M. Hopkins, pers. comm. 1981).

In summary, the Lost Chicken Creek section spans the Boutellier period (approximately 80 000-30 000 yr BP), the Duvanny Yar period (approximately 30 000-14 000 yr BP; although most Duvanny Yar sediments [unit 4] are missing or have been disturbed), the Birch Interval (14 000-8500 yr BP) and recent Holocene sedimentation (Hopkins, 1982).

COMPARISON WITH OTHER PUBLISHED SECTIONS

A small but growing number of measured, well-dated and published Beringian vertebrate fossil sites make it possible here to compare sediments at Lost Chicken Creek to those at two other localities (Fig. 3): Eva Creek, near Fairbanks, Alaska; and Canyon Creek, on the Richardson Highway, between Fairbanks and Lost Chicken, Alaska.

Eva Creek, Alaska

Sedimentation at Eva Creek, 16 km west of Fairbanks, Alaska, was the subject of a 1952 Ph.D. dissertation from Stanford University by T.L. Péwé. The site and the report are well known to Alaskan Quaternary stratigraphers. Four principal units of silt and sand and three buried forests are recognized at the Eva Creek placer mining exposure. Five radiocarbon dates have established a chronology of sedimentation (Fig. 3).

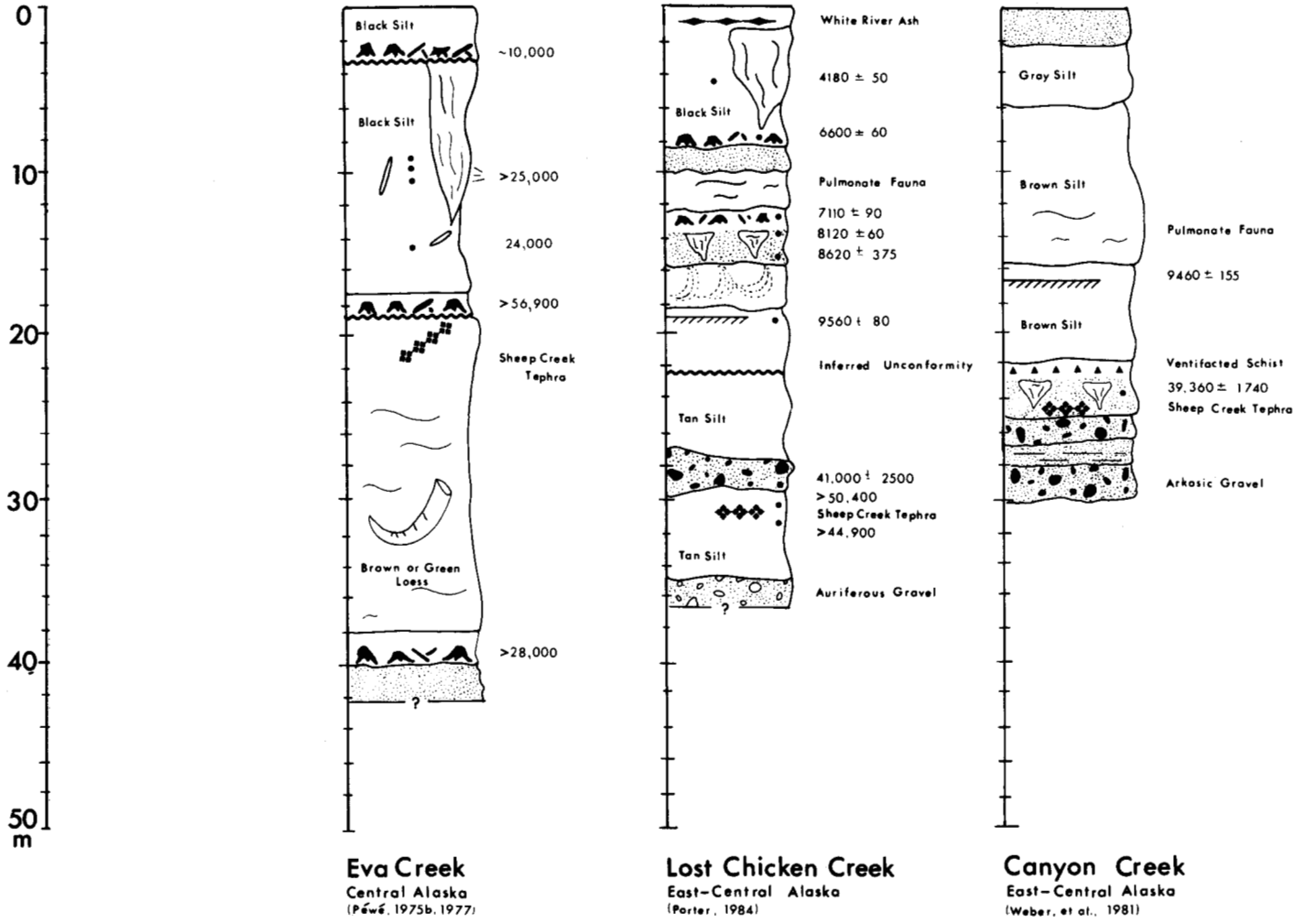

FIG. 3. Stratigraphic comparison among three late Pleistocene Beringian vertebrate localities.

A basal early-Pleistocene sand at Eva Creek is overlain by a forest bed belonging to the Dawson Cut Formation of ?Yarmouthian age. This forest is bured by 20 m of unconsolidated Illinoian sediments of the Gold Hill Formation, containing vertebrate remains of mammoth and bison. The Sheep Creek Tephra is present in redeposited concentrations near the upper contact of the Gold Hill Formation.

Gold Hill sediments, which chiefly are loess, are overlain by colluvial loess of Wisconsinan age (the Goldstream Formation). In many exposures, including Eva Creek, an interglacial forest bed lies between Wisconsinan retransported silt and the Gold Hill loess. The forest is called the Eva Creek Forest Bed and it is assigned a Sangamonian age.

Wisconsinan Goldstream sediments at Eva Creek contain fossil remains of *Bison priscus*, *Mammuthus primigenius*, *Equus lambei* and *Rangifer tarandus*, in decreasing order of abundance. A microtine fauna consisting of *Citellus* (= *Spermophilus*) *undulatus*, *Microtus gregalis*, *Lemmus sibericus* and *Dicrostonyx torquatus* also is known from the Goldstream Formation at Eva Creek (Guthrie, 1968b).

