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Late Pleistocene records of felids from Medicine Hat, Alberta, including the first Canadian record of the sabre-toothed cat *Smilodon fatalis*

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Abstract

In the late 1960s, a team led by C. S. Churcher and A. MacS. Stalker collected over 1 000 vertebrate fossils, mostly representing large herbivorous mammals, from bluffs along the South Saskatchewan River near Medicine Hat, Alberta, Canada. The records from this area also include the only documented case of the sabre-toothed cat, *Smilodon fatalis*, but these specimens have not been described or illustrated, and therefore their identification has never been verified. Here, all felid fossils recovered from the Medicine Hat bluffs are described and identified. We confirm the presence of the machairodontine *S. fatalis* and three additional taxa: the feline *Lynx* and the pantherines *Panthera* cf. *P. atrox* (American lion) and *Panthera* cf. *P. spelaea* (cave lion). Notably, this record of *S. fatalis* is its first confirmed occurrence in Canada and is a significant northerly range expansion, bringing the global distribution of this species in line with what is typical for a large felid. Should the tentative record of *Panthera* cf. *P. spelaea* be correct, this would represent its first occurrence in Alberta and a southeastern range extension, bringing it into the range of *P. atrox*. The possible presence of both *P. atrox* and *P. spelaea* suggests that Late Pleistocene pantherine biogeography in North America may be more complex than previously believed, particularly during relatively warm interglacial periods.

Keywords: *Smilodon*, *Panthera*, *Lynx*, sabre-toothed cat, lion, biogeography

36 Introduction

37 Between 1965 and 1970, C. S. Churcher of the Royal Ontario Museum (ROMVP) and A.
38 MacS. Stalker of the Geological Survey of Canada (GSC) conducted fieldwork in the
39 southwestern Canadian prairies (southern Alberta and southwestern Saskatchewan), with the
40 purpose of correlating deposits associated with the Laurentide glaciation (Stalker and Churcher
41 1972). Much of their work took place in and around the city of Medicine Hat in southeastern
42 Alberta (Figure 1), which was particularly suited for their purposes due to the presence of fossil
43 beds within a buried valley exposed in bluffs along the South Saskatchewan River. Of the
44 mammals recovered, artiodactyls (*Antilocapra americana*, *Bison bison*, *Camelops hesternus*, cf.
45 *Hemiauchenia*, *Odocoileus virginianus*, and *Rangifer tarandus*), perissodactyls (*Equus*
46 *conversidens* and *E. scotti*), and proboscideans (*Mammuthus*) predominate, with other
47 mammalian orders represented including carnivorans, lagomorphs, rodents, and at least one
48 xenarthran. While the aforementioned taxa were recorded in faunal lists (e.g. Churcher 1970,
49 1984, Russell and Churcher 1972, Harington 1978), few of these identifications have been
50 verified through description and illustration of the material in the scientific literature (Akersten
51 and McDonald 1991). While felid fossils have been found in Late Pleistocene assemblages from
52 Alberta (e.g. Harington 1971, Burns 1991, Ewald et al. 2018), it has been noted that they are
53 quite rare (Jass et al. 2011). Only eight specimens from the Medicine Hat fauna were identified
54 as felids by C. S. Churcher. Based on specimen labels, felid taxa included in the fauna were *Lynx*
55 *canadensis*, *Panthera atrox*, *Homotherium* sp., and *Smilodon fatalis*. This notably includes the
56 only record of the sabre-toothed cat *Smilodon fatalis* from Canada, an occurrence that would
57 represent a significant northerly range expansion for the species. Here, we describe and illustrate
58 the felid specimens from the Medicine Hat area for the first time and verify their taxonomic

identifications. We then discuss the implications that these occurrences have on the biogeography of felids in North America.

