SKULL AND SKELETAL REMAINS OF A RUMINANT OF THE PREPTOCERAS-EUCERATHERIUM GROUP

FROM THE

McKITTRICK PLEISTOCENE, CALIFORNIA

BY

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CONTENTS

INTRODUCTION

In studies of the Pleistocene mammalian assemblages of California the ruminant genera *Preptoceras* and *Euceratherium* have come to be regarded as characteristic of the faunas known from cave deposits of the State. Although the record of mammalian life at Rancho La Brea is unusually complete, it is noteworthy that no trace of these ungulates has been found. With continuation of excavations in the asphalt deposit of McKittrick, Kern County, situated between the occurrence in Los Angeles and the cave deposits of northern California, the discovery of remains of one of these ruminants by Mr. Charles H. Sternberg adds a new and important member to the list of mammals recorded from this horizon.

The recognition of a representative of the *Preptoceras-Euceratherium* group in the McKittrick fauna lends strength to the belief that a faunal difference exists between the McKittrick and Rancho La Brea stages of the Pleistocene which cannot be wholly accounted for by a geographic separation of the deposits. The occurrence of a member of this group and of a llama[1] (*Lama stevensi*) at McKittrick

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[1] Merriam, J. C., and Stock, C., Carnegie Institution of Washington, Publication 347, pp. 37–42, 1925.

and the absence of these mammals at Rancho La Brea strongly suggest that similar environmental conditions did not prevail at the two localities and may furnish evidence in support of the view that the two faunas were not contemporaneous. A solution of the problem of time relationship of the two asphalt assemblages appears to possess fundamental importance in any attempt to establish a faunal succession for the Pleistocene of western North America.

The illustrations have been prepared by Mr. John L. Ridgway of the Carnegie Institution of Washington.

DESCRIPTION OF MATERIAL

PREPTOCERAS? cf. SINCLAIRI Furlong

Locality.—McKittrick Pleistocene asphalt deposits, U. C. loc. 7139. No. 27118, U. C. Mus. Pal. Vert. Coll.

The materials available include a fragmentary skull with incomplete horn cores, complete cheek-tooth series of one side, and a nearly complete ramus with incisors and canine of the lower dentition missing. The posterior cannon bones, astragalus, cubo-navicular and phalangeal elements (no. 27119 Mus. Pal. U. C.) are presumably to be referred to the individual represented by the skull.

In no. 27118, all the permanent premolars and molars are in function and M^3 is only slightly worn. Judging from the state of wear of the teeth, no. 27118 belonged to an older individual than those of *Preptoceras* represented by specimens nos. 8896 and 1109 U. C. Mus. Pal. Vert. Coll. from Samwel Cave, but was not so old as that represented by the type specimen of *Euceratherium,* no. 8751 U. C. Mus. Pal. Vert. Coll. The individual from the McKittrick Pleistocene resembles in size *Preptoceras sinclairi* and is slightly larger than the type of *Euceratherium collinum,* both from the Samwel Cave deposit.

Horn cores.—The horn cores in no. 27118 have a shape and curvature, in so far as these characters can be determined from the structures preserved, like those in the type specimen of *P. sinclairi.* Some resemblance is seen when the McKittrick form is compared with the type of *Euceratherium.* The horn cores are certainly much stouter than those of the type of *Euceratherium,* no. 8751, in which respect they are like those in *Preptoceras.* At the base of these structures the long diameter (anteroposterior) through the core is close to that in the type of *Preptoceras,* no. 8896, but the diameter taken normal

to the long diameter is greater in the McKittrick specimen. On the right side of the skull the horn core extends approximately 90 mm. from the side of the cranium. Two separate sections of a horn core, belonging to the outer half, are present in the collection and apparently belong to the right side of no. 27118. Unfortunately, the sections cannot now be connected with the basal portion of the horn core in the McKittrick skull. The horn core is flattened near the base, while toward the outer end it has a circular cross-section. The surface is marked by ridges and vascular canals, which are particularly in evidence on the lower posterior and anterior sides. The basal portions of the horn cores approach each other more closely than in *P. sinclairi,* distinctly more so than in *Preptoceras mayfieldi* from the Rock Creek Pleistocene of Texas, and less so than in *Euceratherium.* A transverse measurement taken across the frontals and between the outer lower borders of the horn cores is much greater in no. 27118 than in *Euceratherium,* and is comparable to that in *P. sinclairi.*

Important differences in size and in curvature of the horn cores have been generally regarded to exist between *Preptoceras* and *Euceratherium.* In *Preptoceras* the horn cores are stouter and are situated farther apart at the base than in *Euceratherium.* In the latter genus the horn core in its backward and outward curve reaches a point, measured from the dorsoposterior rim of the orbit to the posterior or upper surface of the horn core, which is distinctly farther back than in *Preptoceras.* When measured vertically in the plane of the occiput, the upper border of the horn core in *Euceratherium* is farther removed from the ventral border of the occipital condyle than in *Preptoceras.* In *Preptoceras,* the horn cores extend farther out from the skull than in the type of *Euceratherium.* In the latter specimen the horn core is elliptical in cross-section near the base, but becomes circular near the outer end. As noted by Furlong, the anterior surface of the proximal two-thirds of the horn core in *Preptoceras* is flattened while the posterior surface is strongly convex.

In no. 27118 from McKittrick, the flattening of the anterior surface of the proximal portion of the horn core is better expressed than in no. 8896. The greatest distance behind the dorsoposterior rim of the orbit reached by the posterior or upper surface of the horn core in its backward and outward curve from the skull is comparable to that in *Euceratherium.* Since the proximal portion is much larger than in the latter genus, the anterior or lower surface is not so far removed from the orbital rim as that in the type of *Euceratherium,*

and the distance is more nearly equal to that in the type of *Preptoceras.* A measurement taken vertically in the plane of the occiput from the inferior border of the occipital condyle to the superior border of the horn core gives a height which exceeds that in *Preptoceras* and closely corresponds to that in *Euceratherium.*

The McKittrick species appears to resemble *Preptoceras* in some characters of the horn cores, while in other characters it is like *Euceratherium.* The resemblance to *Preptoceras* is seen chiefly in the size and shape of the proximal portion of the horn core and in the extent to which this portion reaches outward and backward from the skull before curving forward. With orientation of the separate distal sections in the McKittrick specimen, a curvature is given to the horn core which presumably is like that in *Preptoceras,* although suggestive at least of that seen in *Euceratherium.*

While the lower anterior border of the horn core in no. 27118 reaches in its outward and backward curve a point behind the orbital rim comparable to that reached in *Preptoceras,* the opposite border is much farther removed, in which respect no. 27118 is more like *Euceratherium.* The upper portion of the horn core also reaches farther above the inferior border of the condyle, measured in the plane of the occiput, as in *Euceratherium.* Furthermore, the horn cores are more closely placed than in *Preptoceras,* less so than in *Euceratherium.*

It appears reasonable to suppose that in a skull like this one from McKittrick, with, however, completely preserved horn cores, a resemblance to *Euceratherium* would be more clearly indicated. Possibly no. 27118 belongs to a eucerathere. On the other hand there may be drawn, perhaps, from the comparisons which have been made, an inference that the characters presented in the horn cores which distinguish *Preptoceras* from *Euceratherium* are not sharply defined and are subject to considerable variation within a single group.