Goldstream colluvial silts are subsequently overlain by 1-5 m of the Ready Bullion (Qrb) Formation. The Ready Bullion Formation ranges in age from ~ 3000 to 10 000 yr BP, with most of the radiocarbon dates from other sections in the neighborhood of 5000-7000 (Péwé *et al.*, 1977). An early, unnamed Holocene forest marks the beginning of Ready Bullion silt accumulation.

In summary, the Eva Creek exposure contains sediments representing the Happy Interval, the Boutellier, the Duvanny Yar, the Birch Interval and recent sediments (Péwé 1975a; Hopkins, 1982). Duvanny Yar sediments at Eva Creek are nowhere younger than 23 000 yr BP and 11 000 yr BP (Péwé *et al.*, 1977). A hiatus of sedimentation between 22 000 and 11 000 yr BP is recorded at Eva Creek.

Lost Chicken Creek, Alaska

Stratigraphic relationships at Lost Chicken Creek agree with the broad schematic outline for Eva Creek, although an early Wisconsinan date is here inferred for the Sheep Creek Tephra in unit 2, rather than a pre-Sangamonian age. This concurs with the prevailing opinion of many Quaternary Alaskan geologists (D.M. Hopkins, pers. comm. 1984).

Deposition at Lost Chicken Creek begins with a fluvial gravel of Boutellier (early to mid-Wisconsinan) age and proceeds with three successive fluvial deposits separated by periods of eolian and colluvial sedimentation. The Sheep Creek Tephra is found in unit 2, inferred early Wisconsinan sediments. A pronounced unconformity, or series of unconformities, occurs between approximately 41 000 and 9560 yr BP at Lost Chicken Creek and represents the truncation of Duvanny Yar sediments at the time of the maximum expansion of late Pleistocene glaciation. Approximately 20 m of Holocene deposits (including two forest beds and one extensive peat deposit) have since accumulated in the valley of Lost Chicken Creek. The section spans the interval from mid-Boutellier to recent time.

Stratigraphic relationships at Lost Chicken Creek are particularly interesting because they so nearly approximate the classic relations of Alaskan Quaternary sections. The only departure at Lost Chicken Creek from average conditions is a minor one. It appears that Holocene climatic amelioration began a little later at Lost Chicken Creek than at some other localities where Pleistocene climates terminated between 12 000 and 10 000 yr BP. If it is accepted that the peat accumulation of unit 5 (between 9500 and 8600 yr BP) is evidence of a postglacial climate, and we recall that Holocene stabilization of Pleistocene dune fields near Lost Chicken Creek was not completed until 8200 yr BP (Fernald, 1965), it could be concluded that postglacial climates arrived at Lost Chicken about 1200-1500 years later than at some other Alaskan localities.

