

**BULLETIN**  
**OF THE**  
**American Museum of Natural**  
**History.**

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**Vol. XXXIV, 1915.**

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**EDITOR, J. A. ALLEN.**

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**NEW YORK:**  
**Published by order of the Trustees.**  
**1915.**

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(Continued from 3d page of cover.)

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### **Article I.—A REVISION OF THE LOWER EOCENE WASATCH AND WIND RIVER FAUNAS.**

BY W. D. MATTHEW and WALTER GRANGER.

#### *Introduction.*

IN 1891 the Department of Mammalian Palæontology of this Museum was founded by Professor Henry Fairfield Osborn. The first expedition for fossil mammals was sent out in charge of Dr. J. L. Wortman to the Lower Eocene Wasatch formation of the Big Horn Basin, Wyoming. The results of this auspicious beginning of the Museum's fossil-hunting expeditions were described in the 'Bulletin' for 1892, volume IV. Another very successful expedition was conducted by Dr. Wortman the next year into the Paleocene (Puerco) of New Mexico. In 1895 the Museum purchased the Cope Collection of North American Fossil Mammals, including the Eocene and Paleocene collections obtained by Professor Cope and his assistants and described and figured in 'Tertiary Vertebrata.' Expeditions in charge of Dr. Wortman in 1893-96 added largely to the Eocene collections thus brought together. In 1903 Mr. Walter Granger began a systematic and thorough search of the Middle and Lower Eocene and Paleocene formations of Wyoming and New Mexico which has continued for ten years with great success.

The thorough stratigraphic studies made by these expeditions and exact records of level and locality of every specimen, have made it possible to correlate the faunas and trace the evolution of the various races much more precisely and certainly. The great amount of new material, and more complete specimens of rare and little known species have as yet been described only in small part.

The present revision is concerned with the Lower Eocene faunæ, the

Wasatch and Wind River and their equivalents. Preliminary notes on the stratigraphy and correlation have been published by Sinclair and Granger, and the Artiodactyls have been revised in a recent paper by Dr. Sinclair in this 'Bulletin.' The systematic revision of the Amblypoda, Condylarthra, Perissodactyla, Tillodontia and Tæniodonta has been undertaken by Mr. Granger, of the Carnivora, Insectivora, Primates, Rodents, etc., by Dr. Matthew. Dr. W. K. Gregory will contribute a series of studies of the morphology and general relationships of some of the more important groups.

Through the courtesy of the United States National Museum, we have been accorded the exceptional privilege of borrowing for study and comparison the type specimens of fossil mammals from the New Mexican Wasatch described by Cope in 1874-77. The rest of the types from the Lower Eocene formations are in this museum, except for a number in the Amherst Museum and in the Marsh Collection at Yale University. Through the courtesy of Dr. Loomis, Dr. Schuchert and Dr. Lull we have been enabled to examine and study these types also. The Museum is largely indebted to Dr. W. J. Sinclair of Princeton University for valuable services in the field, both in stratigraphic work and collecting, as well as for the published contributions above noted. The success of Mr. Granger's expeditions is in no small part due to the coöperation of his able and energetic assistants now or formerly on the Museum staff, Messrs. George Olsen, William Stein, Paul Miller, C. Forster Cooper and P. L. Turner, who have been attached to one or more of the parties in the Lower Eocene formations. Following is a summary of the earlier and later explorations in these horizons:

(1) Typical Wasatch, near Evanston, Wyoming. Fossils first found in 1871 by Wm. Cleburne. These and some other specimens obtained in 1872-73 by Professor Cope are in the American Museum collection. A number of specimens were secured subsequently by Professor Marsh and are now in the Yale Museum. Systematically explored by Granger in 1906,<sup>1</sup> and a small collection secured. The exposures are limited and fossils scarce.

(2) New Mexican Wasatch. San Juan Basin, in Rio Arribas Co. Explored by Cope for the Wheeler Survey in 1874 and an important collection made which is now in the U. S. National Museum. A few specimens collected for Professor Marsh about 1875-76 are in the Yale Museum. Dr. Wortman conducted a party in these beds in 1896 for the American Museum, but only a few specimens of any value were obtained. Systematically explored by Granger in 1912 and 1913 with considerable success.

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<sup>1</sup> The stratigraphy was revised by Veatch in 1904 for the U. S. Geological Survey.

(3) Black Buttes (margin of the Washakie Basin) Wyoming. A few fragmentary Wasatch fossils obtained in this vicinity by Cope in 1872 and by Marsh a few years later. No subsequent collecting.

(4) Wind River Basin, Wyoming. A valuable collection obtained by Wortman for Cope in 1880, including the famous *Hyracotherium venticolum* skeleton. Wortman obtained a number of specimens for the American Museum in 1891 and again in 1896. In 1904 Dr. Loomis led a successful expedition for Amherst College, and in 1905 and 1909 the formation was systematically searched by Granger for the American Museum and large although mostly fragmentary collections obtained. Wortman's collections were made in the upper levels of the formation, Loomis's in the lower horizon; Granger's material is from all the fossiliferous horizons.

(5) Big Horn Basin, Wyoming. This is by far the richest region for Wasatch fossils, the beds being extensively exposed and fossils often fairly common, although rarely complete or perfectly preserved. It was discovered by Dr. Wortman in 1881 and a large collection obtained for Professor Cope including the famous skeletons of *Phenacodus*. In 1884 a party from Princeton University obtained a small collection. In 1891 and 1896 Wortman again explored it in the interests of the American Museum obtaining many valuable specimens. In 1904 Loomis obtained a considerable collection for Amherst Museum. In 1910, 1911 and 1912 Granger searched the formation systematically with great success, his collections exceeding in amount and value all those previously obtained. In 1913 Mr. Stein completed the exploration of the basin under Granger's direction.

6. Clark Fork Basin. A small basin adjoining the Big Horn to the northwest, but draining independently into the Yellowstone River, and apparently semi-distinct in its Lower Eocene deposition. It was visited by Wortman in 1896, but the first fossils of any importance were obtained by Granger in 1911-12 and by Stein in 1913. The earliest Wasatch and sub-Wasatch beds are best represented in this basin, containing many new and primitive species herein described.

Most of the above collections are in the American Museum; the remainder in the National, Yale, Amherst and Princeton museums. I do not know of any other Lower Eocene fossil mammals in this country, save for a few specimens from the Uinta Basin in the Carnegie Museum at Pittsburgh. A number of field parties of the U. S. Geological Survey have made important contributions to our knowledge of the stratigraphy of these Lower Eocene formations, but none so far as I am aware have obtained any considerable collections of their fossil vertebrates.

From the lower Eocene (Suessonian) formations of England, France and Belgium a small mammalian fauna has been obtained. It is closely allied



to the Wasatch faunæ and most if not all of its genera are represented by more perfect material of related, possibly identical, species in this country.

The lower Eocene mammals of the rest of the world are totally unknown.<sup>1</sup>

This series of contributions deals therefore with practically all that is known to science of the Lower Eocene mammalia. The authors, while in entire accord as to their conclusions, are separately responsible for the sections of the revision appearing under their individual names, and it is requested that they be so quoted.

## PART I.—ORDER FERÆ (CARNIVORA). SUBORDER CREODONTA.

By W. D. MATTHEW.

The Creodonta of the Eocene form a relatively compact order, whose affinities are well understood, owing chiefly to the more or less complete knowledge of the skeleton of the principal genera. The affinities and classification of the several families were discussed at some length by the writer, in the memoir on the Bridger Carnivora and Insectivora.<sup>2</sup> The new material from the Lower Eocene confirms in detail the views there set forth, and illustrates very clearly the progressive stages in the differentiation of the several groups during the successive horizons of the Lower Eocene. The more complete material now at hand clears up the affinities of several doubtful groups, notably of the Oxyclænidæ, some of which at least appear to be nearly related to the Arctocyoniidæ. These two families should probably be united, but a further study of the Paleocene Creodonta with the new and more complete material now at hand is desirable before this change is made.

Only one Paleocene Creodont has been known hitherto to survive into the Wasatch formations. To this genus, *Didymictis*, we are now able to add two others, *Dissacus* and *Chriacus*, while the new genus *Thryptacodon* is distinctly a Paleocene type. No trace of any Pseudocreodine genus is found in the Paleocene except in the transitional Clark Fork beds, but the Eucrodi and Acreodi of the older Torrejon and Puerco faunas are more nearly related to those of the later horizons than had previously appeared.

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<sup>1</sup> The *Notostylops* fauna of Patagonia I regard as late Eocene if it is a faunal unit at all.

<sup>2</sup> Carnivora and Insectivora of the Bridger Basin, Middle Eocene. By W. D. Matthew. Mem. Am. Mus. Nat. Hist., Vol. IX, part vi, August, 1909.

*Key to the families of Creodonta.*

- A. *Procreodi*. Ungual phalanges fissured or unfissured, but not flattened.
  - 1. No carnassials.....*Arctocyoniðæ*, *Oxyclænida*.
- B. *Eucreeodi*. Ungual phalanges not fissured.
  - 2. Carnassial teeth  $p^4$  and  $m^1$ .....*Miacida*.
- C. *Pseudocreeodi*. Ungual phalanges fissured.
  - 3. Carnassial teeth  $m^1$  and  $m_2$ .....*Oxyænida*.
  - 4. Carnassial teeth  $m^2$  and  $m_3$ .....*Hyænodontida*.
- D. *Acreodi*. Ungual phalanges fissured and flattened.
  - 5. No carnassials.....*Mesonychida* and *Trisodontida*.

OXYCLÆNIDÆ *Scott* 1892.<sup>1</sup>***Chriacus* Cope** 1883.<sup>2</sup>

*Type*, *C. pelvidens* (Cope 1881 <sup>3</sup>) from Torrejon of New Mexico.

This genus is common in the Torrejon but not hitherto discovered in the Wasatch. As with most of the Paleocene mammals its systematic status has been doubtful. Cope and Scott referred it to the Creodonta; Osborn and Earle in 1895 <sup>4</sup> tentatively referred it to the Primates, to which Scott had suggested that it was probably related. Matthew in 1897 and subsequently, referred it to the Creodonta more or less provisionally as a member of the primitive family *Oxyclænida*. Wortman in 1902 <sup>5</sup> suggested that this family might prove to be of Insectivore affinities "with numerous transitional or Metatherian characters." The specimen described below affords some important evidence as to the affinity of this genus. The construction of the manus is completely in accord with the less specialized Creodonts, as are also the parts preserved of the hind foot. While not wholly conclusive, the evidence is decidedly in favor of the Creodont affinities of *Chriacus*.

A subfamily distinction from the Arctocyoniinæ is perhaps afforded by the reduced and non-opposable pollex in this genus. The hallux is unreduced, and compares with Miacinæ and Arctocyoniidæ.

The characters of the manus exclude *Chriacus* from the Primates to which it was tentatively referred by Osborn and Earle, and make it very improbable that it has any Insectivore affinities.

<sup>1</sup> Proc. Acad. Nat. Sci. Phila., Vol. XLIII, p. 294.

<sup>2</sup> Proc. Acad. Nat. Sci. Phila., Vol. XXXIV, p. 80.

<sup>3</sup> *Lipodectes pelvidens* Cope 1881, Amer. Nat., Vol. XV, p. 1019.

<sup>4</sup> Bull. Am. Mus. Nat. Hist., Vol. VII, p. 20.

<sup>5</sup> Am. Jour. Sci., Vol. XIII, p. 434, footnote.

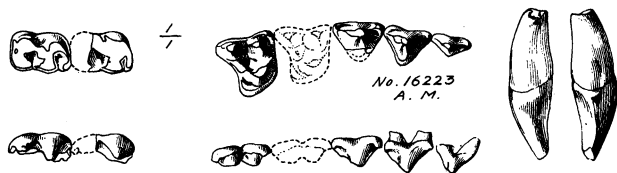
**Chriacus gallinæ** sp. nov.

Fig. 1. *Chriacus gallinæ*, upper and lower teeth of type specimen, natural size, crown and outer views of  $m_1-2$ ,  $p_2-m_2$ , and inner and outer views of upper canine. Almagre beds, Wasatch formation of San Juan Basin, New Mexico.

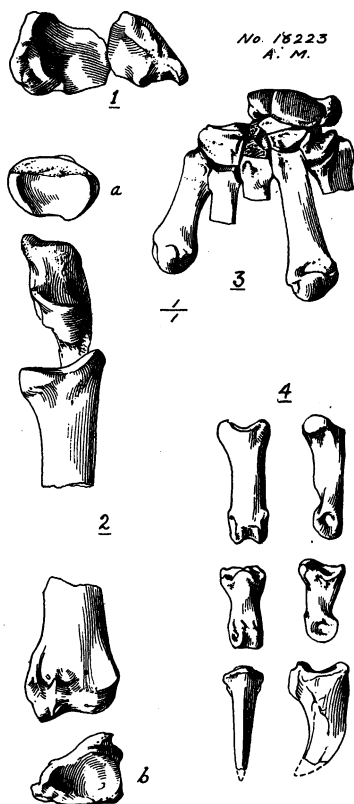


Fig. 2. *Chriacus gallinæ*, parts of limb bones and fore foot, natural size: 1, distal ends of tibia and fibula; 2, radius and ulna, a, head of radius, b, distal end of radius; 3, dorsal view of carpus and metacarpus, lacking cuneiform and ends of three metacarpals; 4, phalanges, dorsal and lateral views. All from the type specimen.

Type, No. 16223, upper and lower teeth, fore feet and various skeleton fragments, from the lower division of the New Mexican Wasatch.

*Specific distinctions:* Size of *C. pelvidens*; paraconid of lower molars stronger, more internal in position; external cingulum of upper molars weak;  $p^3$  without deutercone and protocone of more trihedral form.

*Diagnosis of skeleton parts.* The head of the radius is round oval, not flattened; the bicipital tubercle elongate, not prominent; the distal end of radius trihedral, styloid process weak. The olecranon is short, expanded laterally, not deep; sigmoid cavity rather shallow. Scaphoid, lunar and centrale separate, the scaphoid shallow, centrale larger than in *Oxyænidae* otherwise similar, trapezoid wider and deeper than in *Oxyænidae* and *Miacidae*, trapezium smaller and more quadrate, lacking the inferior peg characteristic of the *Arctocyonidae* and present to a less extent in the other families. The magnum is high and narrow, its proximal keel compressed and obliquely set in relation to the body. The unciform is of moderate height with a rather narrow subproximal lunar facet.