A horn core in the paleontological collections of the University of California obtained many years ago from gravels of the Klamath River, thirty feet below water level, at Gottville, Siskiyou County, California, is of interest in the present study since it probably belongs to a member of the *Preptoceras-Euceratherium* group. This specimen, no. 2337, U. C. Mus. Pal. Vert. Coll., has been generally regarded as belonging to *Euceratherium,* although a description of the material has never been published. No. 2337, shown in figure 1, has a shape and curvature very much like that in the type specimen of *Euceratherium.* No. 2337 differs, however, from the horn core in no. 8751 in being

decidedly larger, in which respect it resembles more the horn core of the McKittrick specimen. The proximal half is distinctly compressed in a direction transverse to the long diameter, and in this character no. 2337 differs quite noticeably from the McKittrick form. The distal third does not appear to have been so large as that in no. 27118 from McKittrick, and the outer posterior surface is flatter. In no. 2337 the proximal portion extends farther out from the base before turning forward, than in no. 27118.

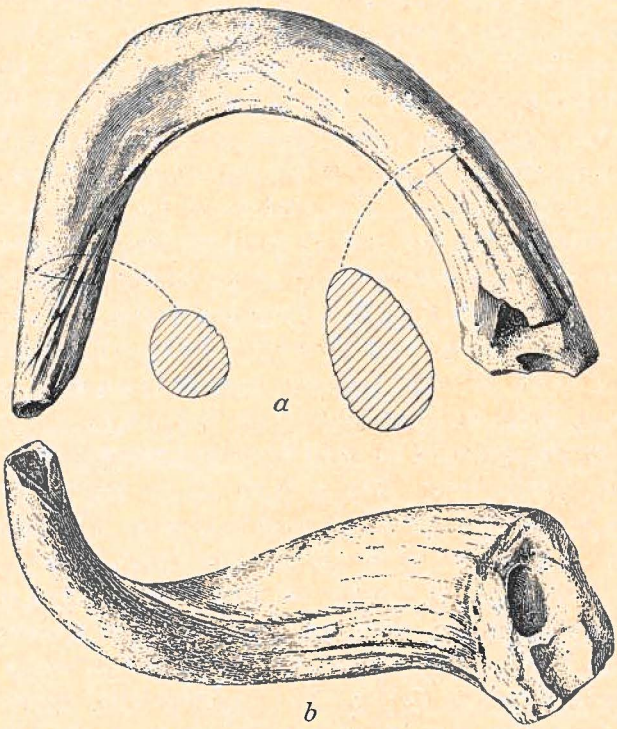

Fig. 1. *Euceratherium* sp. Right horn core, no. 2337 U. C. Mus. Pal. Vert. Coll. Two views with cross-sections; × 0.25. Klamath River, Gottville, Siskiyou County, California.

Presuming that the specimen from the Klamath River gravels has been rightly identified as belonging to *Euceratherium,* considerable variation in size of horn core is seen to exist in this genus, and in this latter character *Euceratherium* may resemble *Preptoceras.* On the other hand, no. 2337 differs as much in shape and curvature from the type of *Preptoceras* as does the type of *Euceratherium.* Unfortunately, the horn core in the skull from McKittrick is not sufficiently well preserved to permit a decision as to the extent of similarity in

shape and curvature of horn core between no. 27118 and no. 2337. It appears within the range of possibility, however, to recognize a greater resemblance between no. 27118 and no. 2337 than exists between the latter specimen and the type of *Preptoceras.*

Cranium.—The frontals rise in their backward extent from the fronto-nasal suture to the horn cores. In side view of the skull (pl. 61), this is expressed in an elevation of the forehead region somewhat like that in *Preptoceras.* The elevation is, however, not so pronounced as in no. 1009 of *Preptoceras* from Samwel Cave, but appears to be slightly more evident than in *Euceratherium.* Between the orbital rims the frontals have a width similar to that in the type of *Euceratherium* and like that in the skull of *P. sinclairi,* no. 1009. The supra-orbital foramina are situated 33 mm. from the orbital rim. The orbits are distinctly less tubular and do not protrude so much as in the living musk ox. The surface of the lachrymal is more depressed than in the skulls of *Preptoceras* from the cave deposit. The difference may be ascribed to age, since the cave specimens belong to younger individuals than that from McKittrick. In the type of *Euceratherium,* however, the surface of the lachrymal is less depressed than in no. 27118, although the skull belongs to an older individual than those of *Preptoceras* and that from McKittrick.

The forward portion of the skull is poorly preserved and the nasals are largely broken away. The position of the fronto-nasal suture appears to be slightly farther back than in *Ovibos.* The nasal indents the frontal to a greater extent than in the living musk ox. In no. 27118, as in the skulls of *Preptoceras* from Samwel Cave, the maxillary eminence is situated above M^1. In the musk ox this eminence is situated above M^2. The infra-orbital foramen has also a position farther forward than in *Ovibos.* The maxillopalatine suture appears to extend forward to a point between the anterior ends of the second superior molars. The postnarial notch is V-shaped and narrow, resembling that in *Euceratherium.* In no. 1009 of *Preptoceras* the notch is broader, but the difference in breadth may be due, at least in part, to the imperfect preservation of the borders. The notch is like that in no. 1009 and differs from that in *Euceratherium* in reaching farther forward. In no. 27118 as in no. 1009, the posterior narial notch reaches forward to a point opposite the posterior lobe of M^3. In the type of *Euceratherium,* no. 8751, the anterior end of the notch is opposite the posterior ends of the third superior molars. It should be recalled, however, that no. 8751, judging from the state of wear of

the teeth, belongs to an older individual than those represented by skulls, nos. 1009 and 27118. On each side of the posterior narial opening in no. 27118 occurs an indentation of the palatine, which does not quite reach forward to a point opposite the anterior border of the opening. Similar indentations are to be seen in no. 1009. In *Euceratherium,* as might be expected from the more posterior position of the postnarial notch, no decided indentation of the palatine is to be seen on either side of the opening. In an adult skull of *Ovibos* in the University collections, in which the permanent cheek teeth are more worn than in no. 27118 from McKittrick, the postnarial notch is broader and is situated decidedly farther back than in *Preptoceras* or in *Euceratherium.* The indentation of the palatine on each side of this notch reaches distinctly beyond the anterior end of the postnarial notch, but does not reach a point opposite M^3. In the series of skulls of *Ovibos* figured and described by Allen,[2] the lateral palatine indentation is seen to move backward relative to the tooth row with the increase in age of the individuals.