Marine warming in the Bering Sea at the end of the Pleistocene began as early as 17 000 yr BP, with almost complete flooding of the Bering Land Bridge by about 15 500 yr BP (Hopkins, 1982). In the Yukon, however, Laurentide ice did not reach its maximum extent before 14 000-13 500 yr BP (Rampton, 1971). Locally cool interior temperatures probably were maintained by proximity to this pervasive body of ice. Even today, steep barometric gradients often develop between Alaskan maritime and continental regions, tending to isolate the local climates of each area (Taber, 1943). Pleistocene cool temperatures, therefore, may have persisted slightly longer over the stable, cool Yukon-Tanana Upland than at other localities.

Canyon Creek, Alaska

The Canyon Creek vertebrate locality is an exposed road cut on the north side of the Richardson Highway, 85 km southeast of Fairbanks, Alaska (Weber *et al.*, 1981). Twelve to 22 m of sand, silt and gravel are assignable to 11 stratigraphic units at the site (Fig. 3). Five radiocarbon dates, two bone-apatite dates and four bone-collagen dates provide control for the section.

A basal arkosic gravel of early Wisconsinan to ?Illinoian age underlies the Canyon Creek section. This fluvial gravel is overlain by bedded sands and silty sands of middle-Wisconsinan age. The Sheep Creek Tephra (dated greater than 40 000 yr BP) is associated with a remarkably diverse vertebrate fauna of *Mammuthus primigenius*, *Equus lambei*, *Camelops hesternus* (Yesterday's camel), *Rangifer* sp., *Bison* cf. *crassicornis* (= *Bison* cf. *priscus*), *Ovis* cf. *dalli*, *Canis lupus* and *Lepus* sp. Weber *et al.* (1981) were able to discriminate between the bones of animals that died at the site (the camel and the hare) and bones of the other animals that apparently washed in by a small stream crossing the site. All the animal remains were found in association with the Sheep Creek Tephra, permitting a tentative dating of the ash by its fauna. Bone apatite dates of 28 140 ± 4150 and 32 160 ± 1250 yr BP were recorded, while bone collagen yielded dates of 38 000 ± 2050, 39 360 ± 1740 and 40 430 ± 2790 yr BP (Weber *et al.*, 1981:Table 3).

Unit 6 at Canyon Creek (above the Sheep Creek Tephra and below 21 m of other sediments; Weber *et al.*, 1981:Unit 6) contains a distinctive ventifact-rich unconformity overlain by brown loess of early Holocene age. This unconformity indicates truncation of Duvanny Yar sediments corresponding to the period of the late Pleistocene glacial maximum (18 000-13 000 yr BP) in nearby foothills of the Alaska Range.

Early Holocene sediments of unit 5 (Weber *et al.*, 1981:Unit 7) at Canyon Creek bear a reddish-brown oxidized paleosol with fossil grass roots, radiocarbon dated at 9460 ± 155. The Canyon Creek paleosol records the same climatic interval preserved by a paleosol at Lost Chicken Creek dated at 9560 ± 80 yr BP. Above the paleosol, 5 m of middle Holocene loess containing a pulmonate gastropod fauna of *Succinea* cf. *strigata* and *Columella edentula* were deposited.

The Canyon Creek section is completed by two Holocene units, a gray silt and a dune sand deposit at the modern surface, which formed from dissection of earlier deposits (Weber *et al.*, 1981). Radiocarbon dates indicate the two units formed between

3500 and 1600 yr BP, a period of cool temperatures throughout most of the Northern Hemisphere.

Summary

The sediments, fauna, ice wedges, stratigraphy and ages of silts at the three localities described here are remarkably similar (Fig. 3). Each site apparently occupied a similar periglacial position at the close of the Pleistocene and throughout the Holocene. Each site received loess sedimentation from glacier outwash 100-200 km distant. Each location accumulated the bones of Pleistocene animals. Each site saw the decline of the steppe-tundra biome, the extinction of its mammoth-bison-horse fauna and its replacement by a mesic, taiga community.

As a group, the three sites suggest cold, xeric Illinoian environments in Beringia characterized by loess sedimentation and a fauna somewhat less populous than the Wisconsinan fauna for which Alaska is famous. Sangamonian interglacial climates are recorded by reforestation in Alaska. The Wisconsinan is introduced by a resumption of loess accumulation at all four sites. At Lost Chicken and Canyon creeks, eolian sedimentation is punctuated by local fluvial deposits that disrupt the Wisconsinan loess record.