Geological setting

The specimens described here were recovered from a series of Pleistocene rocks laid down as part of a buried valley system that has since been exposed along the South Saskatchewan River near Medicine Hat, Alberta (Figure 1). Stalker and Churcher (1972) based their correlation of the Medicine Hat stratigraphy on 17 bluffs along the river, extending from approximately 11 km west of the city to 13 km northeast. The entire Medicine Hat sequence was divided into 27 units, numbered I (oldest) to XXVII (youngest), consisting of Upper Cretaceous bedrock unconformably overlain by Pre-Illinoian to recent deposits (Stalker 1976). The units consist of tills with layers of sands, silts, clays, and/or gravels in between. Nine of the non-glacial units described by Stalker (1976) are fossiliferous, and Churcher (1984) designated each of these, from youngest to oldest (instead the conventional oldest to youngest), as a fauna numbered from 1 to 9. Three of the faunas discussed in Churcher (1984) – Faunas 4, 5, and 7 – contained felid specimens described herein. Unit XIII (containing Churcher's Fauna 7) is 29 metres thick and consists of sands and gravels with Canadian Shield clasts occurring at the base. Unit XIII is overlain by a dark grey, contorted till, underlain by black till and is considered to be Sangamonian in age (Harington 1978). Unit XXII (containing Churcher's Fauna 5) is a 32-metre-thick unit of silt containing sand and minor clay, is both overlain and underlain by gravel, and is Wisconsinan in age based on radiocarbon dating of wood recovered approximately one to two metres above the faunal remains ($42\,290 \pm 940$ cal. years BP [GSC-1442] and $42\,970 \pm 920$ cal. years BP [GSC-1442-2]; Harington 1978). Unit XXVI (containing Churcher's Fauna 4) is a

24.4-metre-thick unit of sands and gravels, overlain by a yellow-buff till and underlain by a gravel bed (Harington 1978, Churcher 1984). Unit XXVI is interpreted as being Wisconsinan in age (Harington 1978). All three of these faunas were interpreted by Harington (1978) as representing grassland ecosystems.

Materials and methods

As part of their work in the area, C. S. Churcher and A. MacS. Stalker collected 1 224 specimens from the Medicine Hat buried valley. These specimens are now housed in the Vertebrate Palaeontology collection at the Royal Ontario Museum (ROMVP) in Toronto, Ontario, Canada. Detailed locality information for all specimens described here is held at the Royal Ontario Museum and is available to qualified researchers upon request. All specimens that were previously identified as felids by C. S. Churcher were examined. Two of these specimens, including the shaft of a left metatarsal III (ROMVP 71693) originally identified as *Homotherium* sp. and an odontoid process of cervical II (ROMVP 71684) identified as *Smilodon fatalis*, were considered too fragmentary for identification and will not be discussed further. An incomplete right navicular (ROMVP 73586), originally identified as *Panthera atrox*, was determined to not belong to any felid and thus will also not be discussed further.

The specimens described here were compared with material from the Vertebrate Palaeontology and Mammalogy collections at the ROM, the Canadian Museum of Nature (CMN) in Ottawa, Ontario, Canada, and the Florida Museum of Natural History (FLMNH) in Gainesville, Florida, USA, as well as the published literature. A list of specimens used for the bulk of comparative work can be found in Table S1. Previously published radiocarbon dates, where discussed, have been calibrated using OxCal 4.3 online. Computed tomography scans of

some specimens (ROMVP 71566, ROMVP 04321 E, ROMVP 28842, and ROMVP 44951) were taken at Spatio-temporal Targeting and Amplification of Radiation Response (STTARR) imaging facility located in the MaRS Discovery District in Toronto. These scans were used to generate 3D surface models using Avizo Lite 9.4.0 (FEI, Hillsboro, United States). All measurements reported here were collected by ARR or KLS using calipers or taken from the literature where indicated. Taphonomic weathering stage is reported following Behrensmeyer (1978). Range sizes for several large cat species were either taken from the literature, or were estimated by ARR by mapping known localities onto a map and calculating an estimated geographic distribution using ImageJ.