The metacarpals are five in number, the fifth having the most robust shaft, mc.I the most slender; mc.II is considerably longer than mc.V, the shaft somewhat slenderer; the shafts of mc.III and IV are smaller, that of mc.I much smaller, but their lengths are not preserved.

The phalanges are very like those of



*Vulpavus* except that the unguals are longer, not quite so high and compressed, the sub-ungual processes heavier.

The entocuneiform is as broad as in *Vulpavus* but lacks the characteristic asymmetry of that genus; it is broader than in *Didymictis* and decidedly broader than in *Oxyænida*.

The middle caudals are long and heavy.

### **Thryptacodon** gen. nov.

*Type, T. antiquus*, infra.

*Generic characters:* Upper molars low-crowned, quadrate-oval or rounded, cusps round conic, hypocone prominent on  $m^{1-2}$ , enamel rugose,  $m^{\frac{3}{2}}$  somewhat reduced, round oval;  $p^4$  trihedral with small deuterococone, distinct para- and metastyles. Lower molars broad with very small submedian paraconid and four sub-equal opposite principal cusps. Heavy external cingula on lower molars; heavy encircling cingula on upper molars. Anterior premolars slender; canines long, compressed and ridged posteriorly. Skull short with comparatively large brain-case, skeleton relatively large, resembling that of *Miacina*.

This genus is not rare in the lower horizons of the Big Horn Wasatch, but has not been found in the Lysite or Lost Cabin. It appears to be related to *Tricentes* and *Chriacus*, but has more rounded teeth than the former,  $m^{\frac{3}{2}}$  more reduced; differs from *Chriacus* in the lower cusps, broad rounded teeth, rugose enamel and heavy cingula. It approaches the *Arctocytonida* more nearly than do any other *Oxycænids*, but is less specialized and the skull and skeleton are more progressive. The very marked detailed resemblance to *Clænodon* in the construction of the molar teeth can hardly be interpreted otherwise than as proof of close affinity, and makes the propriety of separating *Oxycænida* and *Arctocytonida* as distinct families very questionable. There is a notable difference indeed in the form and proportions of the skull and in the proportions of the skeleton. But it is not as wide as between *Didymictis* and *Palæarctonyx* in the *Miacida*.

In size and general proportions of the teeth these two species are not unlike *Palæosinopa*. The detail construction of the molars easily distinguishes the two genera. In *Palæosinopa* the cusps are decidedly higher, more angulate, the paraconid more prominent, placed nearer to the inner border,

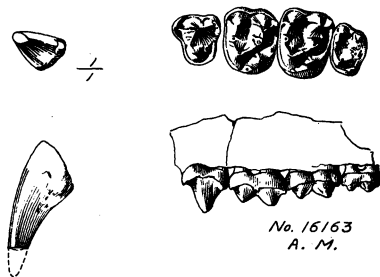


Fig. 3. *Thryptacodon olseni*, upper teeth, crown and external views, natural size. No. 16163, Gray Bull beds, Big Horn Basin, Wyoming.

trigonid distinct from talonid, heel of  $m_3$  longer with high hypoconulid and entoconid. There are no cingula on the molars and the posterior mental foramen is beneath  $m_1$ . The upper molars show corresponding differences, being in *Palæosinopa* triangular in outline, with high sharp protocone, hypocone represented only by a cingular flange, paracone and metacone smaller, sharper, somewhat inset from the border, and with small stylar crests at the anterior and posterior angles. The deuterocones of the premolars are also better developed, and the last molar is transverse.

In all these characters of the teeth *Palæosinopa* comes decidedly nearer to the Miacidæ than does *Thryptacodon*. But the skeleton of the new genus is that of a Creodont, related to the Miacidæ and Arctocyoniidæ, whereas the skeleton of *Palæosinopa* is widely different from the Creodont type, and agrees nearly with that of the Insectivore *Pantolestes*. The distinctions in the teeth are therefore not to be regarded as of ordinal value.

Two species or subspecies are represented in the collection, distinguished as follows:

*T. antiquus*:  $m^{1-3} = 17.5$  mm.; upper molars round-quadrate, no hypocone on  $m^3$ , no protostyles.

*T. olseni*:  $m^{1-3} = 21$  mm., upper molars quadrate, distinct hypocone on all, protostyle on  $m^{1-2}$ , deuterocone of  $p^4$  larger.

### ***Thryptacodon antiquus* sp. nov.**

*Type*, No. 16162, upper and lower jaws and parts of radius and ulna, from the Systemodon zone in Clark Fork Basin, Wyoming.

*Distinctive characters*: Upper molars round-oval, with low rounded cusps, heavily cingulate, enamel rugose, distinct hypocone on  $m^{1-2}$ , none on  $m^3$ , conules distinct but small.  $P^{3-4}$  trihedral, three-rooted, strong deuterocone on  $p^4$ , none on  $p^3$ . Lower molars broad, low cusped, with heavy external cingula, paraconid much reduced, submedian, protoconid and metaconid equal and opposite, heel wide-basined, with  $hy^d$  and  $en^d$  strong, wider apart on  $m_{1-2}$  than the trigonid cusps, hypoconulid rudimentary except on  $m_3$ , in which it is moderately large median-internal. Heel of  $m_3$  and  $m^3$  reduced in size. Posterior lower premolars short and robust with small heels and anterior basal cusps and heavy cingula.  $P_2$  two-rooted, slender,  $p_1$  one-rooted. Canines moderately large, slender, ridged posteriorly.

Thirteen specimens from the Sand Coulée and Gray Bull horizons in the Big Horn and Clark Fork basins represent this species, all agreeing quite closely in size and characters. Two jaw fragments with  $m_{2-3}$  from the Clark Fork beds probably represent a distinct species or subspecies, distinguished by broader teeth and a distinct protostyle on  $m_2$ , but the material seems inadequate for a specific type.

These teeth are very suggestive of *Tricentes*, but the molars are more rounded in outline,  $m_3$  more reduced, and the size is greater. In many features they also suggest *Clanodon* and *Palæarctonyx*, but the cusps although low, are not flattened out as in those genera, the proportions of the

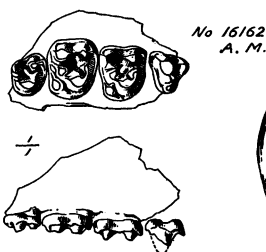


Fig. 4.

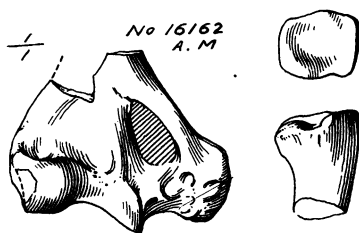


Fig. 6.

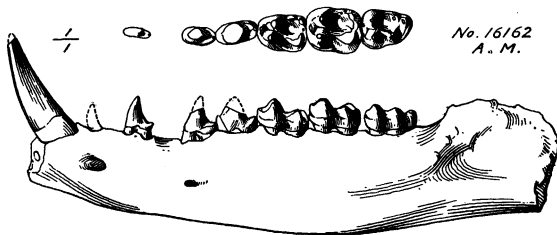


Fig. 5.

Fig. 4. *Thryptacodon antiquus*, upper teeth outer and crown views of  $p^4$ - $m^3$  and outer view of upper canine, natural size. Type specimen, Gray Bull beds, Clark Fork Basin, Wyoming.

Fig. 5. *Thryptacodon antiquus*, lower jaw, outer view, and crown view of lower teeth, natural size. Type specimen, Gray Bull beds, Clark Fork Basin, Wyoming.

Fig. 6. *Thryptacodon antiquus*, type specimen, distal end of humerus and proximal end of radius, natural size. Gray Bull beds, Clark Fork Basin, Wyoming.

molars are different. But there is probably a near affinity between the less specialized Arctocyoniadæ, the Cercoleptoid Miacidæ and the Oxycelænidæ, although part of the resemblance is due to parallelism.

### ***Thryptacodon olseni* sp. nov.**

*Type*, No. 15252, a skull and large part of the skeleton, found by Mr. George Olsen a few miles east of Saint Joe in the Gray Bull horizon of the Wasatch.

The specimen is poorly preserved, and more or less encrusted with a flinty matrix. It consists, besides the skull, of eighteen vertebræ, most of the limb bones and an incomplete fore foot. A second specimen No. 16163, upper jaws with well preserved teeth, is referred to this species but has more rounded teeth, approaching *P. antiquus* in this respect.



*Skull.* Owing to the poor preservation no sutures can be safely distinguished. The general proportions of the skull are much as in *Vulpavus*. The frontal region appears to be wider than in that genus, the front of muzzle broader. The sagittal crest is of moderate height, the occiput appears to be broad and low, and the brain-case is fairly capacious, comparing with *Vassacyon*, smaller relatively than in *Vulpavus* but much larger than in

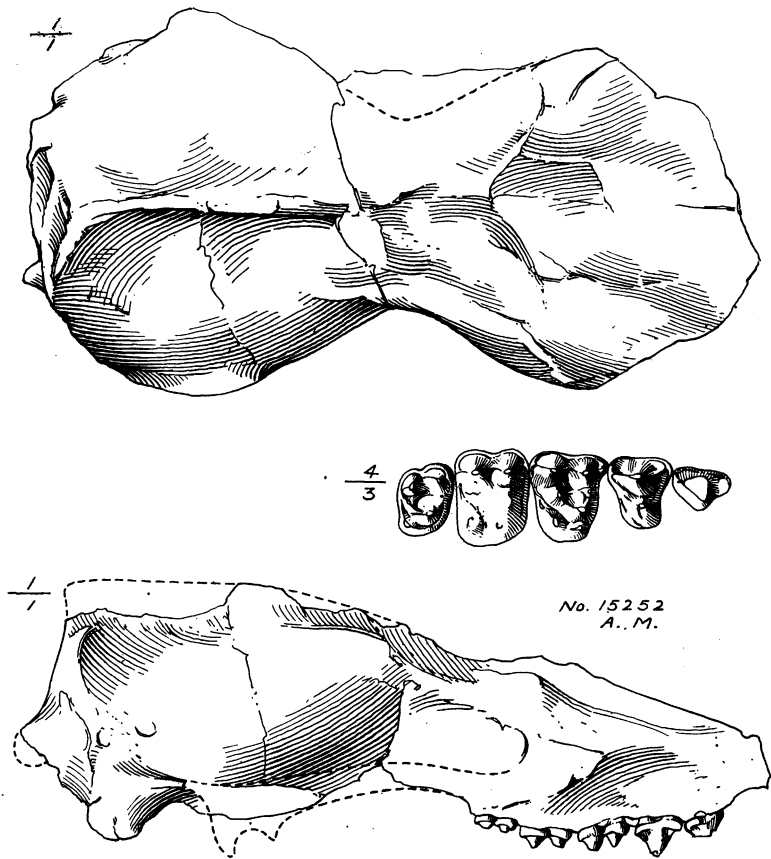


Fig. 7. *Thryptacodon olseni*, skull, top and side views natural size, and crown view of upper teeth, four-thirds nature. Type specimen, Gray Bull beds, Big Horn Basin, Wyoming.

*Arctocyon* and materially larger than in *Didymictis*. The basicranial region appears to be shorter than in *Didymictis* and *Vulpavus*; the bulla is absent as usual, the auditory prominence large and prominent (? owing to crushing). In other respects it accords with *Vassacyon* so far as comparisons can be made.

*Dentition.* The anterior teeth cannot be determined with certainty. There is a pair of large, stout, oval canines, apparently little curved, and in front of them are at least two unusually large incisive alveoli. The first two premolars are indeterminate, the third is of moderate size without inner cusp but triangular in outline. The fourth premolar has a triangular protocone, strong, well separated deutocone, external, internal and posterior cingula. The true molars are of subquadrate outline, one-fourth greater in transverse than in antero-posterior diameter, with low rounded conic cusps of equal height and an encircling cingulum. The second molar is a little larger than the first, the third much smaller. Paracone and metacone are close to the external margin, rounded, protocone more trihedral, metaconule moderately developed, paraconule rudimentary, hypocone prominent and distinct, extended anteriorly on  $m^{1-2}$  in a strong shelf internal to the protocone. In all three the hypocone is developed from the internal cingulum.

The measurements of the skull and teeth are about one-fifth greater than those of *Vulpavus profectus*, while the limbs are about one-half greater.

*Vertebrae.* The vertebrae are at present so much buried in matrix that a detailed description is not possible.

*Limb bones.* The humerus is like that of *Arctocyon* and the Cercoleptoid *Miacidæ*. The deltoid crest is shorter and more abruptly ended than in *Vulpavus*, the radius facet less convex from side to side.