The palate in no. 27118, as measured between the second superior molars, is narrower than in skull no. 1009 of *Preptoceras,* and in width is more like that of *Euceratherium.*

In the basicranial region there is considerable resemblance between no. 27118 from McKittrick and the skulls of *Preptoceras* from Samwel Cave. There is also considerable resemblance in this region between the McKittrick specimen and *Euceratherium.* The details of structure are better shown in no. 27118 (fig. 2), than in the cave skulls and hence afford an opportunity for closer comparison with *Ovibos* and other bovid forms. In the McKittrick skull the occipital condyles are relatively small and in ventral view are seen to be separated by a narrower notch than is present in the cave skulls. In the latter character, no. 27118 is more like *Ovibos.* The basioccipital is quite different in shape from that in *Ovibos* and closely resembles the element in *Preptoceras* and in *Euceratherium.* As in these forms, the basioccipital is traversed in its anteroposterior extent by a wide groove which broadens posteriorly. In *Symbos* a narrow median groove is present, which broadens posteriorly. The angle (20°) which the basisphenoid makes with the basioccipital in the vertical plane is the same as that in *Preptoceras* from Samwel Cave and in *Euceratherium.*

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[2] Allen, J. A., Ontogenetic and other variations in the musk oxen, with a systematic review of the musk ox group, recent and extinct, Mem. Am. Mus. Nat. Hist., n.s., vol. 1, pt. 4, 1913.

On each side of the basisphenoid the posterior border of the alisphenoid descends more abruptly than in *Ovibos*. No. 27118 appears to differ in this regard from no. 1009 and from the type of *Euceratherium*, but the descending process of the alisphenoid may not be completely preserved in the cave skulls.

The postglenoid process is small, comparable to that in no. 1009 and in no. 8751 of *Euceratherium*. At the outer side of the process is the large lower exit of the squamosal canal. The auditory capsules are smaller than in *Ovibos*. The tubular portion of the tympanic

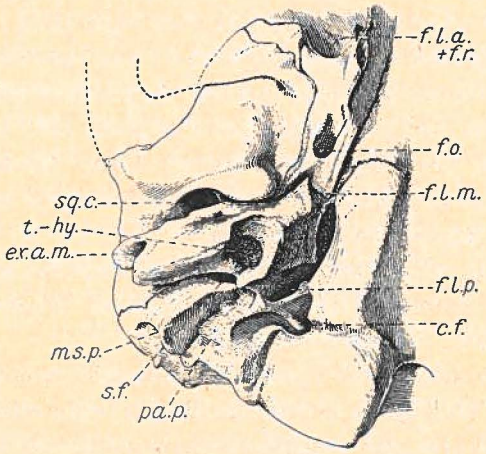

Fig. 2. *Preptoceras?* cf. *sinclairi* Furlong. Basicranial region of right side of skull, no. 27118 U. C. Mus. Pal. Vert. Coll., × 0.50. *f.l.a* + *f.r.*, confluent foramen lacerum anterius and foramen rotundum; *f.o.*, foramen ovale; *f.l.m.*, foramen lacerum medius (muscular process beneath this foramen has been broken away); *f.l.p.* foramen lacerum posterius; *c.f.* condylar foramen; *sq.c.*, squamosal canal; *ex.a.m.*, external auditory meatus; *s.f.*, stylomastoid foramen; *t.hy.*, tympano-hyal pit; *ms.p.*, mastoid process; *pa.p.*, base of paroccipital process. McKittrick Pleistocene, California.

reaching outward to form the external auditory meatus is fuller than in *Ovibos*. The backward deflection of the external auditory meatus is distinctly less than in *Ovibos* and comparable to that seen in the cave skulls of *Preptoceras* and *Euceratherium*. In *Ovis* and in *Oreamnos* this deflection is even less than in *Preptoceras*. In *Symbos*, according to Osgood,[3] the external auditory meatus is larger and less deflected backward than in *Ovibos*. The tympano-hyal pit is deep. The foramen lacerum posterius is large. The mastoid process is prominently developed, relatively more so than in *Ovis* or in

[3] Osgood, W. H., Scaphoceros tyrrelli, an extinct ruminant from the Klondike gravels, Smithson. Misc. Coll., vol. 48, p. 175, 1905.

Oreamnos. In *Ovis* and *Oreamnos* a downward projection of the squamosal fills the space between the mastoid process and the tubular portion of the tympanic, pressing against the posterior surface of the latter structure. In *Ovibos* this portion of the squamosal is thinner. In the McKittrick specimen the squamosal is still less in evidence and an open groove is present between the forward face of the mastoid process and the posterior surface of the tubular portion of the tympanic. No broad depression is present in the region between the foramen lacerum posterius and the occipital condyle, as in *Ovibos,* and the area is shortened considerably in the anteroposterior direction as compared with that in the musk ox. In the McKittrick specimen, as in the cave skulls, the foramen lacerum posterius is separated by a ridge, extending inward from the base of the paroccipital process, from a small depression situated anterior to the condyle. In no. 27118 there are two exits for the twelfth cranial nerve. The paroccipital processes are broken away in the McKittrick specimen. The base of this process is not expanded in anteroposterior direction so much as in *Ovibos.*

The squamosal and parietal are distinctly seen in side view of skull (pl. 61). A large canal pierces the squamosal above the glenoid fossa. The position of the lower opening of this canal has been noted. The upper posterior surface of the squamosal is also perforated by a vascular foramen. The suture separating squamosal from parietal extends backward beneath the lower border of the horn core but the posterior border of the parietal is not visible in the McKittrick specimen on the dorsal surface of the cranium behind the horn cores. Presumably the parietal extends farther forward from the superior crest of the occiput than in the musk ox. The occiput resembles that in the *Preptoceras.* A sharp median ridge above the foramen magnum is absent in this specimen. The angle in the vertical plane between the plane of the occiput and the plane of the dorsal surface of the cranial roof posterior to the horn cores is 139° in the McKittrick specimen. In the type of *P. sinclairi* this angle is 147°, while in the type of *Euceratherium* it is 153°. The transverse suture separating exoccipital from supra-occipital has a position comparable to that in the type of *Preptoceras sinclairi.* The mastoid extends upward along the side of the occiput for approximately two-thirds the extent of this surface. The occipital condyles as seen in posterior view of the skull (pl. 62, fig. 1) are relatively farther apart than in *Ovibos.* In this respect the condyles are like those in *P. sinclairi* and in *Euceratherium.*

Mandible.—The ramus of the mandible of no. 27118 is smaller than that in the musk ox with the inferior cheek-tooth series relatively large (see pl. 63). The greater forward extension of the ramus beyond $P_{\bar{2}}$ in *Ovibos* than in *Preptoceras* is occasioned by a greater lengthening of the symphyseal region in the former genus. The ramus is noticeably swollen externally below the exposed posterior portion of $M_{\bar{3}}$, and relatively more so than in *Ovibos.* The posterior dental foramen is larger than in *Ovibos,* but the mental foramen is smaller and without a well defined groove extending anterior to it, as in the living genus. The anterior end of the ramus below the incisors and canine has a somewhat different appearance in *Preptoceras* than in *Ovibos,* being fuller dorsoventrally and of greater depth. The condyle slopes downward more toward the inner side than in the musk ox. The coronoid process considerably overhangs the condyle. The anterior margin of the process is broadly convex in its extent from the anterior border of the ascending ramus to the upper end.