Results

Systematic palaeontology

Order Carnivora Bowdich 1821
Suborder Feliformia Kretzoi 1945
Family Felidae Fischer von Waldheim 1817
Subfamily Machairodontinae Gill 1872
Genus *Smilodon* Lund 1842
Smilodon fatalis Leidy 1868

Referred Material – ROMVP 71566, incomplete right metacarpal V, proximal half (Figure 2).

Locality and Horizon – Surprise Bluff, on the south bank of the South Saskatchewan River upstream from Medicine Hat, Alberta and north of the water reservoir. From Medicine Hat Unit

128 XXII (Fauna 5, Wisconsinan) or Unit XXVI (Fauna 4, Wisconsinan, radiocarbon dated wood
129 from one to two metres above faunal remains dated as $42\,290 \pm 940$ cal. years BP (GSC-1442)
130 and $42\,970 \pm 920$ cal. years BP (GSC-1442-2); Harington 1978, Churcher 1984).

131
132 *Description* – The proximal part of a right metacarpal V (Figure 2, Table 1) is from an adult
133 individual based on epiphyseal fusion, is broken at midshaft, and shows Stage 3 weathering. The
134 element is robust, as is characteristic for the sabre-toothed cat *Smilodon fatalis*, and is far more
135 robust than any contemporaneous canids, such as *Canis dirus*. The linear shape of the attachment
136 for the *flexor brevis minimi digiti* indicates that this belongs to a felid rather than an ursid of
137 similar size. The angle between the proximal and dorsal surfaces of the unciform facet is
138 relatively obtuse, as in the machairodontine cats *Smilodon* and *Homotherium* and unlike
139 *Panthera atrox* (Figure 3). Although the distal part is missing, there is an increase in transverse
140 width toward the point of breakage, suggesting that the element was broken past the midpoint
141 and the total length of the element would be quite short, a feature characteristic of dirk-toothed
142 machairodontine cats, including *S. fatalis*. The attachment site for the *flexor brevis minimi digiti*
143 (Jayne 1898), is located proximally rather than midshaft to distal as in the scimitar-toothed
144 *Homotherium*. This muscle scar is absent in specimens of *P. atrox* and is V-shaped in ursids. The
145 proximal notch on the articular surface for metacarpal IV is difficult to discern due to weathering
146 but appears to be relatively broad as in *S. fatalis*, rather than narrow as in *P. atrox* and *H. serum*.
147 The distal protuberance of the articular surface is longitudinally oriented, as is seen in *S. fatalis*,
148 *Panthera atrox*, and ursids; the same articular surface is oriented in the dorsopalmar plane in
149 *Homotherium*.

150

Comments – ROMVP 71566 was originally identified by C. S. Churcher as *Smilodon fatalis* and we agree that the morphology of the element is consistent with a dirk-toothed cat in the genus *Smilodon*. Since *Smilodon fatalis* was the only species of this genus present in North America during the Late Pleistocene, we thus assign it to this species. The transverse width of the proximal end of ROMVP 71566 is smaller than any reported from Rancho La Brea, which may be due to weathering and abrasion on the articular surfaces of the specimen. It may also simply be the case that individuals in this region were smaller, since it has been reported that *S. fatalis* from the Peruvian site Talara are on average smaller than those at Rancho La Brea (Seymour et al. 2018).

Subfamily Pantherinae Pocock 1917

Genus *Panthera* Oken 1816

Panthera cf. *P. spelaea* Goldfuss 1810

Referred Material – ROMVP 71606, incomplete left ulna, lacking olecranon process and distal quarter (Figure 4).

Locality and Horizon – Galt Island Bluff, on the north bank of the South Saskatchewan River just southwest of Redcliff, Alberta. From Medicine Hat Unit XXII (Fauna 5, Wisconsinan, ~42 500 cal. years BP; Churcher 1984).