The femur has a third trochanter, but quite small. The patellar trochlea

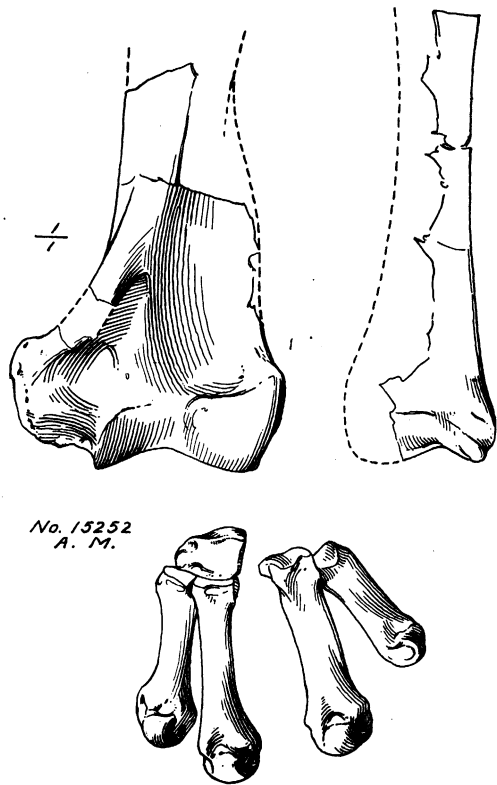


Fig. 8. *Thryptacodon olseni*, parts of fore limb: anterior view of distal ends of humerus and radius, dorsal view of metacarpus, with unciform, lacking digit III. Natural size, type specimen.

is longer than in *Vulpavus* and *Palæarctonyx*. The shaft of the radius is smaller in proportion to the ulna, and the shaft of the fibula is larger in proportion to the tibia than in the *Miacidæ*; the distal facets of tibia and fibula are somewhat more oblique and the astragalar trochlea of the tibia is

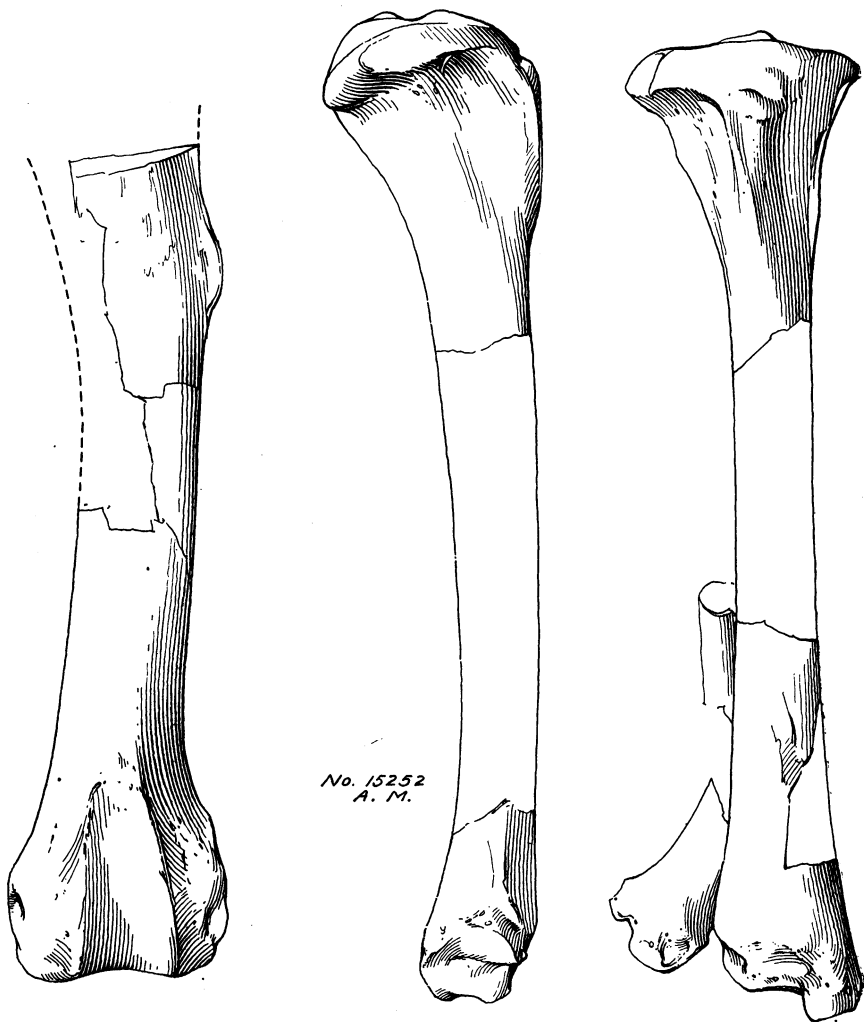


Fig. 9. *Thryptacodon olseni*, hind limb bones natural size, front view of femur, inner and front views of tibia, the latter with fibula somewhat displaced in matrix. Type specimen.

less excavated than in *Vulpavus*. The styloid process of the radius is less prominent. In all these features it approaches more nearly to the *Arctocyonidæ*.



*Fore foot.* The unciform and mc. I, II, IV and V are preserved. They are notably more robust than in *Vulpavus* as well as of larger size. The trapezoid facet of mc.II faces proximad instead of intero-proximad as in *Vulpavus*; the facet of mc.I for the trapezium likewise lacks the obliquity of the corresponding facet of mc.I on *Vulpavus*. These features indicate a less prehensile hand. The unciform is remarkably different from the known Miacidæ and Arctocyoniidæ in that it appears to indicate a serial carpus, there being no proximal facet for the lunar. There is a single proximal facet for the cuneiform, notable chiefly for its extent; a distal facet for mc. IV-V, imperfectly divided; and three internal facets, for mc.II, magnum, and centrale or lunar or both.

#### Measurements.

Length of upper cheek teeth $p^3$ - $m^3$ .....	31.8
Diameters of $p^3$ anteroposterior 4.5 transverse 4.1	
"    " $p^4$ "        5.8        "        6.5	
"    " $m^1$ "        6.8        "        8.2	
"    " $m^2$ "        6.7        "        8.8	
"    " $m^3$ "        5.0        "        7.	
"    " $c^1$ "        6.2        "        5.	
Length of skull from $p^3$ to mastoid process.....	80
Width of skull at prefrontal processes.....	43.5
Width of skull at postorbital constriction (this and the preceding dimension are much exaggerated by the crushing of the skull).....	27.5
Width of brain-case.....	45.3
Humerus, length from distal end to apex diameter of deltoid crest.....	66.8
"    diameter of distal end.....	38.0
Femur, length from distal end to apex of 3d trochanter.....	97.5
Radius, diameters of head, $13.5 \times 14$ .	
"    shaft one-fourth down $8.5 \times 5.5$ .	

#### ARCTOCYONIDÆ.

##### *Anacodon* Cope 1882.<sup>1</sup>

*Type, A. ursidens* from Lysite of Big Horn Basin, Wyoming.

*Generic characters:* Crowns of molar teeth flattened, rugose, cusps obscured, premolars  $\frac{2}{3}$  much reduced. Lower jaw flanged anteriorly, canine and incisors reduced and crowded, upper canine probably laniary.

Three additional specimens of this rare genus were secured by Mr. Granger in Wyoming and one in New Mexico. The Wyoming specimens are from the Lysite and uppermost Gray Bull zones, the New Mexican

<sup>1</sup> Proc. Am. Phil. Soc., Vol. XX, p. 181. Pal. Bull. No. 34.

specimens from the upper part of the Lower Wasatch. The matrix of the type specimen of *A. ursidens* as well as those referred to this species by Osborn in 1892 indicate that they are also from the Lysite horizon.

The new material shows that the lower jaw of *Anacodon* was heavily flanged at the chin as in the *Machærodonts*, the lower canine and incisors reduced and compressed even more than in *Hoplophoneus*. This probably indicates a large compressed sabre-like upper canine.

The specimen from the Lysite indicates a larger but more primitive species than *A. ursidens*. The New Mexican specimen is smaller than any of those from Wyoming and is perhaps a more primitive mutant, but is referred to Cope's species.

The flanged lower jaw is a quite unexpected character in this genus, for no trace of this specialization is present in *Clanodon* nor as far as I know in *Arctocyon*. It points evidently to some highly specialized food-habits, but is not comparable with that of the *Machærodonts* nor with the Oxyænid genus *Machæroides*, since it is here associated with frugivorous or omnivorous cheek teeth. *Bathyopsis* and *Uintatherium* are similarly flanged, but there is no close parallelism in the cheek teeth.

### ***Anacodon ursidens* Cope 1882.**

*Anacodon ursidens* COPE 1882, Pal. Bull. No. 34, Proc. Am. Phil. Soc., Vol. XX, p. 182; 1885, Tertiary Vertebrata, p. 427, pl. xxve, fig. 2; OSBORN (& WORTMAN), 1892, Bull. Am. Mus. Nat. Hist., Vol. IV, p. 115, fig. 13.

*Type*, No. 4261, parts of lower jaws from the Wasatch of the Big Horn Basin, Wyoming.

*Distinctive characters*:  $m_{1-3}=38$ .  $P^4$  rounded, subquadrate, with low protocone and deuterocone and distinct tritto- and tetartocone. Molars with rounded outline, cones low, much obscured by surface rugosities.

To this species is referred in addition to the specimens described by Osborn a lower jaw, No. 15711, from the top of the Gray Bull beds near Fenton in the Big Horn Basin. The greater part of the left ramus and about half of the right ramus are preserved. The jaw deepens anteriorly, and shows a sharply marked, broad, thin and deep dependent flange; the anterior part of the jaw is concave externally, the flange bordered anteriorly by a strong crest which runs up to the canine alveolus. The canine alveolus is relatively small and much compressed, the incisive alveoli are obscurely indicated but were evidently small, laterally compressed and crowded out of series. Behind the canine is a long diastema followed by the vestigial  $p_3$  and small two-rooted  $p_4$ .  $M_1$  is much smaller than  $m_2$ ,  $m_3$  somewhat smaller. The jaw becomes shallower but much thicker under the posterior molars.

The masseteric fossa is deep and extends forward to a point beneath the posterior end of  $m_3$ , bounded inferiorly by a well defined ridge and antero-superiorly by the high crest which runs upward to the anterior margin of the coronoid process.

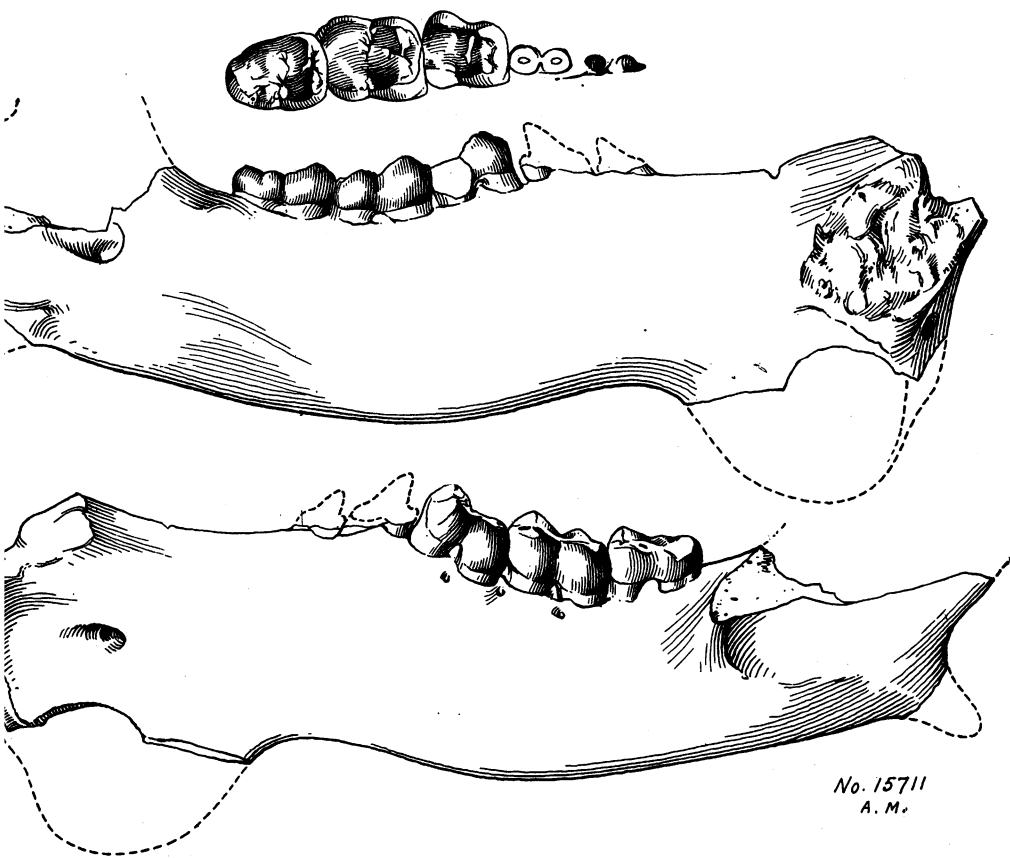


Fig. 10. *Anacodon ursidens*, lower jaw, inner and outer views and crown view of teeth, natural size. No. 15711, top of Gray Bull beds, Big Horn Basin, Wyoming.

No. 16781, lower jaw fragments with  $p_4$ - $m_3$  perfect and unworn, agrees with the described specimens save for smaller size. It is from the Upper Gray Bull horizon at head of Ten-Mile Creek in the Big Horn Basin.

The New Mexican specimen consists of parts of the lower jaw with  $m_{2-3}$  of the left, and  $m_1$  and  $m_2$  of the right side; it is slightly smaller and the teeth appear somewhat more primitive than *A. ursidens* from Wyoming, except No. 16781.

**Anacodon cultridens** sp. nov.

*Type*, No. 15638, upper and lower jaws from Lysite beds of the Big Horn Valley, at the head of Fifteen-mile Creek.

*Distinctive characters*:  $m_{1-2}=50$ ;  $p^4$  subtrigonal with cusps higher than in *A. ursidens*, no trittocone or tetartocone; molar cusps less flattened or obscured by crenulations.

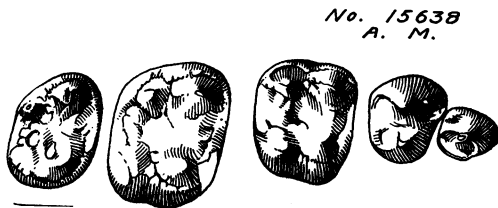


Fig. 11. *Anacodon cultridens*, upper and lower cheek teeth, crown views, natural size. Type specimen, Lysite beds, Big Horn Basin, Wyoming.

This species is about one-fourth larger in lineal measurements, but more primitive in the construction of molar and premolar teeth. The jaw is flanged anteriorly, but the flange does not appear to be so deep as in *A. ursidens*. The specimen consists of upper and lower jaws apparently with some fragments of the skull, but the bone is badly preserved

and obscured by hard matrix, so that little can be determined with certainty beyond the characters of the premolars and molars,  $p^2-m^3$ ,  $p_4-m_3$  which are in good preservation.