The termination of the Pleistocene, between 20 000 and 10 000 yr BP (depending upon geographic position), produced the strongest indicators of similar conditions among the three sites. Late Pleistocene sediments and vertebrates are missing from each locality. Ventifacted stones of the Canyon Creek locality suggest an answer here. Evidently extreme eolian deflation and severely continental climates inhibited deposition in Beringia during that time, or removed what little was laid down.

The Holocene is everywhere heralded by an abundance of wood and plant debris in sediments. Eva Creek grew a forest, while Lost Chicken and Canyon creeks bore warm-climate, oxidized grassy paleosols. At Lost Chicken Creek, in particular, the grass gave way to an extensive woody peat deposit and two successive forest beds.

All three sections record two interesting middle-Holocene events: a period of maximum warming at approximately 8000 yr BP, followed very soon thereafter by a resumption of loess accumulation (and presumably, cool climates) at 7000 yr BP. The period of maximum warming is marked by the melted-down tops of middle Holocene ice wedges at each site. Loess sedimentation is detected afterward at each site, even to the extent of nearly identical gastropod faunas at Lost Chicken and Canyon creeks.

In summary, sites described contain coeval sedimentological evidence of Illinoian, Sangamonian, Wisconsinan and Holocene Beringian climates. These three small creek valley deposits of central Alaska contain very sensitive local records, although they occasionally sacrifice broad climatic data through the provinciality of their separate valley records (e.g., as when Lost Chicken Creek's unit 2 [= Gold Hill Loess] is eroded by Lost Chicken Creek at 41 000 yr BP and replaced by alluvium). There is, however, little doubt that each site is recording the same intervals of time, similar sedimentological regimes, similar climatic responses and similar biotic communities of the vast Beringian landscape.

A detailed view of the faunal community that occupied Lost Chicken Creek throughout the Wisconsin now begins.

THE BIOSTRATIGRAPHY OF LOST CHICKEN CREEK

Ex situ vertebrate remains have eroded out from the lower of two alluvial terraces at Lost Chicken Creek for many years and have been collected, on two occasions, by geologists (Whitmore and Foster, 1967; Harington, 1978, 1980a). Approximately 100 fossil bones comprising nine species (*Panthera leo atrox*, *Equus* [*Asinus*] *lambei*, *Equus* [*Asinus*] cf. *kiang*, *Rangifer tarandus*, *Cervus elaphus*, *Ovis ?dalli*, *Symbos cavifrons*, *Bison crassicornis* [= *B. priscus*], *Mammuthus primigenius* and *Homo* sp. [inferred]) have been discussed previously in scientific literature. All of the fossils have been considered apart from their biostratigraphic context.

Of particular value, Harington's 1980a report gives a summary list of radiocarbon dates (Table 3) taken directly from fossil bones from both the Whitmore and Foster collection and from his own fossils.

TABLE 3. Radiocarbon dates taken directly from fossil bone (Harington, 1980a)

Cervus elaphus (antler)	10 050±150 yr BP (I-9998)
Bison cf *priscus* (tibia)	10 370±160 yr BP (I-8582)
Symbos cavifrons (horncore)	20 500±390 yr BP (I-10649)
Equus sp. (bone)	26 760±300 yr BP (SI-355)

Harington has also suggested the presence of Early Man at Lost Chicken Creek from a series of complexly broken bison and mammoth bones (Harington, 1980a). A radially fractured bison tibia (NMC 25845) has been radiocarbon dated at 10 370 ± 160 yr BP (I-8582), and several other broken bone specimens from his collection may be of this date. Harington has compared Lost Chicken Creek to three Alaskan sites of similar antiquity: the Dry Creek Site, central Alaska (Thorson and Hamilton, 1977: microblades and animal bones dated at 11 120 ± 85 yr BP); the Trail Creek Site, western Alaska (Larsen, 1968: butchered bison bone dated at 13 070 ± 280 yr BP); and Healy Lake Site, central Alaska (Cook and McKennan, 1970: burnt bone dated at 11 090 ± 170 yr BP).