173 *Description* – The ulna (Figure 4) shows Stage 2 weathering and is incomplete, with the
174 olecranon process and distal part missing; due to this, the state of epiphyseal fusion cannot be
175 determined, but bone texture, size, and strong development of muscle scars suggest that the
176 element belongs to an adult individual. The distal end of ROMVP 71606 is broken at a similar
177 position to where the distal epiphysis is present in *S. fatalis*, suggesting that the total length of
178 this element would be longer than in *S. fatalis*. The medial surface of the trochlear notch is broad
179 and flares so that it is broader proximally than distally. The lateral side of the shaft, directly
180 distal to the radial notch, is flat. This surface is flat or convex in *Panthera* and *Smilodon* and is
181 depressed anteriorly in *Homotherium serum*. In lateral view, the posterior margin of the shaft is
182 straight and lacks the pronounced concave profile of *Homotherium*. The attachment site for the
183 interosseous membrane is broad proximally, tapers toward its distal end, and is ridged on its
184 posterior edge, as in pantherine cats.

186 *Comments* – This element was originally identified by C. S. Churcher as *S. fatalis* but is too long
187 relative to known *S. fatalis* specimens and more closely resembles a pantherine morphologically.
188 Three pantherine cats are known from the Middle to Late Pleistocene of northern North America:
189 *P. atrox* (United States, Mexico, and Alberta; Harington 1971, Kurtén 1985), *P. onca* (United
190 States as far north as Oregon; Kurtén and Anderson 1980, Seymour 1983), and *P. spelaea*
191 (Beringia including Alaska and Yukon; Kurtén 1985). It is unlikely the ulna belongs to *P. onca*
192 due to its larger size, since only a single measurement of ROMVP 71606 overlaps with those of
193 *P. onca* (Table 2). Likewise, all measurements are smaller than any reported by Merriam and
194 Stock (1932) for *P. atrox* from Rancho La Brea in Los Angeles, California, USA (Table 2), and
195 the posterior edge of the shaft appears to be straighter in lateral view. Three of the four

measurements taken overlap with the ranges for both *P. spelaea* and *S. fatalis*, but ROMVP 71606 is estimated to be too long to represent *Smilodon* and morphologically more closely resembles a pantherine cat. Thus, we tentatively refer this specimen to *Panthera* cf. *P. spelaea*.

Panthera cf. *P. atrox* Leidy 1853

Referred Material – ROMVP 73568, left metatarsal IV, distal third only; ROMVP 73569, left metatarsal IV, proximal half (Figure 5).

Locality and Horizon – Mitchell Bluff, on the convex side of the sixth meander downstream from the railway bridge in Medicine Hat, Alberta. From Medicine Hat Unit XIII (Fauna 7, Sangamonian, Churcher 1984).

Description – Both proximal and distal parts of the left metatarsal IV (Figure 5, Table 3) show Stage 3 weathering. The size of the distal portion is consistent with that of the proximal portion and thus the two parts are possibly associated, but their proximity *in situ* is unclear based on available data. ROMVP 73568 lacks the pronounced curvature of the distal metatarsal IV in *S. fatalis* and shows no sign of a scar for the origin for the third *plantar interosseous*, which in *H. serum* extends distally to where this specimen is broken. The proximal half is more massive and broader than in either *Smilodon* or *Homotherium* and is more similar to *Panthera atrox*. The articulation with the cuboid is broad and extends fully to the plantar side of the proximal surface; the same articulation is relatively narrow in ursids, *S. fatalis*, and *H. serum* and truncates before the plantar margin in *S. fatalis*. The lateral tuberosity on the plantar side of the cuboid facet is

219 more pronounced than that seen in *H. serum* or *Panthera spelaea*, but is less extensive than in *S.*
220 *fatalis*; this projection is absent altogether in ursids. There is a distinct groove between the
221 cuboid facet and lateral tuberosity in ROMVP 73569, which is present in *Panthera atrox* but
222 absent in *Panthera spelaea*. The dorsal articular surface with metatarsal III is long and oriented
223 relatively dorsopalmarly, as in *Panthera atrox*, rather than being relatively short and
224 longitudinally oriented in *Panthera spelaea*. The origin for the third *plantar interosseous* is
225 proximally located and consists of a flattened rugose region; the same origin is raised in *S. fatalis*
226 and both raised and located more distally in *H. serum*.