Measurements of Skull, No. 27118

Greatest transverse width of occiput above occipital condyles	148. mm.
Greatest transverse width of condyles across posterior articulating surface	88.3
Greatest transverse diameter of foramen magnum, measured between inner borders of occipital condyles	37.1
Greatest dorsoventral diameter of foramen magnum	23.8
Height of occiput measured from ventral surface of occipital condyles to superior border	107.3
Width of cranium measured between outer surface of lateral walls of parietals	108.
Greatest width measured between lower borders of horn cores	150.2
Least distance between basal margins of horn cores	36.4
Least distance across frontals measured between the orbital rims and the basal margins of the horn cores	134.9
Greatest width across frontals and between posterior rims of orbits	192.3
Greatest diameter (dorsoventral?) of horn core near base	96.8
Transverse (anteroposterior?) diameter of horn core near base	76.7
Length of diastema between $P_{\bar{2}}$ and alveolus for canine	73.3
Length of symphysis	48.6
Depth of ramus at anterior end of $P_{\bar{2}}$ measured normal to inferior border	38
Depth of ramus at posterior end of $M_{\bar{3}}$ measured normal to inferior border	*a* 61.8
Greatest transverse diameter of ramus at $M_{\bar{3}}$	26
Height of condyle above inferior border	136.6
Height from inferior border to tip of coronoid process	*a* 174.
Length from anterior end of symphysis to posterior border of ascending ramus	336.5
Length from anterior end of symphysis to posterior border of condyle	357

a, approximate.

Dentition.—In no. 27118 the lower premolar series ($P_{\bar{2}}$ to $P_{\bar{4}}$ inclusive) is longer relative to the lower molar series than in *Ovibos.* This proportionately greater length of the premolar series is not evident when the superior dentition is compared with that of *Ovibos.* The superior dental series resembles that in *Preptoceras* and *Euceratherium* from Samwel Cave. Furlong noted in *Preptoceras* the presence of a very small accessory style formed in the re-entrant angle between the anterior and posterior crescents of the inner wall of the superior molars and stated that the style is absent in *Euceratherium.* It should be indicated, however, that the style is not invariably present in molar teeth of *Preptoceras* from the cave deposits. In no. 1009 the style is clearly in evidence, particularly in $M^{\underline{1}}$ and $M^{\underline{2}}$, but in the type, no. 8896, the style is not to be seen along the exposed inner face of $M^{\underline{2}}$, which extends some 11 mm. below the palate. In *Ovibos* a similar style may be present in the upper molar teeth as noted by Rütimeyer, by Lönnberg, and by Osgood.[4] In a skull of *Ovibos* in the University collections in which all the teeth are in function and worn, the accessory column is not present in the upper molars. In no. 27118 from McKittrick no median accessory style is present.

In $P^{\underline{2}}$ no style is present along the anteroexternal border of the tooth as in the musk ox. On the outer surface a well developed longitudinal groove assists in the definition of the anterior and posterior pillar (pl. 62, fig. 2). Along the posterior border of the wearing surface occur two depressions of which the inner is the smaller and the deeper one. A somewhat similar pattern of wearing surface is seen in $P^{\underline{3}}$ and $P^{\underline{4}}$ but the crests of the crown are more fully formed than in $P^{\underline{2}}$. Well developed anterior and posterior styles are present on the outer sides of these teeth.

A small enamel-enclosed pit is seen on the wearing surface of the worn molar teeth lying between the two enamel lobes.

The lower incisor and canine teeth have dropped from the alveoli and have not been found in the collection. Judging from the alveoli in the McKittrick specimen and from mandibular materials belonging to the *Preptoceras-Euceratherium* group of the California caves, these teeth were larger than in *Ovibos.* Lönnberg[5] has stated that in *Ovibos* the incisors are very small, comparatively thick, and less spatulate than in other ruminants. In the Pleistocene forms from California the

[4] Osgood, W. H., Smithsonian Misc. Coll., vol. 48, p. 177, 1905.

[5] Lönnberg, E., On the structure and anatomy of the Musk-ox (*Ovibos moschatus*), Proc. Zool. Soc. London, p. 709, 1900.

lower incisors and canine resemble much more closely the comparable teeth in the musk ox than they do those in *Ovis* or in *Oreamnos*.

In the lower premolar series the teeth become progressively more molariform from $P_{\bar{2}}$ to $P_{\bar{4}}$ inclusive (pl. 63, fig. 1*a*)). In the second premolar two crests extend backward and inward from the principal cusp. The posterior of the two crests forms the outer and posterior rim of the occlusal surface.

In $P_{\bar{3}}$ the principal outer crest, which extends forward, bifurcates anteriorly, the two crests continuing to the inner side. A transverse crest connects the principal outer crest with a median pillar of the inner side. A posterior lobe, completely enclosed by enamel on the occlusal surface, is defined anteriorly on the external surface of the tooth by a distinct longitudinal furrow. The groove is more pronounced than in *Ovibos*. $P_{\bar{4}}$ resembles that in the musk ox. In this tooth the posterior moiety is less compressed anteroposteriorly than in $P_{\bar{3}}$ and is more strongly suggestive of the posterior half of $M_{\bar{1}}$. In $M_{\bar{3}}$ the third or posterior lobe does not reach the stage of development seen in the comparable tooth of *Ovibos*.

MEASUREMENT OF DENTITION, No. 27118

Greatest length of cheek tooth series, P^2 to M^3 inclusive	136.9 mm.
P^2, anteroposterior diameter	14.6
P^2, transverse diameter	13.8
P^3, anteroposterior diameter at wearing surface	17
P^3, transverse diameter	14
P^4, anteroposterior diameter	18
P^4, transverse diameter	14
M^1, anteroposterior diameter	26.9
M^1, transverse diameter	19.2
M^2, anteroposterior diameter	30.2
M^2, transverse diameter	17.2
M^3, anteroposterior diameter	29.1
M^3, transverse diameter	16.1
Length of cheek-tooth series from anterior end of $P_{\bar{2}}$ to posterior end of $M_{\bar{3}}$	146.7
$P_{\bar{2}}$, greatest anteroposterior diameter	13.5
$P_{\bar{2}}$, greatest transverse diameter	9.2
$P_{\bar{3}}$, greatest anteroposterior diameter	17.5
$P_{\bar{3}}$, greatest transverse diameter	11.1
$P_{\bar{4}}$, greatest anteroposterior diameter	20.6
$P_{\bar{4}}$, greatest transverse diameter	13.3
$M_{\bar{1}}$, greatest anteroposterior diameter	25.9
$M_{\bar{1}}$, greatest transverse diameter	13.1
$M_{\bar{2}}$, greatest anteroposterior diameter	30.
$M_{\bar{2}}$, greatest transverse diameter	13.
$M_{\bar{3}}$, greatest anteroposterior diameter	38.2
$M_{\bar{3}}$, greatest transverse diameter	13.2