From 1976 until 1979, and again in 1983, I collected the fossil remains of one invertebrate and 16 vertebrate species from sediments at the Lost Chicken Creek placer gold mine. Forty-six of 1055 specimens were recovered *in situ*, placing the Lost Chicken Creek fauna among the three largest *in situ* Rancholabrean collections from Alaska (Jack Wade Creek, Lost Chicken Creek and Canyon Creek respectively). Fossils have been recovered from each of nine stratigraphic units at the site and range in age from approximately 1400 yr BP (moose) to greater than 50 400 yr BP (Yukon ass, caribou, musk-ox, steppe bison, and mammoth) (Fig. 4).

The Lost Chicken Creek vertebrate assemblage includes an occurrence of gallinaceous birds (*Lagopus* sp., ptarmigan), wolverine (*Gulo gulo*), the extinct American lion (*Panthera leo atrox*), collared lemming (*Dicrostonyx torquatus* and the saiga antelope (*Saiga tatarica*). Table 4 gives an expanded Rancholabrean faunal list from Lost Chicken Creek.

Vertebrate remains collected *in situ* by this writer were recovered directly from the frozen walls of the placer pit. The stratigraphic distribution of these fossils is given in Table 5 and Figure 4. *In situ* fossils were exhumed by jets of pressurized cold water used in placer mining to remove overburden above

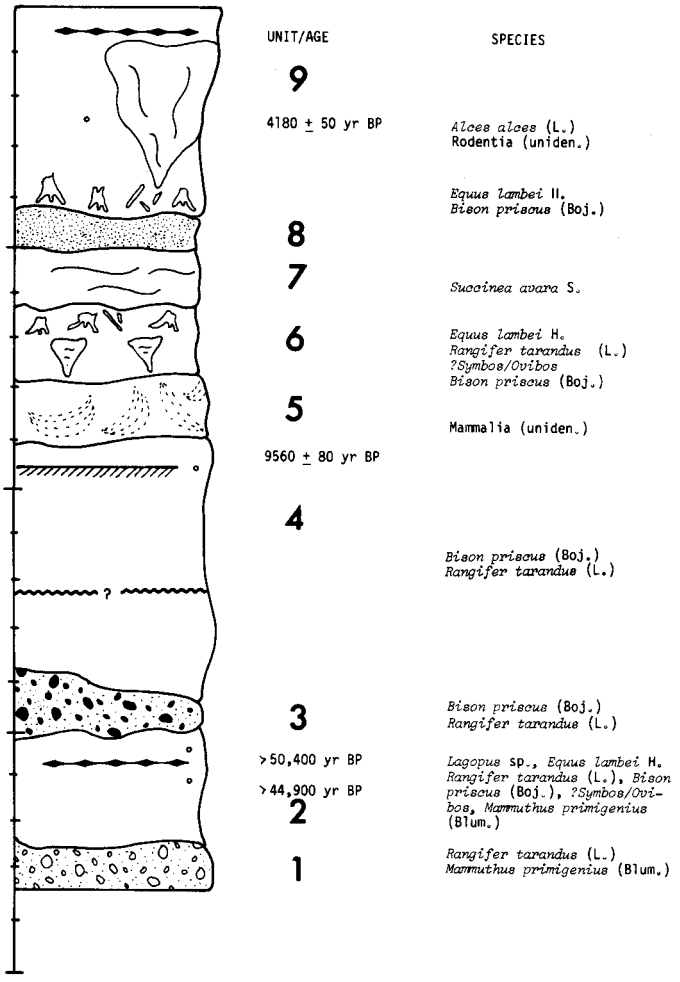

FIG. 4. Biostratigraphic relations of *in situ* vertebrate taxa from Lost Chicken Creek recovered from 1976 to 1980 and 1983.

TABLE 4. Rancholeabrean fauna from Lost Chicken Creek, Alaska

Phylum Mollusca
  Class Gastropoda
    Genus *Succinea avara* Say — Pulmonate Snail[1]
Phylum Chordata
  Class Aves
    Order Galliformes
      Family Tetraonidae
        Lagopus sp. — Ptarmigan[1]
  Class Mammalia
    Order Rodentia
      Family Cricetidae
        Dicrostonyx torquatus (Pallas) — Collared Lemming
      Unidentified rodent burrows[1]
    Order Carnivora
      Family Mustelidae
        Gulo gulo (Linnaeus) — Wolverine
      Family Felidae
        **Panthera leo atrox* (Leidy) — American Lion[2]
    Order Perissodactyla
      Family Equidae
        **Equus (Asinus) lambei* Hay — Yukon Wild Ass[1,2]
        **Equus (Asinus)* cf *kiang* (Moorcroft) — Kiang-like Wild Ass[2]
    Order Artiodactyla
      Family Cervidae
        Rangifer tarandus (Linnaeus) — Caribou[1,2]
        Alces alces (Linnaeus) — Moose[1]
        Cervus elaphus (Linnaeus) — Wapiti[2]
      Family Bovidae
        Saiga tatarica (Linnaeus) — Saiga
        Ovis ?dalli Nelson — Dall Sheep[2]
        [+]*Symbos cavifrons* (Leidy) — Helmeted Musk-ox[1,2]
        ?Ovibos moschatus (Zimmerman) — Musk-ox[1]
        **Bison priscus* (Bojanus) (=*B. crassicornis*) — Steppe bison[1,2]
        Bison bison (Linnaeus) — Bison
    Order Proboscidea
      Family Elephantidae
        [+]*Mammuthus primigenius* (Blimenbach) — Woolly Mammoth[1,2]
    Order Primates
      Family Hominidae
        Homo sp. — Man[2]