227
228 *Comments* – ROMVP 73568 and ROMVP 73569 were originally identified by C. S. Churcher as
229 *Panthera atrox*, with which we agree. We tentatively assign the metatarsal IV as *Panthera* cf. *P.*
230 *atrox*, pending a better sample of pantherine material from this horizon and a more complete
231 understanding of how intraspecific variation may impact our interpretation of the characters
232 discussed above.

233 The taxonomic status of *Panthera atrox* has been historically contentious, with it
234 alternatively being considered a subspecies of the extant lion *P. leo* (e.g. Kurtén 1985, Burger et
235 al. 2004), or its own species of pantherine cat (e.g. Merriam and Stock 1932, Simpson 1941,
236 Christiansen 2008, Christiansen and Harris 2009). In either case, it is typically regarded as being
237 closely related to the cave lion *P. spelaea*, but the inclusion of both taxa within a single analysis
238 of pantherine phylogenetic relationships is rare, making assessments of the relationships and
239 taxonomy of extant and Pleistocene big cats difficult. Phylogenetic analysis based on
240 craniomandibular, soft tissue, and ethological characters resolved a “lion clade” of (((*leo* +
241 *pardus*) *atrox*) *spelaea*) (Christiansen 2008). Thus, neither *P. atrox* nor *P. spelaea* can be

considered subspecies of *P. leo* and each should be their own species. Fragments of the mitochondrial hypervariable region 1 (HVR1) and *ATP8* suggest that *P. atrox* and *P. spelaea* are sister taxa, forming a “lion clade” of ((*atrox* + *spelaea*) *leo*) (Barnett et al. 2009). In this analysis, the authors considered both *P. atrox* and *P. spelaea* to be subspecies of *P. leo*, forming a distinct clade separate from all modern lions. However, based on mitogenomic analyses, *P. spelaea* and *P. leo* are sufficiently different for the former to be considered a species rather than a subspecies (Barnett et al. 2016). Should previous genetic work suggesting *P. atrox* and *P. spelaea* are sister taxa to the exclusion of *P. leo* be correct, and *P. spelaea* is not a subspecies of *P. leo*, then *P. atrox* is likewise not a subspecies of *P. leo*. Rather, *P. atrox* is either a species (*P. atrox*), or a subspecies within *P. spelaea* (*P. spelaea atrox*). Further work including a broad sample of pantherine taxa will be required to fully resolve this issue, but for the purposes of this paper we refer this taxon to *P. atrox*.

Subfamily Felinae Fischer von Waldheim 1817

Lynx sp. Kerr 1792

Referred Material – ROMVP 73744, left P₄, anterior accessory cusp and mesial root broken (Figure 6).

Locality and Horizon – Mitchell Bluff, on the convex side of the sixth meander downstream from the railway bridge in Medicine Hat, Alberta. From Medicine Hat Unit XIII (Fauna 7, Sangamonian, Churcher 1984).

265 *Description* – The P₄ (Figure 6, Table 4) is broken at the paraconid and exhibits light to moderate
266 tooth wear on the crown. The protoconid is spade-shaped and is more pronounced and elongated
267 mesiodistally than in any similarly-sized caniforms. The metaconid is pronounced above the
268 cingulum, which is projected distally. A lingual accessory cusp is absent.

269
270 *Comments* – ROMVP 73744 was identified by C. S. Churcher as *Lynx canadensis*, and the size
271 of the tooth compares favourably with Recent *L. canadensis*, which is typically larger than
272 Recent *L. rufus*. However, the P₄ of Pleistocene *L. rufus* was larger than today, and thus size
273 alone may therefore not be sufficient for assignment to *L. canadensis* (Merriam and Stock 1932).
274 While Medicine Hat currently falls within the geographic range of *L. rufus* and not *L.*
275 *canadensis*, a colder climate during the Late Pleistocene may have made this region more
276 suitable for the latter. Given this uncertainty in Pleistocene range and potential overlap in size
277 between *L. rufus* and *L. canadensis*, we identify this element as *Lynx* sp.