Pes.—Elements of the feet available from McKittrick include the astragalus, cubo-navicular, the two posterior cannon bones and phalanges, no. 27119. The astragalus and fused cuboid and navicular are shown in figures 3 and 4. The tarsal elements resemble in size

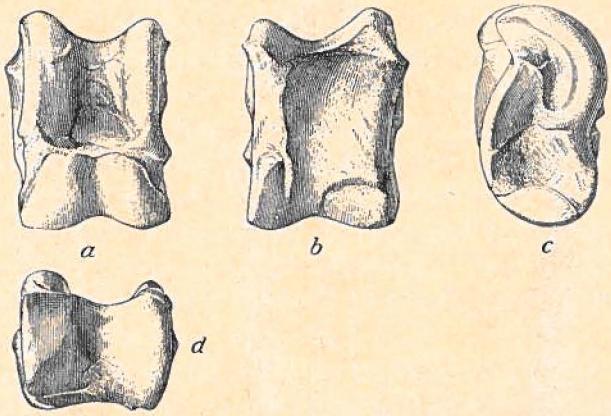

Fig. 3. *Preptoceras?* cf. *sinclairi* Furlong. Right astragalus, no. 27119 U. C. Mus. Pal. Vert. Coll., × 0.50. *a*, anterior view; *b*, posterior view; *c*, outer view; *d*, view of surface articulating with cubo-navicular. McKittrick Pleistocene, California.

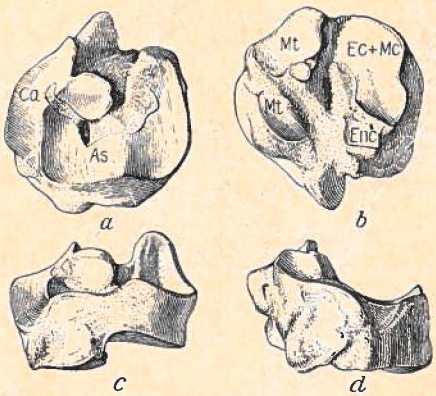

Fig. 4. *Preptoceras?* cf. *sinclairi* Furlong. Right cubo-navicular, no. 27119 U. C. Mus. Pal. Vert. Coll, × 0.50. *a*, proximal view with articulating surfaces for calcaneum, *Ca*, and for astragalus, *As; b*, distal view with articulating facets for metopodial, *Mt*, for fused ecto- and mesocuneiform, *Ec* and *Mc*, and for entocuneiform, *Enc; c*, anterior view; *d*, outer view. McKittrick Pleistocene, California.

and shape the comparable bones belonging to members of the *Preptoceras-Euceratherium* group from the Pleistocene of the Shasta caves.

The cannon bone (fig. 5*a*, *b*, *c*) is slightly smaller but resembles closely in general appearance no. 8556 from the Pleistocene of Potter

Creek Cave determined by Sinclair[6] as belonging to the genus *Euceratherium*. The McKittrick specimen is more slender. A second cannon bone from Potter Creek Cave, no. 8152, approaches more closely in its

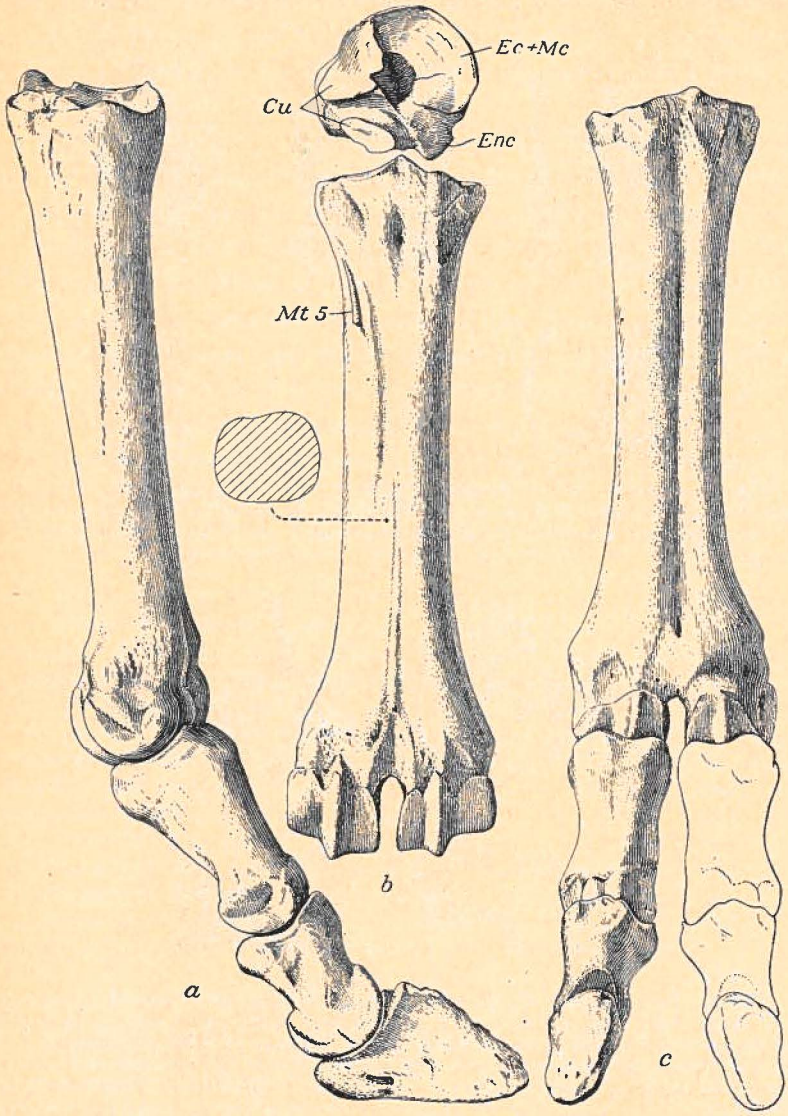

Fig. 5. *Preptoceras?* cf. *sinclairi* Furlong. Left cannon bone and phalanges, no. 27119 U. C. Mus. Pal. Vert. Coll., × 0.50. *a*, inner view; *b*, posterior view with view of proximal end (*Cu*, facets for cuboid; *Ec* and *Mc*, facets for fused ecto- and mesocuneiform; *Enc*, facet for entocuneiform) and cross-section of shaft, *Mt. 5*, rudiment of metatarsal V; *c*, anterior view.

[6] Sinclair, W. J., New mammalia from the Quaternary caves of California, Univ. Calif. Publ. Bull. Dept. Geol., vol. 4, pp. 150–152, pl. 20, fig. 1, 1905.

slenderness the McKittrick specimen. In a series of three posterior cannon bones from Potter Creek Cave the proximal rudiment of metatarsal V is best developed in nos. 8549 and 8556 and is not so well represented in no. 8152.

No. 27119 resembles closely a comparable cannon bone, possibly of *Preptoceras,* no. 9361 from Samwel Cave. There is probably a greater resemblance between the two elements in slenderness than exists between the McKittrick specimen and those from Potter Creek Cave.