## MIACIDÆ.

This family is represented by six genera and fourteen species in the Lower Eocene formations. Four of the genera survive into the Middle Eocene. The Miacidæ are a group of genera divergently specializing into predaceous and frugivorous adaptations, ancestral to the Fissipede carnivora, and to some extent foreshadowing their broader groups. In the Lower Bridger they are divided primarily into two groups, the Viverravinæ with one genus *Viverravus*, and the Miacinæ with *Uintacyon*, *Miacis*, *Oödetes* and *Vulpavus*. Following these divisions down into the Wasatch horizons, we find the Viverravinæ (represented by *Viverravus* and *Didymictis*) still well distinguished from the Miacinæ (represented by *Uintacyon*, *Miacis*, *Vassacyon* and *Vulpavus*), but the genera of each group approximate, especially

towards the base of the Wasatch, so that it becomes much more difficult to distinguish the species and assign them to their proper genera. The Lower Eocene species of the family are far less divergent than those of the Bridger, and often combine in varying proportions distinctive characters which in the Bridger stage have become sorted out into well differentiated and distinct genera. In 1909 I based a new genus, *Vassacyon*, upon one of these Wasatch species which combined characters of *Miacis*, *Vulpavus* and *Uin-tacyon* and referred the remaining described species to those genera to whose type species they appeared to be most nearly related. I knew at that time of a number of undescribed species from the Lower Eocene, but postponed description until more and better material should be at hand as a result of Mr. Granger's expeditions. This new material confirms the arrangement made in 1909, but shows that in addition to the four genera there noted, two others are represented. In every case the species, and especially the species or mutants from the older horizons, are more or less synthetic in type.

Had we to deal with the species of *Didymictis* and *Viverravus* from the Gray Bull, it would be natural to put them under a single genus. But the Lost Cabin species fall into two well distinguished genera. Similarly, if we had to deal only with the Gray Bull species of *Miacinæ*, they might well be included under a single, rather broadly inclusive genus, while the Middle Eocene species fall into four clearly distinct generic groups. It might seem that the affinities of the Lower Eocene species would be better expressed by so uniting them into a single primitive genus from which the specialized genera of the Middle Eocene could be derived. But I have failed to find any primitive characters which would serve to define such a genus in distinction from the Middle Eocene genera already described, and have therefore been compelled to distribute the Lower Eocene species for the most part, among the specialized genera. That is to say, the evolution of the several Miacid phyla was divergent, and not to any extent parallel progressive.

The affinities of the phyla as illustrated by the known species with their geological range appear to be about as follows: *Miacis* represents the central type, from which have diverged a number of specialized phyla, some becoming more predaceous, others frugivorous or omnivorous, as indicated by the teeth and other adaptive features of skull and skeleton. Of these, *Didymictis* is the earliest, and presents a succession of species of progressively larger size and with the carnassial dentition more differentiated, but retaining the tubercular dentition much as in *Viverra*. *Viverravus* is an allied phylum paralleling some of the smaller modern Viverridæ, with the tubercular dentition more reduced; its earlier species show a much more

marked approach to the Miacinæ in the premolar teeth than do the earlier species of *Didymictis*. *Uintacyon* is nearly allied to *Miacis* but with trenchant heels on the molars, and progressively reduced premolars. It is intermediate in numerous particulars between *Viverravus* and *Miacis*. The central genus *Miacis* diverges in the later Eocene into a number of subgenera, the genus thus repeating the differentiation which the family Miacidæ underwent at an earlier stage. *Vassacyon* and *Vulpavus* are specializations from the *Miacis* type towards a more frugivorous mode of life paralleling the Procyonidæ especially *Cercoleptes*<sup>1</sup>; the Lower Eocene species are closely allied to those of *Miacis* but *Vulpavus* is more divergent in the Middle Eocene, paralleling *Procyon* and differentiating into subgenera; *Palæarctonyx* is a more extreme frugivorous adaptation, paralleling *Cercoleptes*, and probably derived from some species of *Vulpavus*. *Oödictes* seems to be another specialization from *Miacis* in somewhat the same direction, but with suggestions of insectivorous adaptation.

The Arctocyonidæ represent one or more earlier specializations in the same direction as these Cercoleptoid and Procyonoid Miacidæ. But they are derivatives not from the *Miacid* type, but from an earlier evolutionary stage in which the carnassial dentition had not yet specialized. In adaptation, *Clænodon*, *Thryptacodon* and *Vulpavus* correspond rather closely; so do *Anacodon* and *Palæarctonyx*. But they belong evidently to different phyla.

*Key to Genera of Miacidæ.*

- A. Antero-external cusp of  $p^4$  prominent. Molars  $\frac{2}{3}$ ,  $m_2$  elongate oval.
  - B. Lower molars with basin heels.....*Didymictis*.
  - BB. Lower molars with trenchant heels.....*Viverravus*.
- AA. Anteroexternal cusp of  $p^4$  weak or absent. Molars  $\frac{3}{4}$ ,  $m_2$  and  $m_3$  short-oval or round.
  - B. Carnassials well differentiated,  $p^4$  extended postero-externally, trigonid of  $m_1$  high, of  $m_{2-3}$  low.
    - C. Lower molars with trenchant heels.....*Uintacyon*.
  - CC. Lower molars with basin heels.
    - D.  $M_2$  and  $m_3$  and heel of  $m_1$  relatively small, premolars unreduced.  
*Miacis*.
    - DD.  $M_2$  and heel of  $m_1$  large, premolars reduced.....*Vassacyon*.
  - BB. Carnassials little differentiated,  $p^4$  not extended posteroexternally, trigonids of molars similar.
    - C. Lower molars with trenchant heels, trigonids high.....*Oödictes*.
    - CC. Lower molars with basin heels, trigonids low,  $m_2$  and  $m_3$  and heel of  $m_1$  large.....*Vulpavus*.
    - CCC. Lower molars flat topped, premolars much reduced....*Palæarctonyx*.

<sup>1</sup> I take occasion to note that the expression "Cercoleptoid Miacidæ" does not involve any hypothesis that *Cercoleptes* is descended from this group, but merely that the teeth show a similar adaptation.

***Didymictis* Cope 1875.<sup>1</sup>**

*Type, D. protenus* (COPE 1874) from Wasatch of New Mexico.

*Syn., Viverravus* WORTMAN (and MATTHEW) 1899, MATTHEW 1901, in part.  
Not *Viverravus* MARSH 1872.

Distinguished from *Viverravus* by the broader, basined heels of the lower molars; upper molars with metaconule and posterior crest of protocone well developed.

This genus is among the most abundant and best known of the Lower Eocene Creodonts, ranging from Torrejon to Lost Cabin, the species pro-



Fig. 12. *Didymictis*, upper teeth of *D. altidens* (Lost Cabin beds), *D. protenus* (Gray Bull beds) and *D. haydenianus* (Torrejon formation). All natural size, crown views.

gressively larger and more robust, with the tubercular and sectorial dentition more clearly differentiated in the later species, the jaw heavier and deeper.

The Torrejon *Didymictis*, *D. haydenianus*, differs materially from the later species, approaching *Viverravus* in the acute angulate form of the cusps, higher trigonid of  $m_2$ , and the compressed premolars, although it shows the basined heels of the molars which are the primary generic distinction.

<sup>1</sup> Syst. Cat. Vert. Eoc. New Mex., p. 5.



*Key to Species of Didymictis.*

- A.  $M_2$  with higher trigonid, imperfectly tubercular. Protocone of  $m^1$  high angulate, with posterior wing weak. Two posterior accessory cusps on  $p_4$ , none on  $p_3$ .
  - 1. Length of  $p_1-m_2 = 33-38$ , of  $m_{1-2} = 14$  mm. . . . . *D. haydenianus*.
- AA.  $M_2$  tubercular with low trigonid. Protocone of  $m^1$  broader with anterior and posterior wings subequal. A posterior accessory cusp on  $p_3$  and  $p_4$ .
  - 2a. Length of  $p_1-m_2 = 45-53$  mm.,  $m_{1-2} = 16-18$  mm. . . *D. protenus leptomylus*.
  - 2. Length of  $p_1-m_2 = 55-60$  mm.,  $m_{1-2} = 19-22$  mm. . . . . *D. protenus*.
  - 2b. Length of  $p_1-m_2 = 65-70$  mm.,  $m_{1-2} = 21-24$  mm. . . *D. protenus lysitensis*.
  - 3. Length of  $p_1-m_2 = 70-75$  mm.,  $m_{1-2} = 24-26$  mm. . . . . *D. altidens*.

***Didymictis protenus leptomylus* Cope 1880.**

*Didymictis leptomylus* COPE 1880, Amer. Nat., Vol. XIV, p. 908; 1885, Tertiary Vertebrata, p. 309, pl. xxva, fig. 12; pl. xxvd, fig. 6; MATTHEW 1901, Bull. A. M. N. H., Vol. XIV, p. 10.

*Type*, A. M. No. 4238, lower molars ( $m_{1l}$ ,  $m_{2r}$  &  $l$ ) recorded as from the Wind River Basin, Wyoming, but more probably from Big Horn Basin.

Cope distinguished this species from *D. protenus* by the smaller size and more elongate  $m_2$ . In 1885 he referred to it, as a larger variety, a number of jaws from the Big Horn Basin intermediate in size between the type and *D. protenus*. Matthew in 1901 referred to this larger variety a number of upper and lower jaws and fragmentary skeletons from the lower levels of the Big Horn Wasatch, and pointed out certain additional distinctions in the teeth. Several specimens of upper and lower jaws obtained by the Museum parties of 1910-12 from the Clark Fork and Sand Coulée (red-banded beds) and lower levels of the Gray Bull, confirm these characters. All the specimens, however, except one, are larger than the type, and the intergradation with the typical *D. protenus* makes it appear that this is a primitive subspecies scarcely entitled to distinct specific rank.

*Distinctive characters*:  $p_1-m_2 = 45-53$  mm.,  $m_{1-2} = 16$  mm. (type) to 18 mm. Parastyle of  $m^1$  less extended.

Nos. 15856, 16071, lower jaws, and several unnumbered jaw fragments with upper and lower teeth from the Clark Fork beds are referable to *D. leptomylus*; Nos. 2806, 2855, upper and lower jaws with considerable parts of skeleton are from the lower beds of the Wasatch in the Big Horn Valley but their exact level is uncertain. Of the later collections, the specimens from the lower levels of the Gray Bull horizon are all of size approximating the above measurements; in the middle and upper levels the specimens are progressively larger and agree more nearly with *D. protenus*.

***Didymictis protenus* (Cope 1874).**

*Limnocyon protenus* COPE 1874, Rep. Vert. Foss. New Mex., p. 15; (*Didymictis*) 1875, Syst. Cat. Vert. Eoc. New Mex., p. 11; 1877, Ext. Vert. New Mex., p. 123, pl. xxxix, figs. 1-9; 1885, Tertiary Vertebrata, p. 311, in part.

*Syn. Didymictis curticens* COPE 1882, Pal. Bull. 34, Proc. Am. Phil. Soc., Vol. XX, p. 160; Tert. Vert. p. 313, pl. xxivd, fig. 10.

*Type*, U. S. Nat. Mus. No. 1092, lower jaws from the New Mexican Wasatch.

*Distinctive characters*:  $P_1-m_2 = 55-60$  mm.;  $m_{1-2} = 19-22$  mm. Parastyle of  $m^1$  considerably extended, with oblique crest, no distinct metastyle on cingulum.

This is the typical and best known species of the genus, and is represented in our collections by a large series of specimens, including several skulls, with fragmentary skeletons, and numerous upper and lower jaws. The greater part are from the Big Horn Basin, but three lower jaws are from the New Mexican Wasatch, a number of parts of jaws from the Wind River and Clark Fork basins, and a single jaw fragment from the Evanston Wasatch.

The New Mexican specimens agree fairly well with the type; they represent both upper and lower horizons. The specimens from the Lysite level in the Big Horn and Wind River basins, are uniformly larger and are referred to a more progressive mutant. To this variety also belong a number of Big Horn specimens of earlier collections; their horizon is not exactly recorded, but from such records as exist of level and locality, and from the character of matrix and preservation, it appears that they are from the Lysite or the upper levels of the Gray Bull. Among these are the specimens figured by Cope in 1885 and Matthew in 1901. This larger variety (*D. protenus lysitensis* infra) is not recognized in the New Mexican Wasatch, but the Evanston specimen appears to be referable to it.

*Didymictis curticens* was based upon a lower jaw fragment in which the space behind the carnassial for  $m_2$  is less than normal; but this may be due to immaturity or to abnormal retardation of the eruption of  $m_2$ ; it is not distinguishable otherwise from *protenus* and no other specimens confirm its supposed characters.

***Didymictis protenus lysitensis* mut. nov.**

*Didymictis protenus* COPE 1885, Tert. Vert. p. 311, pl. xxvd, figs. 4 and 5; (*Viverravus*) MATTHEW 1901, Bull. A. M. N. H., Vol. XIV, p. 8, figs. 1-5.

*Type*, No. 15639 from Lysite of 15-mile Creek, Big Horn Basin, Wyoming.

*Distinctive characters*:  $p_1-m_2 = 65-70$  mm.;  $m_{1-2} = 21-24$  mm. Parastyle of  $m^1$  much extended with oblique crest, sometimes double cusped; metastyle a more or less distinct cusp.

This is intermediate between *protenus* and *altidens*. All the specimens from the Lysite horizon in the Big Horn and Wind River basins conform to the above characterization. A number of specimens in the older collections also agree with it, and most if not all of them appear from the character of

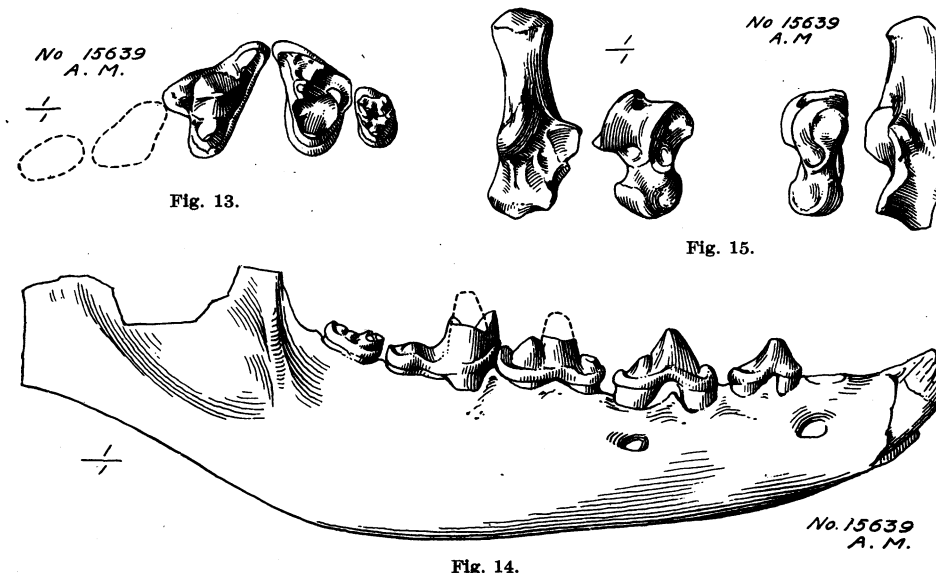


Fig. 13. *Didymictis protenus lysitensis*. Upper teeth of type skeleton, crown view, natural size left side,  $m_1$  reversed from right side. Lysite beds, Big Horn Basin, Wyoming.