[1]Found *in situ*.
[2]Listed in Harington, 1980a.
[+]Extinct genus.
*Extinct species or subspecies.

auriferous gravels. Fossils were located, marked, sprayed, allowed to melt from their frozen positions and collected.

Species identified for the first time at the site include: *Saiga tatarica*, *Succinea avara*, *Lagopus* sp., *Gulo gulo* and *Dicrostonyx torquatus*. Measurements of the rarest taxa from Lost Chicken Creek are recorded in Tables 6-9. The commonest *in situ* taxon at Lost Chicken Creek is *Bison priscus* (18 specimens), followed by *Equus (Asinus) lambei* (11 specimens), *Rangifer tarandus* and *Mammuthus primigenius* (3 specimens). *Mammuthus* probably is underrepresented at Lost Chicken Creek because the mine owner usually kept mammoth teeth, tusks and other elements. Mammoth are reported to be the third most numerous taxon in Wisconsinan-age sediments at other Alaska localities (Guthrie, 1968a).

The most common osteological elements recovered at Lost Chicken Creek were the foot bones of ungulates and the antlers of caribou. These fossils owe their preservation to their strong construction and their compact shapes. Similar findings have been reported by Guthrie (1967) from the Fairbanks mining district. Other bones, such as humeri, radii, tibiae and femora, were preserved less often, apparently because they were less sturdily constructed and because natural predators prefer these elements for the fat-rich marrow they contain (Guthrie, 1967). Robust and horn-bearing crania of bison, musk oxen and mountain sheep also were preserved more commonly than the skulls of horses and caribou (Guthrie, 1967).

The rarest fossils collected at Lost Chicken Creek are an adult male cranium of *Saiga tatarica* (USNM 374407) (Fig. 5), the Central Asian saiga antelope and a right humerus of the same animal (USNM 374408). Saiga antelope are known in North America from six bone fragments from central Alaska, one from the Canadian Northwest Territories and two fossils from the Alaska North Slope (Harington, 1980b, 1981). The skull collected at Lost Chicken Creek is the most complete specimen of *Saiga* recovered in North America (E. Anderson, written comm. 1984) (Fig. 5).

Carnivore remains also are rare wherever they are found, and in this connection it is unfortunate that no direct stratigraphic data are available for the Lost Chicken Creek wolverine skull (USNM 262527) (Fig. 6), lion mandible (USNM 262536) and the lion paw element (USNM 262537). All carnivore remains were recovered *ex situ*. The fossils are Pleistocene, as *Panthera leo atrox* evidently disappeared from North America around 10 300 yr BP (Kurtén and Anderson, 1980), and the particular wolverine skull recovered at Lost Chicken Creek is that of a

TABLE 5. Biostratigraphic distribution of vertebrate taxa from Lost Chicken Creek placer mine, recovered *in situ* from 1976 to 1979 and 1983