279 **Discussion**

280 *Smilodon fatalis* in Canada

281 Two species of *Smilodon* are found in North America during the Pleistocene: *Smilodon*
282 *gracilis* in the Blancan to early Irvingtonian land mammal ages and *Smilodon fatalis* in the late
283 Irvingtonian to Rancholabrean (Kurtén and Anderson 1980). Previously, *S. fatalis* has been
284 documented across much of the United States as well as in Mexico, Ecuador, Peru, and Uruguay,
285 but has only been identified as far north as American Falls in Idaho, USA (Pinsof 1998). Thus,
286 the Medicine Hat specimen represents the most northerly record of the species by about 1 000
287 km and is the only material of *Smilodon fatalis* from anywhere in Canada (Figure 7). Previously,

the species was referenced in faunal lists for this locality (Churcher 1970, 1984, Russell and Churcher 1972, Harington 1978), but it was never properly documented through comparative description of the material. Here, we assessed two specimens that were previously identified as *Smilodon* by C.S. Churcher: a metacarpal V (ROMVP 71566), for which we agree with the diagnosis, and an ulna (ROMVP 71606), which we here tentatively assign to the cave lion, *Panthera* cf. *P. spelaea*. With the addition of Medicine Hat, the estimated Late Pleistocene distribution for *S. fatalis* is at least 12 400 000 km², which, while time-averaged (and thus likely representing a maximum bound), falls within the range documented for extant large felids (Table 5). It also confirms the presence of a hallmark Rancholabrean carnivore in the southern Alberta fauna of the Late Pleistocene, suggesting that the large carnivore guild may have closely resembled those typically found in the United States (Kurtén and Anderson 1980, Stock and Harris 2001, Bell et al. 2004). Given the broad distribution of most large felids (Table 5), the presence of *S. fatalis* in the non-glaciated areas of Pleistocene Canada should be expected, and the lack of fossil evidence is at least in part due to the typical rarity of carnivorans in fossil deposits that are not carnivore traps such as the asphalt seeps at Rancho La Brea in Los Angeles, California, USA (Martin 1989).

Biogeography of North American *Panthera*

Typically, two Pleistocene lions are recognized from North America: *Panthera spelaea* in Alaska and Yukon, and *P. atrox* in all other areas, including as far north as Edmonton, AB (Harington 1971, Burns and Young 1994). Indeed, it has been proposed that the Late Pleistocene fauna of eastern Beringia is distinct from the Rancholabrean fauna south of a relatively data-poor region at around 55°N (Bell et al. 2004). Unfortunately, ROMVP 71606 is too fragmentary to

311 identify with certainty. However, should our tentative identification of the ulna as *Panthera* cf.
312 *P. spelaea* be correct, this would mark an occurrence of this taxon over 500 km south of where it
313 would otherwise be expected to occur as part of the Pleistocene Beringian fauna, as well as its
314 only Canadian record outside of the Yukon. Typically, *P. atrox* is exclusive to the
315 Rancholabrean fauna of southern North America, while *P. spelaea* is likewise exclusive to the
316 Beringian fauna; the possible occurrence of both lions in Medicine Hat could complicate our
317 understanding of their biogeography should definitive material of *P. spelaea* be found. Due to
318 Medicine Hat's location between the Cordilleran and Laurentide ice sheets, it is plausible that
319 regional deglaciation (and thus recolonisation of these areas as they became habitable again) may
320 have allowed some Beringian fauna, such as *P. spelaea*, to migrate further south than their usual
321 range. A similar mechanism has been proposed to explain the presence of Beringian wolves at
322 Natural Trap Cave, Wyoming, USA (Meachen et al. 2016). Currently, only three Canadian
323 localities outside the Yukon have produced *Panthera* material: Blindloss, Alberta (Harington
324 1971), Pit 48 near Edmonton, Alberta (Burns and Young 1994), and Medicine Hat, Alberta
325 (discussed here). With such a scant fossil record, and without detailed comparisons between
326 known postcrania of *P. atrox* and *P. spelaea*, it is difficult to ascertain if both Pleistocene lions
327 were present in Alberta, but this possibility should be considered when further data are obtained.