Fig. 14. *Didymictis protenus lysitensis*, lower jaw, outer view, natural size. From type specimen, fragmentary skeleton from Lysite beds of Big Horn Basin, Wyoming.

Fig. 15. *Didymictis protenus lysitensis*, calcaneum and astragalus of type specimen, natural size, superior and internal views.

the matrix or the records of locality to be from the Lysite or the upper levels of the Gray Bull. The New Mexican Wasatch has not yielded any specimens referable to this subspecies, although some are larger than the type of *D. protenus*.

Nos. 2831, 4230, 15640-3, 83, 4236, etc., are from the Big Horn Basin, 12812a, 12775 from the Wind River Lysite.

### *Didymictis altidens* Cope 1880.<sup>1</sup>

*Type*, No. 4792, lower jaw fragments with  $m_1$  and  $m_2$ , from the Wind River Basin, Wyoming.

This species is characteristic of the Lost Cabin horizon, from which Mr.

<sup>1</sup> Amer. Nat., Vol. XIV, p. 746.

Granger obtained a number of upper and lower jaws more or less fragmentary, affording between them a fairly complete reconstruction of upper and lower cheek teeth.

The distinctions from *D. protenus* are the larger and more robust teeth,

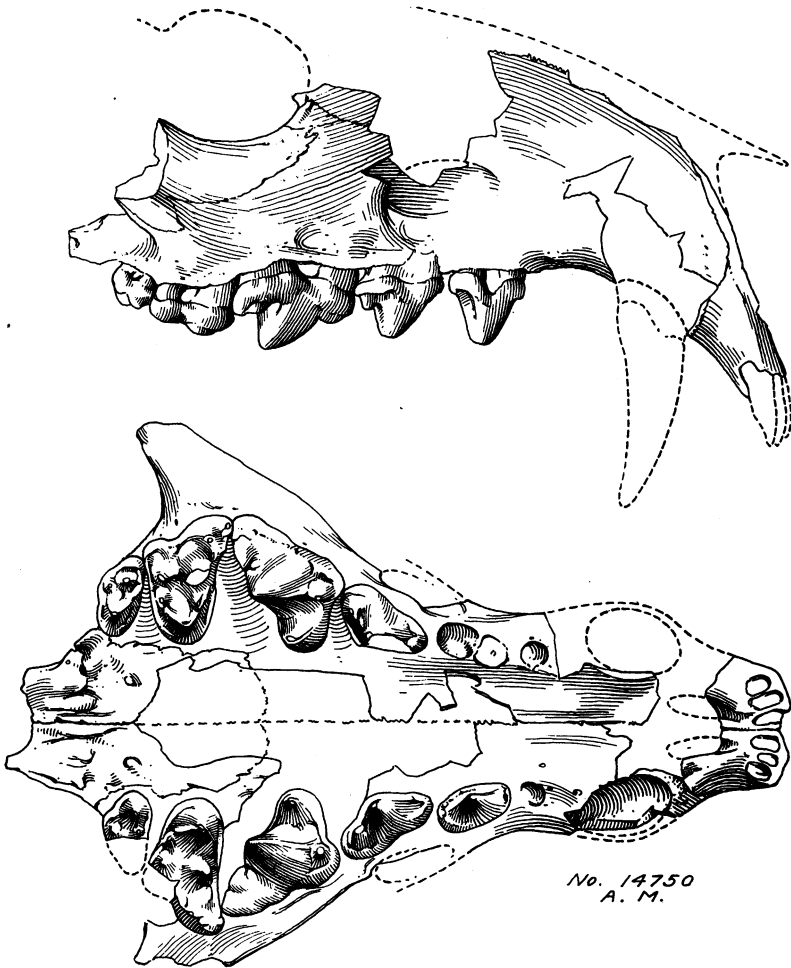


Fig. 16. *Didymictis altidens*, palate, natural size. No. 14750, Lost Cabin beds, Wind River Basin, Wyoming.

heavier protocone and deutocone of  $p^4$ , discontinuous internal cingulum of  $m^1$ ,  $m^2$  more oval in outline, less extended transversely, with broader anteroexternal cingulum and more reduced metacone, lower premolars with

more massive but less distinct posterior accessory cusps, hypoconid of  $m_1$  larger and more massive and more central in position, filling up most of the "basin" of the heel,  $m_2$  broader and with shorter heel. Jaw a little longer than in *D. protenus* but considerably deeper.

Nos. 14749-52 upper and lower jaws from the Lost Cabin horizon in the

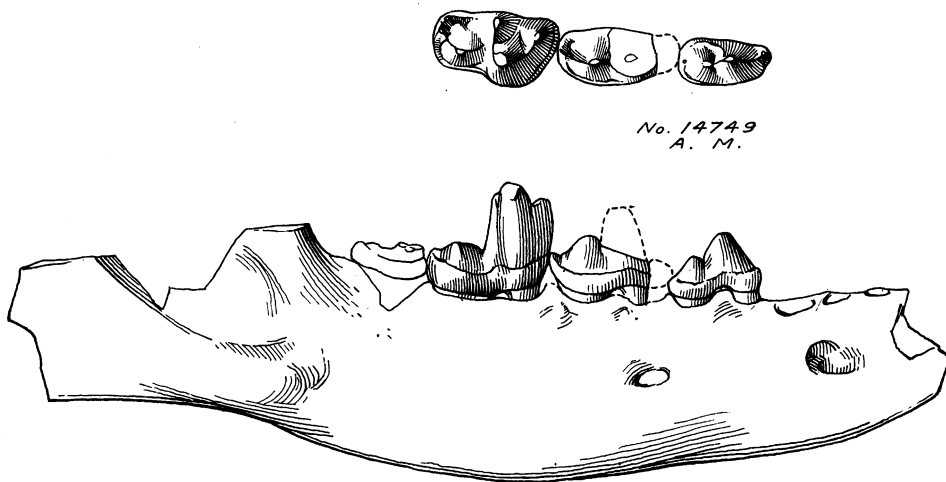


Fig. 17. *Didymictis altidens*, lower jaw, outer view, with crown view of teeth, natural size. No. 14749, Lost Cabin beds, Wind River Basin.

Wind River Basin, and 4792-8 fragments of jaws and teeth probably from the same level, are referable to this species. The specimens from the Lysite horizon are referable to *D. protenus*. In the Big Horn Basin a specimen has been described by Prof. Scott as *D. altidens*.<sup>1</sup> Information as to the exact locality of this specimen was kindly supplied by Professor Scott. It is from the westward extension of Tatman Mountain in the Big Horn Basin and was associated with *Lambdotherium*. Its horizon is thus fixed as Lost Cabin.

In No. 14750 the palate is very well preserved, and in No. 14749 the lower jaw.

I refer to this species No. 14781, a specimen from the Lost Cabin beds in the Wind River Basin, consisting of the tibiae, fibulae and complete hind feet, with a few other fragments. The reference is based upon agreement in construction of the foot bones with the corresponding parts in associated specimens of the smaller species.

<sup>1</sup> SCOTT, 1888, Jour. Acad. Nat. Sci. Phila., Vol. IX, p. 169.

The feet display the characters of *Viverravinae* as outlined by Matthew in 1909. The ungual phalanges are long, not strongly curved or compressed as in the *Miacinae*, but as in all *Eucrodi* they are unfissured at the tips. The symmetry of the pes is paraxonic, mt. III and IV paired. The hallux is not divergent as it is in *Vulpavus*, nor have the cuneiforms the curious oblique facets noticed in that genus; in this and other respects they are more like those of modern *Carnivora*. The astragalus has a considerable cuboid facet, a very oblique and shallow grooved trochlea, the outer crest more distinct than in *Miacinae*. The forward movement of the tibia is limited by two well marked facets upon the neck of the astragalus; one for the internal malleolus upon its inner slope, the other for the anterior face of the tibia upon the outer slope of the neck, and continuous with the trochlea. The astragalar foramen limits the play of the tibia posteriorly so that the motion at this joint is not extensive. The movement of the fibula on the calcaneum is similarly limited. The patellar trochlea of the femur is very long, the patella small and flat, not elongate; the condyles of the femur face posteriorly. The fibula is unusually heavy; tibia and fibula moderately long. The proximal and second row of phalanges are of moderate depth and permit extended movement on the metapodials; the second phalanx is slightly asymmetric but not excavated for a retractile claw.

The unciform is broad and low, with a fairly wide lunar facet, whose angle with the cuneiform facet is very slight.

The construction of the pes in this genus differs very considerably from that in the *Miacinae*, although it has the essential family features. It affords an interesting comparison with the pes of *Oxyæna* from the same formation.

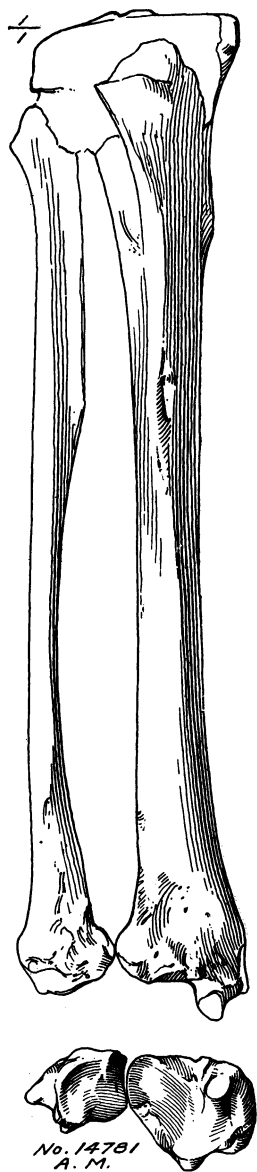


Fig. 18. *Didymictis altidens*, tibia and fibula, natural size, anterior and distal views, No. 14781, Lost Cabin beds, Wind River Basin.

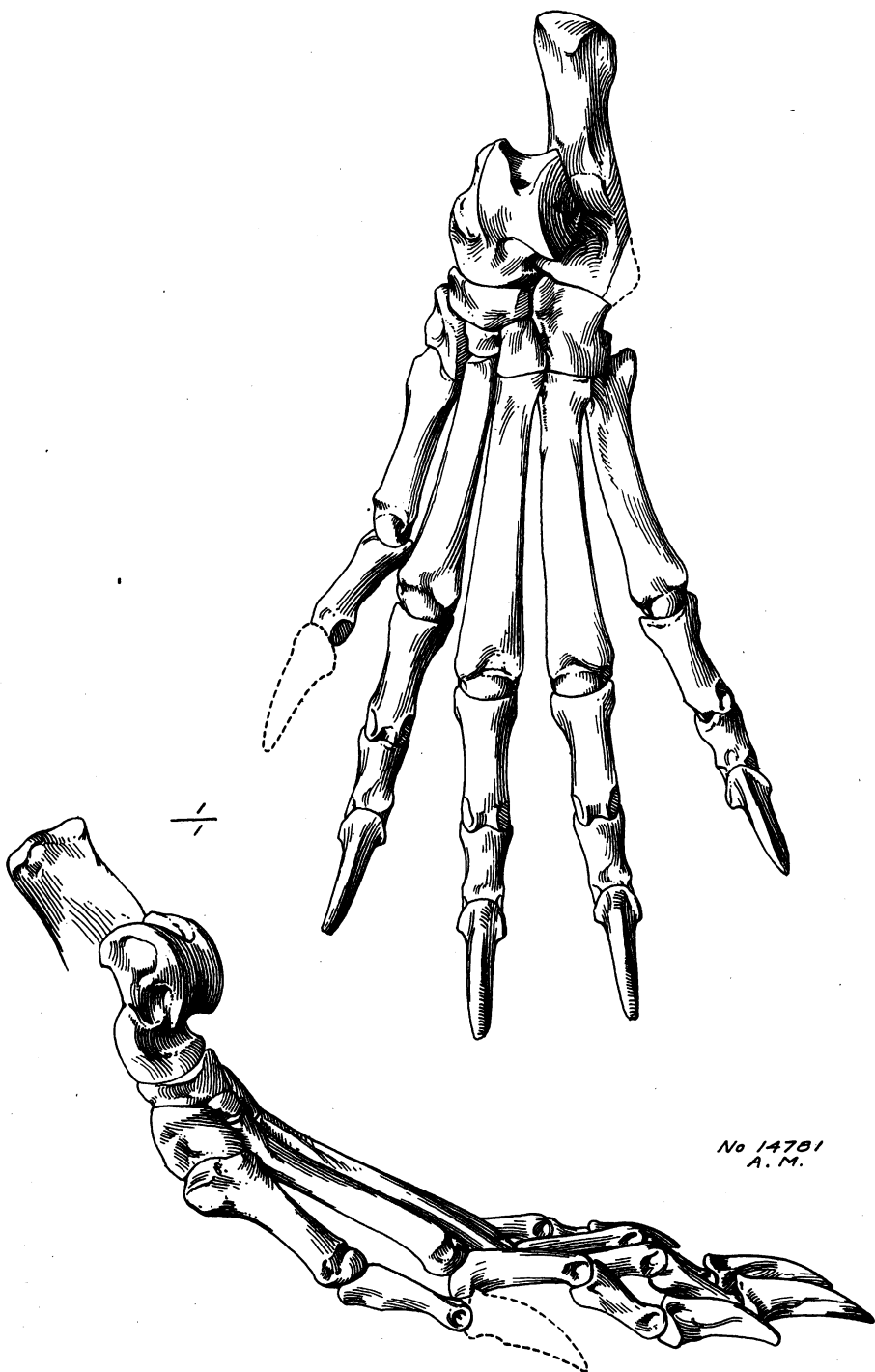


Fig. 19. *Didymictis altidens*, hind foot, dorsal and inner views, natural size. No. 14781, Lost Cabin beds, Wind River Basin.



**Viverravus** Marsh 1872.<sup>1</sup>

*Type*, *V. gracilis* from Lower Bridger of Wyoming.