In *Ovis* the cannon bone is actually longer than in no. 27119 and much more slender. This element does not show the transverse expansion seen in the McKittrick specimen. In *Ovis* there is no indication on the cannon bone of a rudiment or metatarsal V. At the proximal end of the cannon bone in the mountain sheep, the anterior articulating surface for the cuboid is relatively large, while the comparable facet in no. 27119 is relatively small.

As might be readily inferred from the size of the cannon bone, the phalanges are all much stouter than in *Ovis.* In the latter genus the proximal phalanx in the pes is distinctly more slender than that in the manus, and apparently more noticeably so than in the McKittrick form. In phalanx II the distal articulating surface extends farther back along the top of the phalanx in no. 27119 than in *Ovis.* In the distal phalanx the superior border is practically straight, not convex as in *Ovis.* The phalanx when viewed from the side does not have the 'roman nose' appearance seen in *Ovis.* The inferior border is also straighter than in the phalanx of *Ovis.* The ungual foramina are similar to those in the terminal phalanx of the mountain sheep.

Although the cannon bone of *Oreamnos* is approximately one-fourth smaller than that of the Pleistocene form, there is greater resemblance in shape of metatarsus between these two genera than exists between no. 27119 and *Ovis.* This applies in general to the phalanges as well. In the McKittrick specimen the cannon bone is widened transversely, as in *Oreamnos,* but the shaft does not increase so noticeably in width in its downward extent from a point immediately below the proximal end, as in the Recent mountan goat. No rudiment of metatarsal V is present along the upper portion of the outer posterior border of the shaft in *Oreamnos.* There is greater disparity in size between the facets for the fused ecto- and meso-cuneiforms and the cuboid in the Pleistocene form than in *Oreamnos.* In the latter no deep pit is to be noted in the middle of the proximal end between these two facets. Such a pit is well formed in the

McKittrick specimen. The phalanges of the pes in no. 27119 resemble those of *Oreamnos* in their heaviness.

In phalanx III of the McKittrick form the plane of the inferior surface meets the plane of the outer surface to form an acute angle while in *Oreamnos* these two planes meet in a right angle. *Oreamnos* agrees with no. 27119 in lacking the 'roman nose' appearance of the ungual phalanx when viewed from the outer side.

MEASUREMENTS OF ELEMENTS OF PES, NO. 27119

Astragalus:	
Greatest length	57.9 mm.
Greatest width across outer surface	31.9
Transverse width of distal trochlea	40.1
Cubo-navicular:	
Greatest transverse width	49.7
Anteroposterior diameter	44.3
Left posterior cannon bone:	
Greatest length over all	189.
Length measured on anterior surface	182.4
Width of proximal end	44.7
Greatest anteroposterior diameter of proximal end	41.8
Width of shaft at middle	28.3
Anteroposterior diameter of shaft at middle	24.6
Greatest width across distal condyles	54.8
Greatest anteroposterior diameter of distal condyles	32.7
Inner digit:	
Phalanx I (proximal phalanx):	
Greatest length	60.2
Greatest width of proximal end	26.9
Greatest depth of proximal end	29.3
Greatest width of distal end	26.2
Greatest depth of distal end	20.2
Phalanx II (middle phalanx):	
Length from base of proximal articulating surface to middle of distal articulating surface	41.3
Greatest width of proximal end	25.9
Greatest depth of proximal end	25.5
Greatest width of proximal condyle	20.3
Greatest depth of proximal condyle	24.8
Phalanx III (distal phalanx):	
Greatest length along base	56.3
Greatest depth	31.7
Greatest width of proximal end	19.5

RÉSUMÉ OF CHARACTERS OF McKITTRICK FORM

CHARACTERS LIKE THOSE IN PREPTOCERAS. Size and shape and presumably curvature of horn core; extent to which horn core extends outward and backward from base before curving forward; width across frontals between outer lower borders of horn cores; indentation of palatine on each side of posterior notch; absence of median ridge on occiput above foramen magnum and general appearance of occiput; parietals form dorsoposterior roof of skull.

CHARACTERS LIKE THOSE IN EUCERATHERIUM. Backward and upward extent of horn cores; some resemblance possibly in curvature; width of palate; absence of accessory style in upper molars.

CHARACTERS COMMON TO PREPTOCERAS AND EUCERATHERIUM. Width of frontals between orbital rims; presence of a lachrymal depression; shape of elements and position of foramina in basicranial region of skull; position and size of occipital condyle; number and structure of teeth; structure of feet.

CHARACTERS DISTINGUISHING THE McKITTRICK FORM FROM BOTH PREPTOCERAS AND EUCERATHERIUM. Width measured between inner basal borders of horn cores; elevation of frontals in their extent from fronto-nasal suture to horn cores; depth of lachrymal depression; abrupt downward descent of posterior border of alisphenoid; angle (139°) in vertical plane made by plane of dorsal surface of the cranial roof with the plane of the occiput.

RELATIONSHIP OF PREPTOCERAS AND EUCERATHERIUM

The type specimens of *Euceratherium* and *Preptoceras* were both described from the Pleistocene deposit of Samwel Cave, Shasta County, California, but the former genus has been recorded also in the fauna of Potter Creek Cave, Shasta County.[7] In a discussion of the affinities of *Euceratherium,* Sinclair and Furlong[8] regarded tentatively the position of this genus to be in the ovine division of the bovid group, but stated that the Pleistocene form is not nearly related to any living North American representative of that division. In the comparison of *Euceratherium* and *Ovibos* Sinclair and Furlong recognized the similarity in dentition and the decided difference in horn cores of these forms. The genus was excluded from a relationship to the cattle because of decided differences presented in the dentition. *Euceratherium* was also regarded as not closely related to the existing goats.

[7] Several teeth referred tentatively to *Euceratherium collinum* have been found in the Pleistocene fauna of Hawver Cave. Univ. Calif. Publ. Bull. Dept. Geol., vol. 10, pp. 513–514, 1918.

[8] Sinclair, W. J., and Furlong, E. L., *Euceratherium,* a new ungulate from the Quaternary caves of California, Univ. Calif. Publ. Bull. Dept. Geol., vol. 3, p. 416, 1904.

In a later paper Sinclair[9] described and figured foot material from the Pleistocene of Potter Creek Cave, referring the specimens to *Euceratherium* because of an association in the deposit with teeth and horn cores determined as belonging to the latter genus. Sinclair decided from a comparison of the foot materials that *Euceratherium* is not closely related to the existing goat-antelopes or to the sheep. Sinclair also recognized that the feet differed only in minor details from those of *Ovibos.*

Furlong,[10] although recognizing the resemblance in the dentition, regarded the genus *Preptoceras* as not nearly related to *Ovibos,* and tentatively placed the form in the Ovinae. *Preptoceras* was considered by Furlong as a type having many characters in common with *Euceratherium,* and the suggestion was made that the two forms on further study would be placed in a distinct group.