328

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Tables

Table 1. Comparative measurements (mm) of metacarpal V.

	ROMVP 71566	<i>Panthera atrox</i> ^a	<i>Panthera onca</i> /augusta	<i>Smilodon fatalis</i> ^a
Greatest transverse width of proximal end	16.3	24.9 – 30.0 (n = 6)	16.0 – 21.4 (n = 18)	20.1 – 28.8 (n = 1478)
Greatest dorsoventral width of proximal end	24.5	27.0 – 33.2 (n = 6)	18.4 – 22.7 (n = 17)	23.3 – 32.2 (n = 1478)
Transverse width at midshaft	16.3	14.2 – 17.6 (n = 6)	11.0 – 13.2 (n = 15)	12.9 – 17.9 (n = 1478)
Dorsoventral width at midshaft	13.0	12.2 – 15.8 (n = 6)	-	10.8 – 16.1 (n = 1478)

a. From Merriam and Stock 1932

Table 2. Comparative measurements (mm) of ulna.

	ROMVP 71606	<i>Panthera</i> <i>atrox</i> ^a	<i>Panthera</i> <i>spelaea</i>	<i>Panthera</i> <i>onca</i> /augusta	<i>Smilodon</i> <i>fatalis</i> ^a
Greatest transverse width of trochlear notch	30.9	48.0 – 69.7 (n = 7)	39.0 – 44.5 (n = 3)	33.2 – 43.5 (n = 8)	41.5 – 60.2 (n = 10)
Anteroposterior width from posterior border to top of coronoid process	61.4	68.5 – 87.5 (n = 7)	59.8 – 71.7 (n = 8)	42.9 – 57.7 (n = 10)	57.3 – 78.8 (n = 10)
Anteroposterior width of diaphysis at proximal end of tendon scar	38.6	42.5 – 57.7 (n = 7)	37.4 – 46.0 (n = 8)	29.0 – 33.5 (n = 12)	30.0 – 47.6 (n = 10)
Transverse width of diaphysis at proximal end of tendon scar	20.4	20.7 – 24.7 (n = 7)	16.0 – 22.4 (n = 8)	13.7 – 18.2 (n = 12)	19.8 – 29.9 (n = 10)

a. From Merriam and Stock 1932

Table 3. Comparative measurements (mm) of metatarsal IV.

	ROMVP 73568	ROMVP 73569	<i>Panthera</i> <i>atrox</i> ^a	<i>Panthera</i> <i>onca</i> <i>/augusta</i>	<i>Smilodon</i> <i>fatalis</i> ^a
Greatest transverse width of proximal end	-	20.9	18.7 – 25.8 (n = 65)	18.7 – 24.6 (n = 20)	16.1 – 19.9 (n = 1210)
Greatest dorsoventral width of proximal end	-	33.5	28.7 – 35.0 (n = 65)	20.5 – 26.4 (n = 20)	25.8 – 30.9 (n = 1210)
Greatest transverse width of distal end	22.7	-	21.7 – 27.7 (n = 65)	15.6 – 20.9 (n = 17)	18.5 – 25.2 (n = 1210)
Greatest dorsoventral width of distal end	21.7	-	-	15.6 – 20.5 (n = 15)	-

a. From Merriam and Stock 1932

Table 4. Comparative measurements (mm) of fourth lower premolar.