*Syn.*, *Didymictis* COPE, in part.

This genus is represented in the Lost Cabin and Lysite beds by *V. dawkinsianus* (Cope), in the Sand Coulée and Gray Bull by two undescribed species with premolars very like those of *Miacis*. The successive species from Sand Coulée to Bridger show a progressive elongation of the premolar region of the jaw and lengthening of the premolars. *V. dawkinsianus* is close to *gracilis*; the two older species are much more primitive. No notable change occurs in the molar teeth.

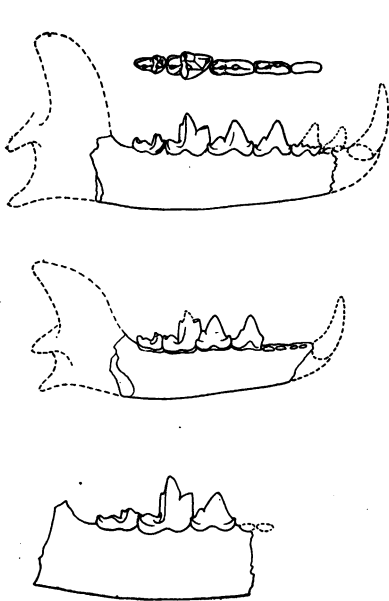


Fig. 20.

Fig. 20. *Viverravus*, lower jaws of three species of the Lower Eocene. Above, *V. dawkinsianus*, Lost Cabin zone, middle figure *V. acutus*, lower figure *V. politus*, both Sand Coulée and lower Gray Bull zone. All natural size.

Fig. 21. *Viverravus acutus*, lower jaw, inner and outer views and crown view of teeth, twice natural size, with outline of natural size. Type specimen, Sand Coulée beds, Clark Fork Basin.

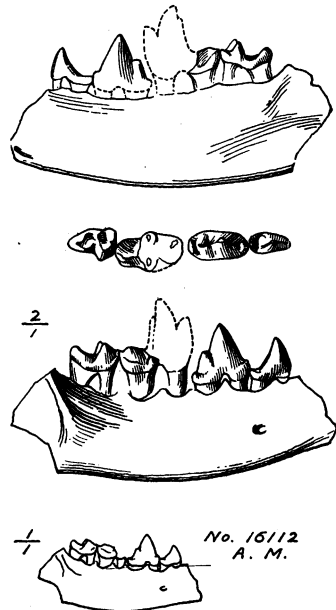


Fig. 21.

**Viverravus acutus** sp. nov.

*Type*, A. M. No. 16112, parts of lower jaws and fragments of upper jaws from Sand Coulée beds, Clark Fork, Wyoming.

<sup>1</sup> Amer. Jour. Sci., Vol. IV, p. 127.

**Distinctive characters:** Premolars high, short, compressed, like those of *Miacinae*. A small posterior accessory cusp on  $p_4$ , none on  $p_3$ .  $m_{1-2}$  7.5 mm.

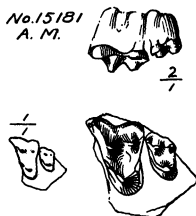


Fig. 22. *Viverravus acutus*, upper jaw fragment with molar teeth, enlarged to two diameters, and outline of natural size. No. 15181, Gray Bull beds, Big Horn Basin.

This species is smaller than *V. dawkinsianus* and readily distinguished by the proportions of the premolars, very different from the elongate teeth of all other *Viverravinae* and resembling those of *Miacis*. The molar teeth are reduced copies of *dawkinsianus*. Five lower jaws Nos. 15174, 15181, from the Gray Bull beds and Nos. 89, 90 and 4247 from the Big Horn basin, probably Gray Bull beds, are referable to this species but all somewhat more progressive in the direction of *V. dawkinsianus*.

### ***Viverravus politus* sp. nov.**

**Type**, No. 16113, lower jaws with  $m_{1-2}r$ ,  $p_4-m_{2l}$ ., from Sand Coulée beds in Clark Fork Basin, Wyoming.

**Distinctive characters:** Premolars short and high, as in *Miacis*;  $m_{1-2}$  = 12.5 mm.

This species, like *V. acutus*, retains the short high premolars of *Miacis*, but is a much larger animal, intermediate in size between *V. gracilis* and *V. sicarius*.

No. 15180, comprising parts of both rami of the lower jaw from the Gray Bull Beds, Big Horn Basin, is referred to this species but is somewhat larger and more robust than the type.

### ***Viverravus dawkinsianus* (Cope 1881).**

*Didymictis dawkinsianus* COPE, 1881, Bull. U. S. G. S. Terrs., Vol. VI, p. 191; 1885, Tertiary Vertebrata, p. 310, pl. xxva, fig. 11; (*Viverravus*) WORTMAN, 1899, Bull. A. M. N. H., Vol. XII, p. 136.

**Type**, No. 4788, lower jaw from the Lost Cabin horizon of the Wind River Basin, Wyoming.

**Distinctive characters:** Premolars long, compressed, not high, prominent posterior accessory cusps on  $p_3$  and  $p_4$ . Length of  $p_{1-4}$  less than twice  $m_{1-2}$ ;  $p_1-m_2$  (approximately) = 27.5;  $m_{1-2}$  = 10 mm.

This species is closely allied to *V. gracilis*. I can find no evidence for Cope's statement that  $p_1$  has but one root, but the premolar portion of the

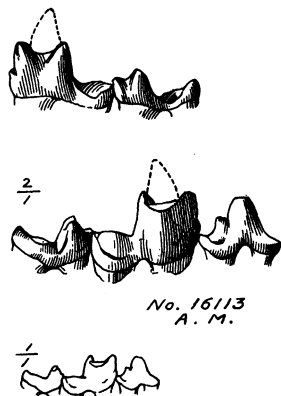


Fig. 23. *Viverravus politus*, lower teeth inner and outer views enlarged to two diameters, and outline of natural size. Type specimen, No. 16113, Sand Coulée beds, Clark Fork Basin.

jaw is shorter than in *V. gracilis* (in which  $p_1 - m_2 = 30$  mm.;  $m_{1-2} = 9.5$  mm.). It is thus intermediate between *V. acutus* and *gracilis*, but nearer to the latter. Six lower jaws, all from the Lost Cabin horizon in the Wind River Basin, are referable here.

### **Uintacyon** *Leidy* 1871.

*Type*, *U. edax* from Middle Eocene (Bridger).

*Generic characters*: Dentition  $\frac{73.1.4.73}{73.1.4.3}$ ;  $p^4$  carnassiform with small parastyle;  $m^{1-2}$  with moderately extended parastyles, metacones slightly smaller than paracones, protocones lacking posterior crest. Lower premolars reduced, posterior accessory cusps rudimentary;  $m_1$  with high trigonid and trenchant heel,  $m_2$  short with low trigonid and small trenchant heel.

Two distinct species are represented in our Lower Eocene collections. One, "*Didymictis*" *massetericus* Cope is about the size of the Bridger species

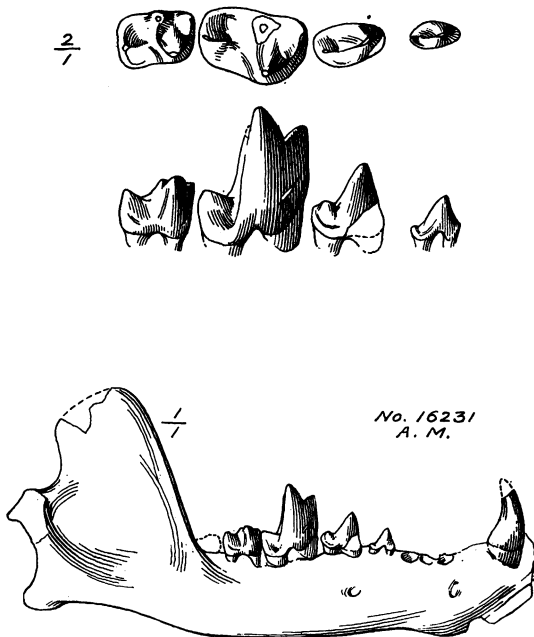


Fig. 24. *Uintacyon massetericus*, lower jaw, outer view, natural size, and crown and outer views of teeth enlarged to two diameters. No. 16231, Almagre beds, Wasatch formation, San Juan Basin, New Mexico.

*U. jugulans*. The other is about as large as *U. vorax* Leidy. Both are rare. The genus is differentiated from *Miacis* by the trenchant heels of its lower

molars and lack of a posterior crest of the protocone on upper molars. From *Viverravus* it is distinguished by the reduced premolars, short molars and retention of  $m_3$ . It occupies therefore an intermediate position between these two genera.

**Uintacyon massetericus** (Cope 1882).

*Didymictis massetericus* COPE 1882, Proc. Am. Phil. Soc. Vol. XX, p. 160; 1885, Fertiary Vertebrata, p. 312, pl. xxive, fig. 11; (*Uintacyon*) MATTHEW, 1909, U. S. G. S. Bull. 361, p. 93.

Type, No. 4250, lower jaw with  $p_4$ - $m_2$  l., from the Wasatch of the Big Horn Basin, probably Lysite or upper Gray Bull.

Specific characters:  $p_{1-4} = 17.5$ ;  $m_{1-3} = 14.5$ . Heels of lower molars shorter and wider than *U. jugulans*, posterior accessory cusp of  $p_4$  much smaller.

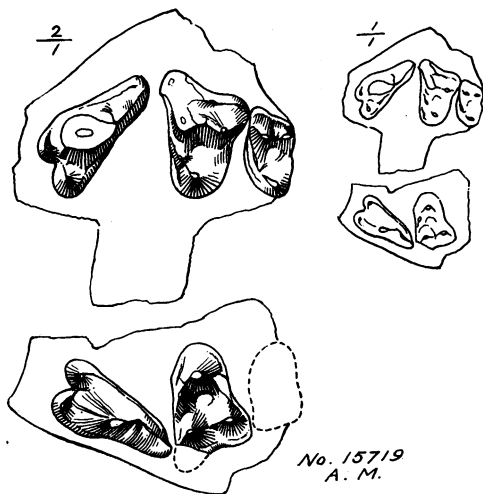


Fig. 25.

Fig. 25. *Uintacyon massetericus*, upper jaw fragments with  $p_4$ - $m_2$  left and  $p_4$ - $m_1$  of right side, enlarged to two diameters, with outline of natural size. No. 15719, lower Gray Bull beds, Big Horn Basin.

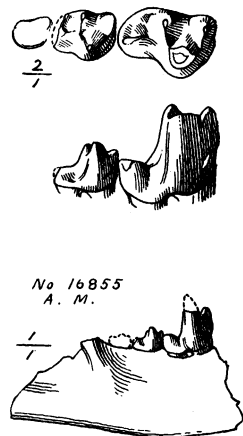


Fig. 26.

Fig. 26. *Uintacyon massetericus rudis*. Type specimen, lower jaw fragment, natural size, outer view, and outer and crown views of teeth, twice natural size. Sand Coulée beds, Clark Fork Basin.

In addition to the type I refer to this species two lower jaw fragments Nos. 15647 from the Lysite of the Big Horn Basin, No. 16749 from the upper Gray Bull beds, Big Horn Basin, and also No. 15719, upper jaw fragments from the Gray Bull horizon of the Big Horn. A nearly complete lower jaw, No. 16231, from the lower beds of the Wasatch of New Mexico also agrees quite closely with the type.

The species is near to *U. jugulans*, but the jaw is deeper, the premolar region more reduced, the molars shorter. The upper jaw shows  $p^4-m^2$  in good preservation.  $P^4$  has the inner cusp comparatively small and anterior in position, and the anteroexternal cusp is stronger than in other species, approaching *Viverravus*. The molars also approach *Viverravus* in construction, the protocone lacking the posterior wing, while the anterior wing is high and nearly continuous with the strong protoconule as a very marked transverse crest. Unlike *Viverravus* the paracone and metacone are of nearly equal size, and parastyle only moderately extended. The second molar has very little parastyle, the external shelf is rather narrow and is practically absent outside the metacone. Presence of  $m^3$  is not demonstrated.

**Uintacyon massetericus rudis mut. nov.**

*Type*, No. 16855, a lower jaw fragment from Sand Coulée horizon in Clark Fork Basin.

*Distinctive characters*:  $M_2$  smaller than in the type, the trigonid more distinct from talonid and higher; talonid smaller.

This is a primitive stage of Cope's species with the carnassial and tubercular dentition less sharply differentiated. Nos. 16750 and 16751, from the Systemodon zone are intermediate between this and typical *massetericus*.

*Measurements.*

	Type, No. 4250	No. 16231, New Mex.	No. 15719, Gray Bull	No. 16750, Gray Bull	No. 15647, Lysite
Total length of jaw, canine to condyles.....	67				
Lower premolars, $p_{1-4}$ .....	17.5				
Lower molars, $m_{1-3}$ .....	13.8				
Upper teeth, $p^4-m^2$ .....			16.6		
$P^4$ anteroposterior diameter.....			8.5		
“ transverse “.....			5.0		
$M^1$ anteroposterior “.....			5.5		
“ transverse “.....			8.0		
$M^2$ anteroposterior “.....			3.1		
“ transverse “.....			5.9		

## Measurements.—(Continued.)

	Type, No. 4250	No. 16231, New Mex.	No. 15719, Gray Bull.	No. 16750, Gray Bull.	No. 15647, Lysite
P <sub>3</sub> , anteroposterior diameter.....					
“ height of crown.....					
P <sub>4</sub> anteroposterior diameter.....	6.1				5.3
“ height of crown.....	4.9				4.4
M <sub>1</sub> anteroposterior diameter.....	6.9			7.0	7.3
“ transverse “ of trigonid.....	4.7			4.1	
“ height of protocone from base of enamel.....	6.9			6.2	
“ anteroposterior length of heel.....	2.5			2.5	
M <sub>2</sub> anteroposterior diameter.....	4.0			4.5	4.6
“ transverse “.....	3.6			3.2	3.8

**Uintacyon cf. vorax.**

A larger species is represented by No. 15748, two lower jaw fragments of one individual from the Gray Bull beds of Shoshone River in the Big Horn Basin. It is very probably distinct from the Middle Eocene species with which I have compared it, but the specimen does not show any clearly distinctive characters.