Taxon	Identification no. (USNM)	Unit
Lagopus sp.	262575, rt. 3rd metacarpal	2
Equus (Asinus) lambei	262516, rt. radius	2
	262519, l. ilium	2
	262550, rt. metatarsal	2
	262548, l. metatarsal	2
	262515, 1st phalanx	2
	262522, humerus flake	6
	262512, l. radius	6
	262667, rt. scapula	6
	262666, femur diaphysis	6
	262517, rt. metatarsal	6
	262526, l. metatarsal	9?
Rangifer tarandus	262513, antler fragment	2
	262523, rt. scapula	2
	374418, tibia fragment	2
	372804, antler fragment	3
	372792, antler fragment	4
	262530, l. calcaneum, burned	6
Alces alces	262509, rt. radius	9
Ovibovini		
cf. *Symbos cavifrons*	262529, metacarpal fragment	2
cf. *Ovibos moschatus*	262507, l. scapula, gnawed	6
Bison priscus	263197, l. mandible	2
	262518, rt. humerus	2
	263195, l. humerus	2
	262510, l. humerus	2
	263196, l. ulnar carpal	2
	262514, l. metacarpal	2
	262534, l. tibia	2
	262511, l. metatarsal	2
	374419, 3rd phalanx	2
	374409, humerus flake	2
	262531, rt. metacarpal	4
	262442, rib	5
	262532, l. radio-ulna	6
	262525, l. radio-ulna	9?
	262508, l. metatarsal, burned	6
	262440, metatarsal fragment	6
	262441, metatarsal fragment	6
	372659, skull	8
Bison bison	372665, skull	9
Mammuthus primigenius	262535, skull fragments	2
	263199, scapula	2
	262520, limb bone diaphysis	2
Unidentified bone	262521, chipped flake	2
	262524, diaphysis fragment	6

young adult, larger than early Holocene specimens from Idaho, and only slightly smaller than large late Pleistocene specimens known from Fairbanks (Anderson, written comm. 1984). The Lost Chicken Creek wolverine skull is darkly stained and mottled black, a coloration typical of Wisconsinan fossils from the site (Fig. 6). Parietal, occipital and palatal sutures are unfused, indicating the youth of the animal. Had the wolverine lived to maturity, it may have achieved the outstandingly large size of other Pleistocene Alaska wolverines (Anderson, 1977). C.R. Harington reports that another very large *Gulo* skull (NMC 36149) also was recovered at nearby Hunker Creek, Yukon Territory, in 1979.

TABLE 6. Measurements of *Lagopus* sp. (USNM 262575, right third metacarpal)

1	2	3	4
32.1	9.41	4.1	5.21

1. Maximum proximal-distal length.
2. Maximum anteroposterior width of proximal head of metacarpal.
3. Maximum mediolateral width.
4. M_1 length.

TABLE 7. Measurements of *Gulo gulo* (L.) (USNM 262627, skull)

1	2	3	4	5	6
44.3	77.2	19.5	9.1	7.1	7.6

*Description: Skull with right and left P^3-M′, alveoli of right and left P^{1-2}, portion anterior to P^1 missing. Young adult, sutures open, teeth slightly worn.
1. Lower P^1-M^1.
2. Maximum width from left P^4 to right P^4.
3. Minimum diameter of basiocciput.
4. Left M^1 inner lobe.
5. Left M^1 constriction.
6. Left M^1 outer lobe.

TABLE 8. Measurements of *Panthera leo atrox* (L.) (USNM 262536, left mandible)*

1	2	3	4	5
39.4	25.8	12.2	27.5	13.5

*Description: Left, anterior fragment of mandible, alveoli of left canine and P_4. Probably male lion.
1. Depth of ramus below anterior end of P_4.
2. P_4 length.
3. P_4 width.
4. M_1 length.
5. M_1 width.

TABLE 9. Measurements of *Saiga tatarica* (L.) (USNM 374407, cranium, and USNM 374408, right humerus)

	1	2	3	4	5	6
USNM 374407	50.1	31.2	20.7	75.6	34.6	30.4

1. Width across occipital condyles.
2. Occipital depth (upper) border of foramen magnum to top of nuchal crest.
3. Height of foramen magnum.
4. Minimum width of cranium immediately posterior to horncore bases.
5. Anteroposterior diameter of horncore at burr.
6. Mediolateral diameter of horncore at burr.

	1	2
USNM 374408	43.2	50.5

1. Maximum mediolateral width of proximal head of humerus.
2. Maximum anteroposterior width of proximal head of humerus.

SUMMARY AND CONCLUSIONS

This report describes a late Wisconsinan fauna comprising one invertebrate and 16 vertebrate species from east-central Alaska. The fossil locality at Lost Chicken Creek, Alaska, consists of 37 m of unconsolidated sediments assignable to nine stratigraphic units exposed during large-scale gold placer mining. Taxa represented by fossils at the site are: *Succinea avara*,

FIG. 5. Anterior view of saiga antelope cranium (*Saiga tatarica* [L.]; USNM 374407) recovered *ex situ* at Lost Chicken Creek, Alaska.