In considering *Ovibos* and allied Pleistocene types occurring outside the California area, several authors have expressed opinions regarding the relationships of *Euceratherium* and of *Preptoceras.* Thus Gidley[11] regards *Liops zuniensis* as apparently much more closely related to *Ovibos* than is either *Euceratherium* or *Preptoceras.* Gidley refers *Liops* to the Ovibovinae. Allen[12] does not regard the California forms as nearly related to either *Symbos* or *Ovibos.* Hay,[13] on the other hand, refers *Euceratherium* and *Preptoceras* to the Ovibovinae, in which subfamily are placed with *Ovibos* the genera *Symbos* and *Boötherium.* Other authors have also referred *Euceratherium* and *Preptoceras* to the Ovibovinae.

A comparison of individuals of the *Preptoceras-Euceratherium* group with the existing genera, *Ovibos, Ovis,* and *Oreamnos* indicates a resemblance in dentition between these forms. Undoubtedly the greatest similarity exists between the California Pleistocene types and *Ovibos.* In the elements of the feet, particularly in the cannon bones, the former group shows greatest resemblance to the musk oxen, less resemblance to the goats, and least resemblance to the mountain sheep. The Pleistocene forms differ of course widely from *Ovibos* in character

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[9] Sinclair, W. J., Univ. Calif. Publ. Bull. Dept. Geol., vol. 4, pp. 150–152, pl. 20, figs. 1 and 2, 1905.

[10] Furlong, E. L., *Preptoceras,* a new ungulate from the Samwel Cave, California, Univ. Calif. Publ. Bull. Dept. Geol., vol. 4, pp. 163–169, pls. 24 and 25, 1905.

[11] Gidley, J. W., A new ruminant from the Pleistocene of New Mexico, Proc. U. S. Nat. Mus., vol. 30, pp. 165–167, 1906.

[12] Allen, J. A., Mem. Am. Mus., vol. 1, p. 169, 1913.

[13] Hay, O. P., The Pleistocene mammals of Iowa, Iowa Geol. Surv., vol. 23, pp. 290–291, 1914.

of horn cores, but perhaps no more widely than do other types referred to the Ovibovinae. Noticeable differences are presented in the basicranial region of the skull. How closely the *Preptoceras-Euceratherium* group is related to the Pleistocene and Recent musk oxen can best be determined when information is available concerning the Pliocene precursors of these forms.

A study of the materials from McKittrick has led to the recognition of a number of characters held in common by *Preptoceras* and *Euceratherium.* Thus may be mentioned the characters in the basicranial region of the skull, in the dentition, and in the feet. Among the characters given in the résumé distinguishing the McKittrick form from both *Preptoceras* and *Euceratherium,* some appear to possess only minor significance. Thus the depth to which the surface of the lachrymal is depressed may be regarded as a variable feature within a particular group. The abrupt downward descent of the posterior border of the alisphenoid may be peculiar to the McKittrick skull, while the preservation of the posterior portion of the alisphenoid may not be complete in the cave skulls. In measurement of width between the inner basal borders of the horn cores, and in the elevation of the frontal anterior to these structures, the McKittrick specimen occupies a position between that of *Preptoceras* and the type of *Euceratherium.*

It appears evident from the comparisons that the characters held in common by the McKittrick form, *Preptoceras* and *Euceratherium* are of greater significance than those which ally the McKittrick type with either *Preptoceras* or *Euceratherium.* In view of these relationships and in view of possible variation in the characters of the horn cores, the suggestion may be warranted that the McKittrick form and the types from the California caves represent in reality a single generic group. Should this prove to be the case the type of *Preptoceras* would possibly belong to a young male and the type of *Euceratherium* to an older female. If the generic identity of *Preptoceras* and *Euceratherium* be established, the name *Euceratherium* has precedence over *Preptoceras.*

EXPLANATION OF PLATE 60

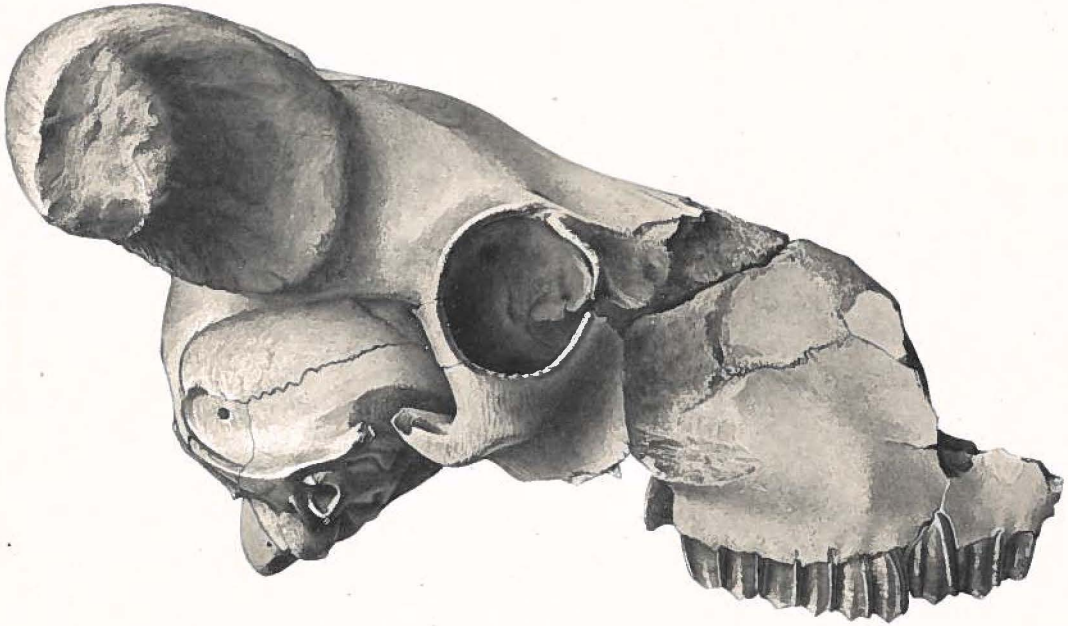
Preptoceras? cf. *sinclairi* Furlong

Skull, no. 27118 U. C. Mus. Pal. Vert. Coll.; dorsal view. × 0.333. McKittrick Pleistocene, California.

EXPLANATION OF PLATE 61

Preptoceras? cf. *sinclairi* Furlong

Skull, no. 27118 U. C. Mus. Pal. Vert. Coll.; view of right side. × 0.333. McKittrick Pleistocene, California.