## Measurements.

P <sub>4</sub> -m <sub>3</sub> .....	26.5
M <sub>1</sub> diameters, a-p × tr.....	8.4 × 5.7
M <sub>2</sub> “ “ “.....	6.0 × 4.2
Heel of m <sub>1</sub> diameters a-p by tr.....	3.3 × 4.7
Depth of jaw beneath m <sub>1</sub> .....	17.1

**Miacis Cope 1872.<sup>1</sup>**

Type, *M. parvivorus* from the Lower Bridger of Wyoming.

To this genus may be referred two species from the Lower Eocene. The differentiation of the carnassial dentition is a little less advanced than in

<sup>1</sup> Pal. Bull. No. 3, Aug. 7, 1872; Proc. Am. Phil. Soc., Vol. XII, p. 470.

*M. parvivorus* of the Lower Bridger, considerably less than in the later species of the genus, but more than in the Lower Eocene species hereafter

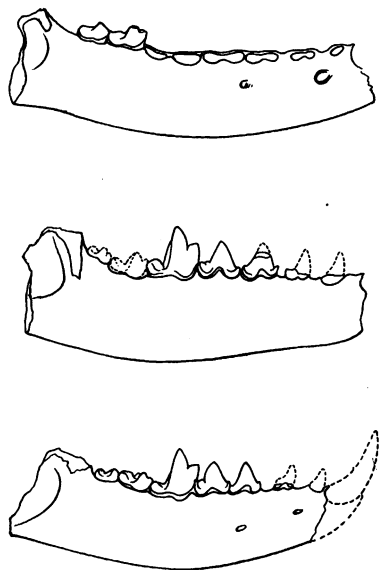


Fig. 27. *Miacis*, lower jaws of two Lower Eocene species. Above, *M. latidens* type. Lost Cabin beds, below, *M. exiguus*, No. 15717, Upper Gray Bull beds; intermediate *M. latidens* mut. prim., No. 15177, Lower Gray Bull beds. All natural size.

referred to *Vulpavus* and decidedly more than in the Middle Eocene typical species of *Vulpavus*.

#### ***Miacis exiguus* sp. nov.**

*Type*, No. 15176, palate, part of lower jaw and fragmentary skeleton; paratypes Nos. 15717, 15718, lower jaws, all from the Gray Bull beds, Big Horn Basin, Wyoming.

*Distinctive characters*:  $P_1-m_3 = 38$  mm.;  $m_{1-3} = 13$ .  $P^4$  and  $m_1$  carnassiform, parastyles of  $m^{1-2}$  extended, upper molars with cingulum continuous around protocone, heavier posteriorly but not forming a hypocone. Parastyle of  $p^4$  minute.  $M_1$  with high trigonid and basin heel;  $m_2$  with low trigonid but not completely tubercular;  $m_3$  tubercular, oval with trigonid cusps distinct, small basin heel and roots imperfectly separate. Premolars rather short, high, compressed with minute anterior and posterior basal cusps, and a small posterior accessory cusp on  $p_4$ .  $P_1$  one-rooted;  $p_2$  spaced.

This is the smallest of the Lower Eocene *Miacidæ* except *Viverravus acutus* and *dawkinsianus*. Fragments of the skeleton associated with the

type show that the animal was a little larger than *M. parvivorus* although the jaws are of the same size or slightly smaller. The vertebral centra (caudals

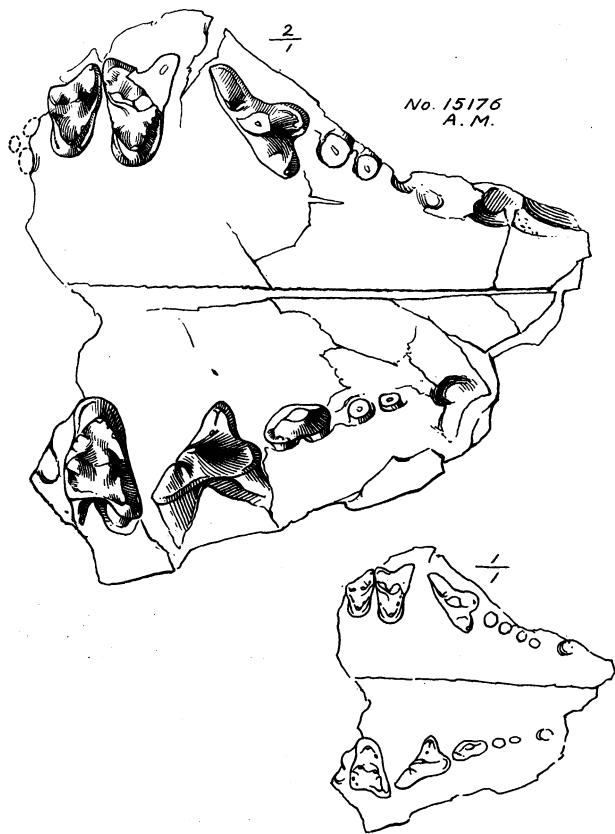


Fig. 28. *Miacis exiguus*, palate, twice natural size, with outline of actual size. Type specimen (fragmentary skeleton), Gray Bull beds, Big Horn Basin.

and lumbar) are more robust, the limb bones heavier, but their length cannot be determined.

Fifteen lower jaws from the Gray Bull horizon of the Big Horn Wasatch are referable to this species.

### ***Miacis latidens* sp. nov.**

*Type*, No. 14766, lower jaw and part of maxilla, with  $m_{2-3}$  and  $m^{1-2}$ , from the Lost Cabin beds of the Wind River Basin.

*Distinctive characters*:  $P_1-m_3 = 35$  mm.,  $m_{1-3} = 16$  mm. Upper molars with



parastyle moderately extended, paracone much larger than metacone, narrow cingulum around protocone, no hypocone;  $m^2$  decidedly smaller than  $m^1$ ,  $m^3$  minute. Lower molars with trigonid larger than heel,  $m_3$  two-rooted, much smaller than  $m_2$ ; heels basined, trigonids low. Premolars rather small, spaced,  $p_1$  one-rooted. Canine moderately large, not compressed.

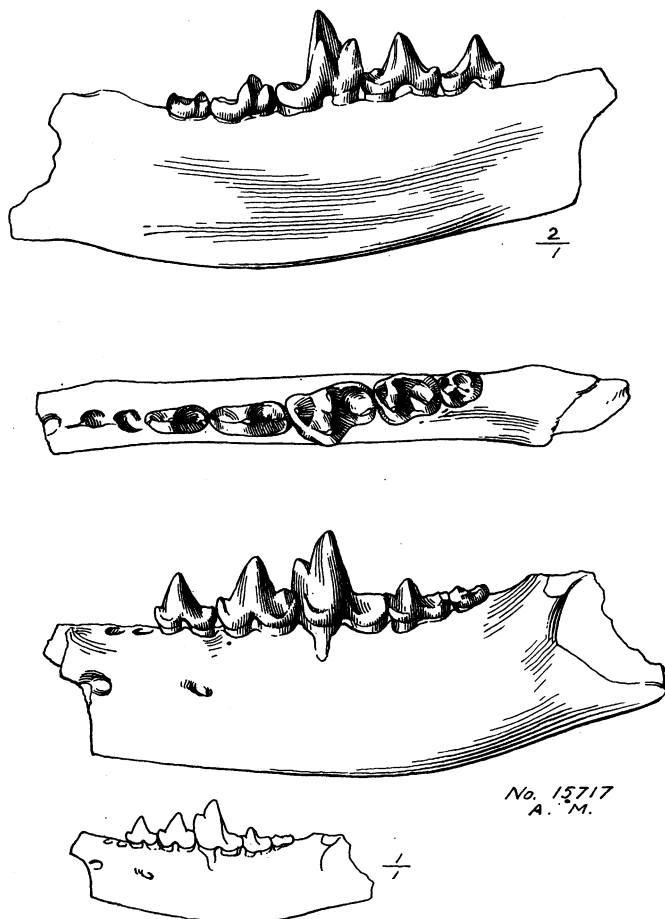


Fig. 29. *Miacis exiguus*, lower jaw, inner, occlusal and outer views, enlarged to two diameters, with outline of natural size. No. 15717, upper Gray Bull beds, Big Horn Basin. The heel of  $m_3$  is badly preserved in this specimen, and has been interpreted from No. 15718.

This species is of the size of *Vulpavus australis* but the construction of the molars agrees with *Miacis*. It is perhaps a descendant of *M. exiguus*. It is a little larger than *M. parvivorus* of the Bridger, the tubercular dentition is relatively larger, and the upper molars broader. Only the type

specimen is known from the Wind River, Nos. 15177-8 from the Gray Bull may be a primitive mutant of this species. The second molar in this mutant is somewhat larger and more like the first in pattern.

Other species of *Miacis* are represented by fragmentary specimens from the Big Horn Basin and the New Mexican Wasatch, but they are inadequate for specific types.

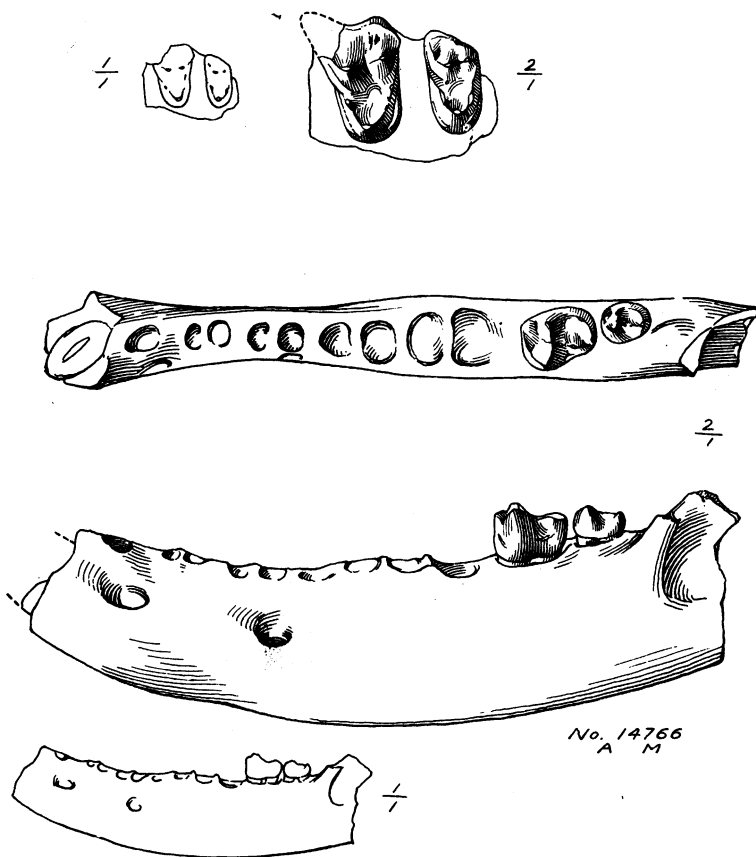


Fig. 30. *Miacis latidens*, upper and lower jaw with molar teeth,  $m_1^{1-2}$ ,  $m_2^{1-2}$ , enlarged to two diameters, with outline of natural size. Type specimen, Lost Cabin beds, Wind River Basin.

### **Vulpavus Marsh 1871.<sup>1</sup>**

Type, *V. palustris*, from the Lower Bridger of Wyoming.

Two Lower Eocene species are referable to this genus. As compared

<sup>1</sup> Amer. Journ. Sci., Vol. II, p. 124.

with the Middle Eocene species they retain considerably more of the tuberculo-sectorial character of the molars. This is most marked in the speci-

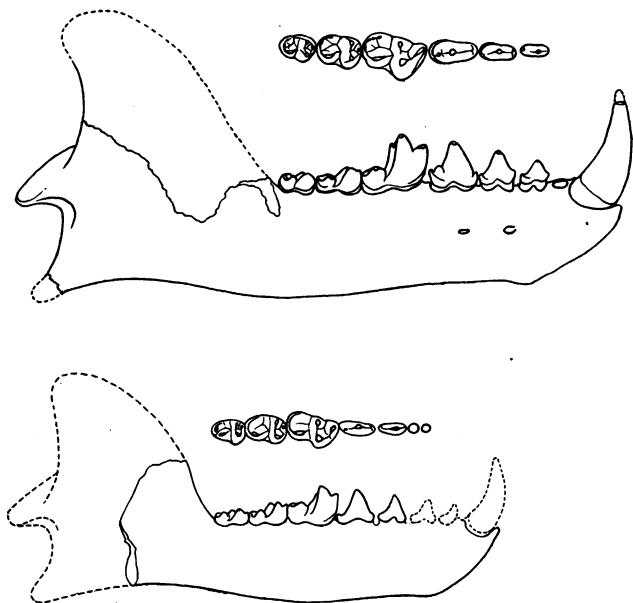


Fig. 31. Lower Eocene species of *Vulpavus*, lower jaws, natural size. Above, *V. canavus*, Nos. 14760 and 14767, Lost Cabin beds, Wind River basin; below *V. australis*, No. 16226 and 16227, Largo beds, San Juan Basin.

mens from the Gray Bull horizon; in the Lysite and Lost Cabin specimens it progressively disappears.

### ***Vulpavus canavus* (Cope 1881).**

*Miacis canavus* COPE, 1881, Bull. U. S. G. S. Terrs. Vol. VI, p. 189; 1885, Tertiary Vertebrata, p. 302; *Uintacyon* WORTMAN, 1899, Bull. A. M. N. H., Vol. XII, p. 112; (*Prodaphænus*) WORTMAN 1901, Am. Jour. Sci., Vol. XI, p. 30; (*Vulpavus*) MATTHEW 1909, Mem. A. M. N. H., Vol. VI, p. 380.

*Miacis brevirostris* COPE, 1881, l. c., p. 190; 1885, l. c., p. 303; WORTMAN, 1899, l. c.

*Type*, Am. Mus. No. 4783, a lower jaw with teeth broken off, from Lost Cabin beds of Wind River Basin.

*Type* of *M. brevirostris*, Am. Mus. No. 4785, a lower jaw with  $m_2$  and part of  $p_4$ , other teeth broken off, from same horizon and locality.

*Distinctive characters*:  $M_{1-3}$  = 19–20 mm.,  $p_1-m_3$  = 36–41 mm. Lower tubercular molars large;  $m_1$  imperfectly carnassiform;  $m_3$  two-rooted; heels of  $m_{1-2}$  as wide and as long as trigonids. Premolars reduced and spaced, slight accessory cusp on  $p_4$ . Jaw short, deep and heavy, canine large, not compressed.