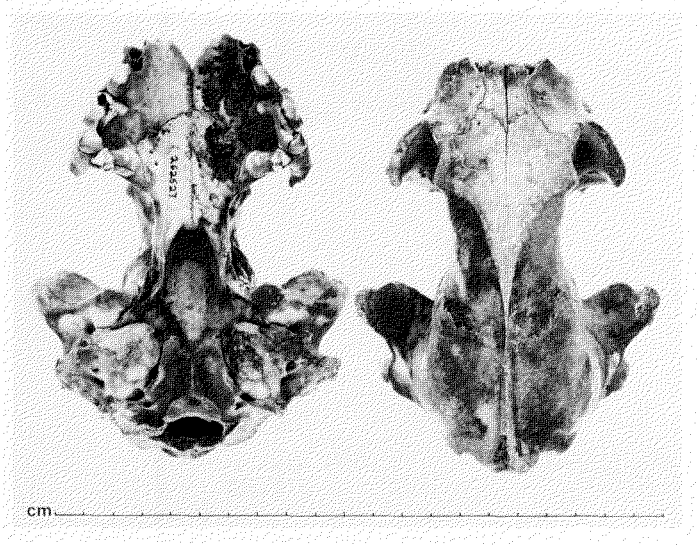

FIG. 6. Wolverine cranium (*Gulo gulo* [L.]; USNM 252627) recovered *ex situ* at Lost Chicken Creek, Alaska.

Lagopus sp., *Gulo gulo, Panthera leo atrox, Dicrostonyx torquatus, Equus (Asinus) lambei, Rangifer tarandus, Alces alces, Cervus elaphus,* unknown Bovid/Cervid species, *Saiga tatarica, Ovis ?dalli, Symbos cavifrons, ?Ovibos moschatus, Bison priscus, Bison bison* and *Mammuthus primigenius.*

The fossil animals of Lost Chicken Creek constitute a typical Goldstream Formation fauna recognized at other eastern Beringian localities. The site is unique in the number of taxa recovered from a single locality (17) and the total number of fossils recovered (1055) and for its large proportion of fossil specimens found *in situ* (46). Lost Chicken Creek has yielded the finest specimen of saiga antelope (*Saiga tatarica*, USNM 374407) recovered in North America and many other excellent and rare specimens of Pleistocene wolverine, ptarmigan, extinct American lion and collared lemmings.

The fauna of Lost Chicken Creek, diverse as it is, shares at least four paleoecologic characteristics significant to the reconstruction of former eastern Beringian climates. These affinities are: (1) an intolerance of deep snow, (2) a preference for open country, (3) a tolerance of continental climates and (4) an abstention from hibernation and estivation, which shield a taxon from threatening environmental conditions. The Lost Chicken Creek fauna represents a hearty cold- and dry-adapted biologic community that lived during the mid-Wisconsinan, late-Wisconsinan and postglacial periods.

Primary geomorphic processes at Lost Chicken Creek during the mid-Wisconsinan, late-Wisconsinan and Holocene are fluvial deposition and erosion, eolian deposition and erosion, and solifluction. Mineralogic and sedimentologic analyses have suggested a local provenance for the sediments of Lost Chicken Creek. Pebbly sands from the creek itself are intercalated with eolian loess sediments deflated locally from the Tanana River valley. Solifluction is responsible for a disturbed biostratigraphy at the site, yielding a fauna that must be considered a thanatocoenosis.

The stratigraphy of Lost Chicken Creek is strikingly similar in general outline to that of at least two other Alaskan localities: Canyon Creek and Eva Creek. Each locality records a cool, dry early Wisconsinan period, a wetter middle Wisconsinan, a distinctive hiatus of Duvanny Yar sedimentation and an abrupt termination of glacial climates between 12 000 and 9000 yr BP. The Holocene of each locality is characterized by an early period of very warm temperatures (ca. 8000 yr BP), followed by a cool period (ca. 7000 yr BP). Holocene climatic amelioration apparently occurred slightly later at Lost Chicken Creek than at other Beringian localities, perhaps due to the site's topographic elevation and geographic insularity.

Finally, an unusual feature of the Lost Chicken Creek fauna is the persistence of two Pleistocene mammal taxa (*Equus* and *Bison*) in sediments radiometrically dated from the early and middle Holocene. The significance of this finding has been pointed out by C.R. Harington (1980a). I affirm that I collected bones of these Pleistocene taxa from sediments less than 9500 yr BP. Only direct dating of the individual fossils can determine whether these fossils are the same age as their encrusting sediments, or whether they are older than their sediments and have been deposited by a means not recognized by this author. These tests have not yet been performed, but I hope they will be in the future.

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