	ROMVP	<i>Lynx</i>	<i>Lynx rufus</i>	<i>Lynx rufus</i>
	73744	<i>canadensis</i> ^a	(fossil) ^a	(recent) ^a
Greatest mesiodistal width	-	10.1 – 11.2 (n = 13)	10.1 – 10.4 (n = 3)	8.1 – 10.0 (n = 39)
Greatest buccolingual width	5.4	4.5 – 5.2 (n = 13)	4.9 – 5.2 (n = 3)	4.0 – 4.7 (n = 39)

a. From Merriam and Stock 1932

Table 5. Comparative historic range sizes (km²) of large felids

Species	Range	Reference(s)
<i>Smilodon fatalis</i>	12,400,000	this study
<i>Acinonyx jubatus</i>	10,740,000	IUCN SSC 2007a, 2007b
<i>Panthera leo</i> ^a	20,220,000	Bauer 2008
<i>Panthera pardus</i>	34,670,000	Jacobson et al. 2016
<i>Panthera onca</i>	19,100,000	Sanderson et al. 2002
<i>Panthera tigris</i>	16,610,000	Dinerstein et al. 2005
<i>Puma concolor</i>	28,260,000	Laliberte and Ripple 2004, Nielsen et al. 2015

a. African populations only

NOTE: Range sizes are rounded to the nearest 10 000 km²

Figure 1. (A) Map of southern Alberta with major cities and rivers indicated. Medicine Hat is indicated with a star. (B) Photograph of Surprise Bluff, a locality that produced material identified as *Smilodon fatalis*.

181x62mm (300 x 300 DPI)

Figure 2. *Smilodon fatalis*, ROM 71566, partial right metacarpal V in (A) dorsal, (B) medial, (C) palmar, (D) lateral, and (E) proximal views. Scale bar is 2 cm.

181x79mm (300 x 300 DPI)

Figure 3. (A – E) *Smilodon fatalis*, ROM 71566, partial right metacarpal V in (A) dorsal, (B) palmar, (C) proximal, (D) lateral, and (E) medial views. (F – G) *Smilodon fatalis*, ROM 4321E, right metacarpal V in (F) palmar and (G) medial views. (H – I) *Homotherium serum*, ROM 28842 (cast of TMM 933-2570), reflected left metacarpal V, in (H) palmar and (I) medial views. (J – K) *Panthera atrox*, ROM 44951, reflected left metacarpal V, in (J) palmar and (K) medial views. dp: distal protuberance of articular surface with metacarpal IV; lt: lateral tuberosity; mc4: articular surface with metacarpal IV; ms: muscle scar; u: articular surface with unciform. Scale bar is 2 cm.

181x236mm (300 x 300 DPI)

Figure 4. *Panthera cf. spelaea*, ROM 71606, partial left ulna in (A) lateral, (B) posterior, (C) medial, and (D) anterior views. io: attachment site for interosseous membrane; rn: radial notch; tn: trochlear notch. Scale bar is 5 cm.

181x149mm (300 x 300 DPI)

Figure 5. (A – E) *Panthera cf. atrox*, ROM 73569, proximal part of left metatarsal IV in (A) dorsal, (B) medial, (C) plantar, (D) lateral, and (E) proximal views. (F – J) *Panthera cf. atrox*, ROM 73568, distal part of left metatarsal IV in (F) dorsal, (G) medial, (H) plantar, (I) lateral, and (J) distal views. cu: articulation with cuboid; mt3: articulation with metatarsal III; mt5: articulation with metatarsal V; pi: origin for the plantar interosseous. Scale bar is 5 cm.

181x175mm (300 x 300 DPI)

Figure 6. *Lynx* sp., ROM 73744, left P4 missing mesial root in (A) buccal, (B) lingual, and (C) occlusal views. Scale bar is 1 cm.

85x52mm (300 x 300 DPI)

Figure 7. Map of North America, with the estimated range of *Smilodon fatalis* in grey. The Surprise Bluff locality is indicated with a star.

85x99mm (300 x 300 DPI)