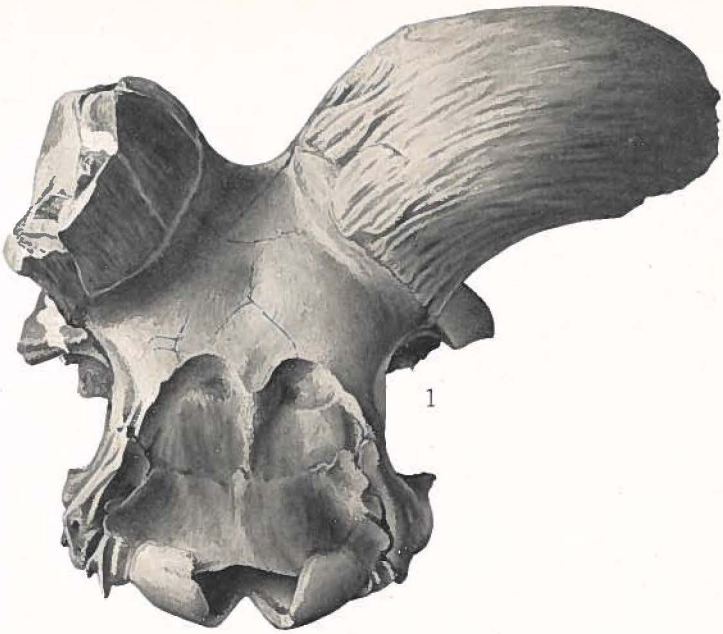


EXPLANATION OF PLATE 62

Preptoceras? cf. *sinclairi* Furlong

Figs. 1 and 2. Skull, no. 27118, U. C. Mus. Pal. Vert. Coll.; fig. 1, posterior view, × 0.333; fig. 2, palate and right cheek-tooth series, × 0.50. McKittrick Pleistocene, California.

Fig. 3. Recent musk ox (*Ovibos*), palate and cheek-tooth series. × 0.50.



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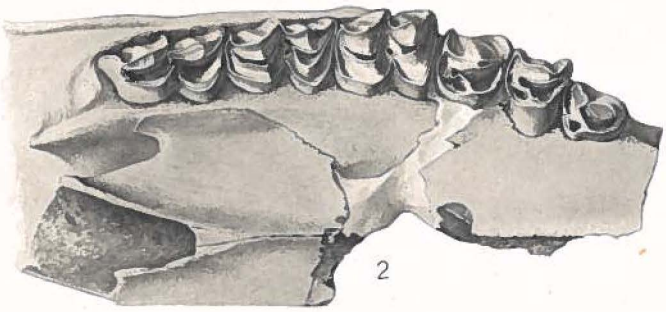

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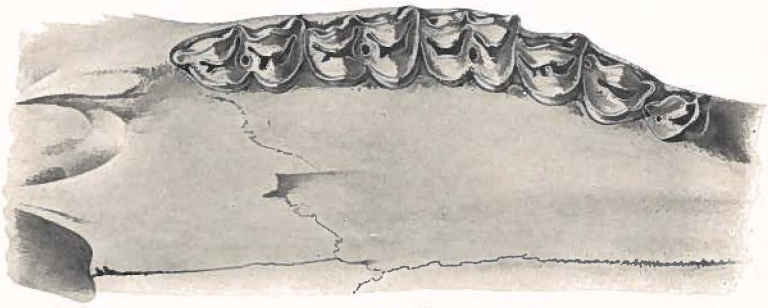

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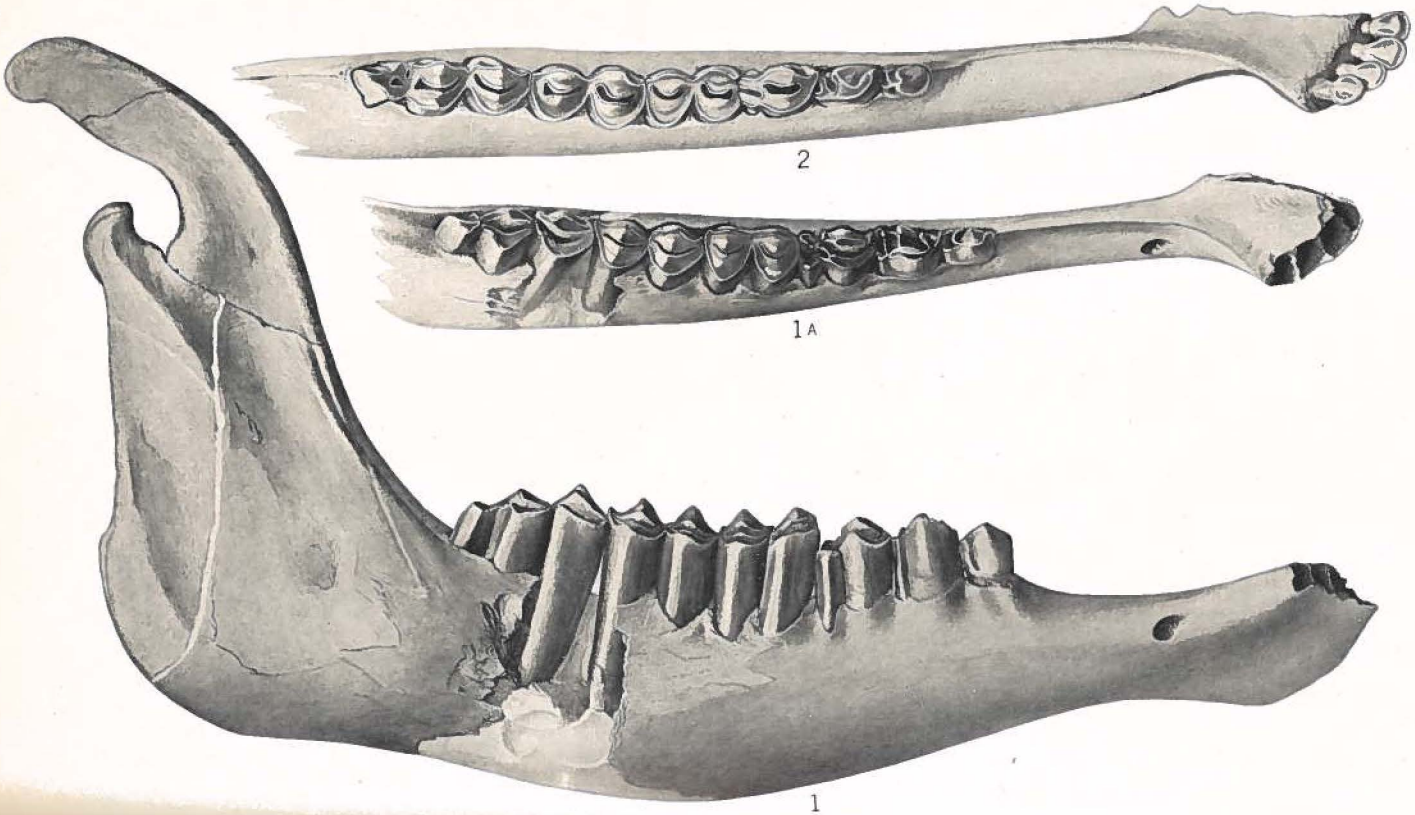
EXPLANATION OF PLATE 63

Preptoceras? cf. *sinclairi* Furlong

Fig. 1 and 1*a*. Right ramus of mandible, no. 27118 U. C. Mus. Pal. Vert. Coll. × 0.50. Fig. 1, outer view; fig. 1*a*, superior view, horizontal ramus, and dentition. McKittrick Pleistocene, California.

Fig. 2. Recent musk ox (*Ovibos*), superior view of horizontal ramus, and dentition.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