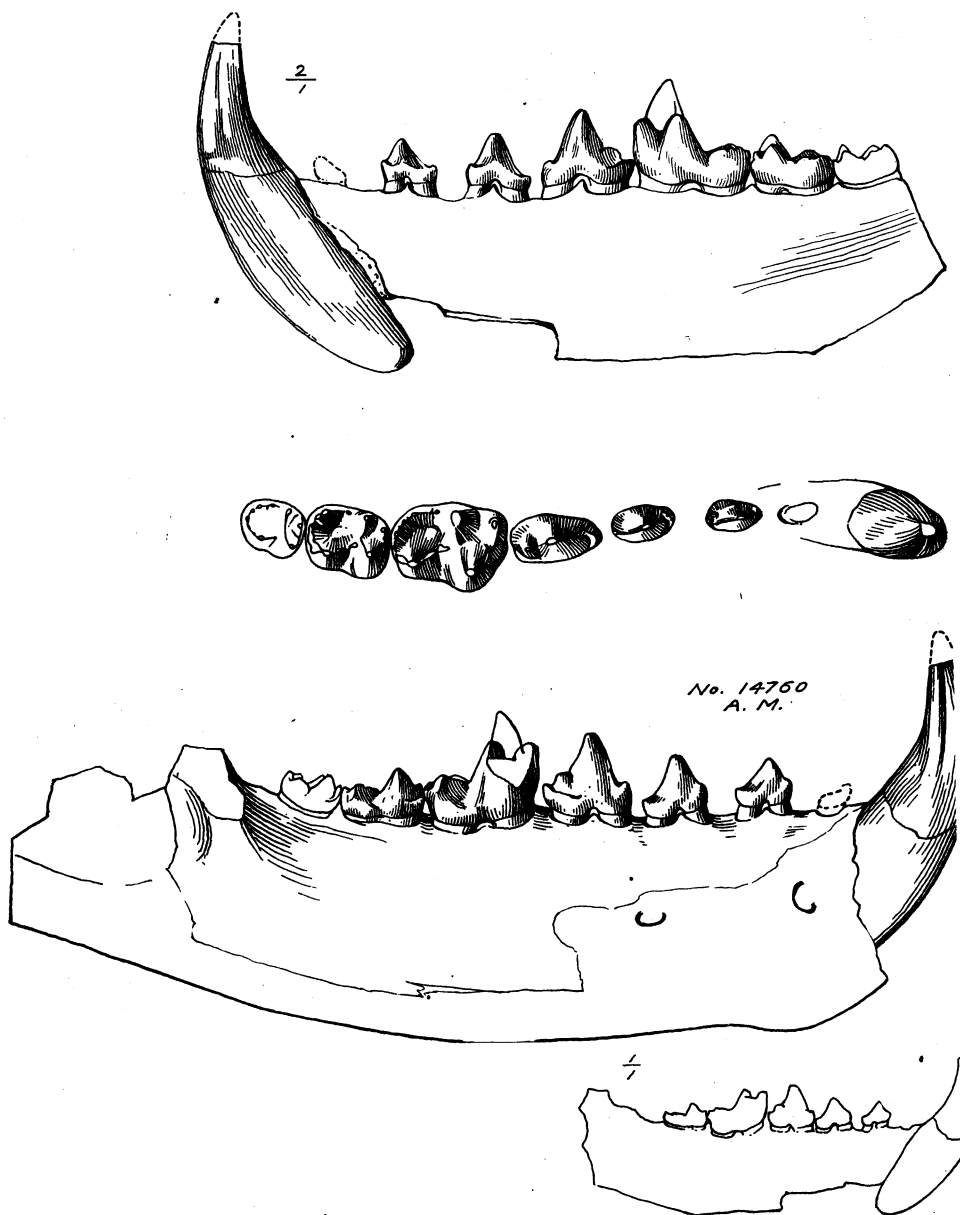


Fig. 32. *Vulpavus canavus*, lower jaw, internal and external, and crown view of teeth, enlarged to ten times natural size. No. 14760; outline of lower jaw and m<sub>3</sub> from No. 14763; tip of m<sub>1</sub> from No. 14761. Lost Cabin beds, Wind River Basin.

Ten lower jaws from the Lost Cabin horizon of the Wind River agree very well with the types of *canavus* and *brevirostris*, which differ only in very trifling or inconstant characters. Five jaw fragments from the Lysite vary a little in innumerable details towards *Miacis*; and in five specimens from the Gray Bull horizon, these differences are more pronounced, the trigonid of  $m_1$  being higher, the heels of  $m_1$  and  $m_2$  narrower, the roots of  $m_3$  imperfectly separated, the premolars relatively larger. Although insufficient in degree to warrant a specific separation, these differences are significant in confirming the approach of these two Miacid genera as we trace them back through the Eocene. Differences of similar kind and equal degree are seen in specimens of the following species from the three horizons.

***Vulpavus australis* sp. nov.**

*Type*, No. 16226, lower jaw with  $p_4$ - $m_3$  from the Wasatch of New Mexico, ?lower beds.

*Distinctive characters*: Smaller than *V. canavus*,  $m_{1-3} = 15$  mm.; canines less robust, teeth less massive, but very similar in constructive details.

Four specimens from New Mexico, two from the Lost Cabin beds of Wyoming, five from the Lysite and four from the Gray Bull beds, are referred to this species. Those from the Gray Bull beds show a distinct approach toward *Miacis*, as in *V. canavus*, but the New Mexican specimens, Nos. 16225-7, 16229, which except the type are all from the upper beds, agree nearly with the Lysite specimens. Nos. 14764-5 from the Lost Cabin are somewhat more progressive towards the typical *Vulpavus* from the Middle Eocene.

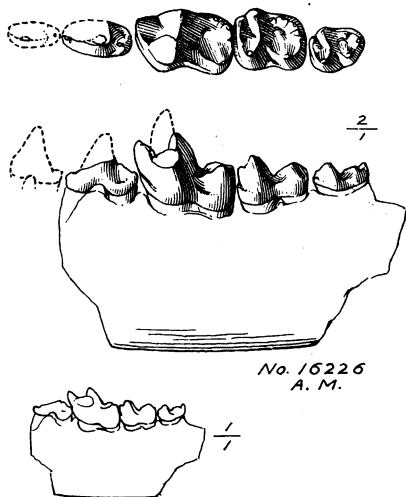


FIG. 33. *Vulpavus australis*, lower jaw, outer view and crown view of teeth enlarged to two diameters, with outline of natural size. Type specimen, Wasatch of San Juan Basin, New Mexico. Dotted outlines restored from No. 16227.

***Vassacyon* Matthew 1909.<sup>1</sup>**

*Type*, *V. promicrodon* from the Wasatch of the Big Horn Basin.

This genus is in many respects intermediate between *Miacis* and *Vul-*

<sup>1</sup> U. S. G. S. Bull. 361, p. 93.

*pavus*, but has some peculiarities of its own. The principal characters of the skull and skeleton are known from specimens secured by Mr. Granger in the Big Horn Basin, and may be compared with *Vulpavus* and *Miacis* as described by Matthew in 1909.

The skull is proportioned as in *Vulpavus*, very much shorter than in the Viverravinæ, the basicranial region broad and long, the glenoid articulations set well forward of the occipital condyles. The detailed construction of this region is obscured by matrix but appears to be much as in *Vulpavus*. Occiput broad and low; sagittal crest moderately developed. Nasals somewhat broader posteriorly than in *Vulpavus*; premaxillæ more reduced. Facial exposure of lachrymal as in *Miacis* and *Vulpavus*.

Upper molars with short extension of parastyle, well developed hypo-

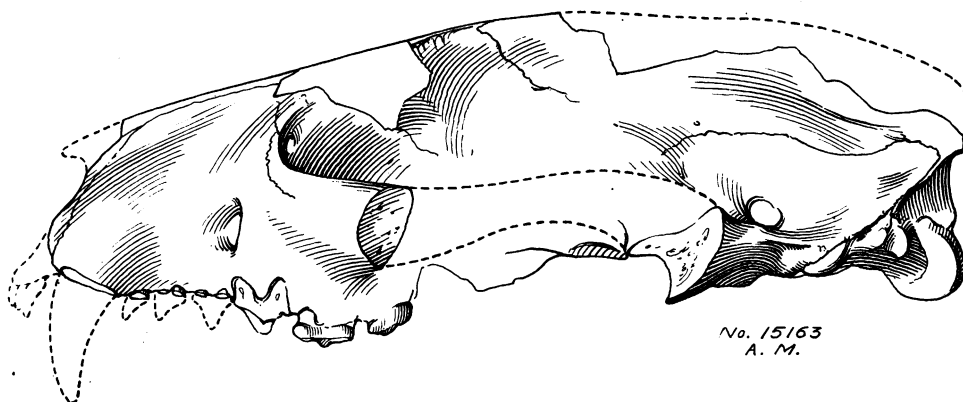


Fig. 34. *Vassacyon promicrodon*, skull, natural size. No. 15163, lower Gray Bull beds, Big Horn Basin.

cone, paracone somewhat larger than metacone;  $m^1$  considerably larger than  $m^2$ ;  $m^3$  two-rooted.  $P^4$  carnassiform. Anterior premolars reduced;  $p^2$  and  $p^3$  two rooted with small or rudimentary heelcusps;  $p^1$  one-rooted. In the lower jaw  $m_1$  is carnassiform with large basin heel;  $m_2$  tubercular, large, with low trenchant heel;  $m_3$  small, one-rooted, oval, tubercular cusps obscured. Premolars reduced, spaced; canine large, flattened, jaw below it angulate.

Skeleton much as in *Vulpavus*. Scaphoid, lunar and centrale united to a single bone. Trapezium larger than in any later Miacidæ. Claws compressed, high and sharp, not fissured at the tip.

***Vassacyon promicrodon* (Wortman 1899).**

*Uintacyon promicrodon* WORTMAN (& MATTHEW) 1899, Bull. A. M. N. H., Vol. XII, p. 111; (*Prodaphænus*) WORTMAN 1901, Amer. Journ. Sci., Vol. XI, p. 30; (*Vassacyon*) MATTHEW 1909, U. S. G. S. Bull., 361, p. 93; Mem. A. M. N. H., Vol. VI, p. 376, pl. xliii, fig. 4.

*Type*, Am. Mus. No. 81, a lower jaw with  $p_1-m_1$  from the Wasatch of the Big Horn Basin, probably *Systemodon* zone.

*Distinctive characters*:  $P_1-m_3 = 40$ ;  $m_{1-3} = 19$ . Other characters given under the genus.

To this species are referred Nos. 15163, skull; 15161 parts of skull and jaws with a large part of the skeleton; 15160 skull, lower jaws and several limb bones; 15162, 15164, etc., lower jaws. All are from the *Systemodon* zone of the Gray Bull in the Big Horn Basin.

No. 84, a fragment of lower jaw with  $m_3$  and the heel of  $m_2$  was considered by Wortman a possible successor of this species in the Wind River (Lost Cabin zone). It is otherwise unknown from any later horizon.

This species is readily recognizable by the peculiar thickening of the lower border of the jaw externally along the symphyseal region. This is associated with a flattened lower canine, and a somewhat triangular but curved upper canine.

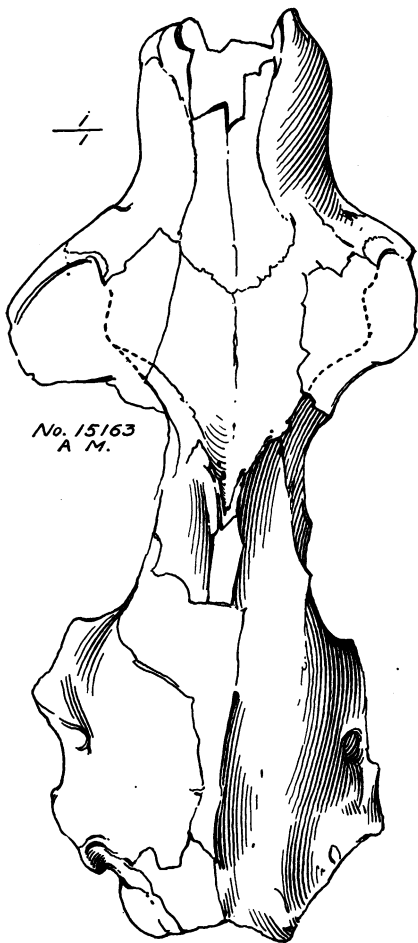


Fig. 35. *Vassacyon promicrodon*, skull, top view, natural size. No. 15163, Gray Bull beds, Big Horn Basin.

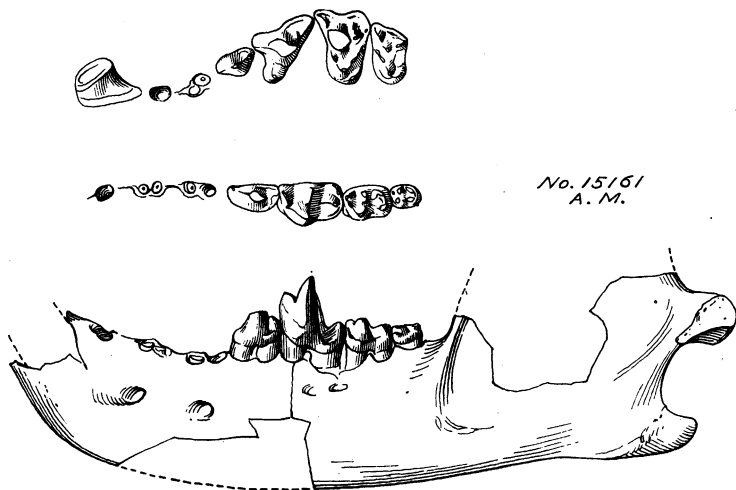


Fig. 36. *Vassacyon promicrodon*, external view of lower jaw and crown views of upper and lower teeth, natural size; from skeleton No. 15161, lower Gray Bull beds of Big Horn Basin.

### OXYÆNIDÆ.

*Family characters:*<sup>1</sup> Carnassials  $m\frac{1}{2}$ , third molar absent.<sup>2</sup> Skull robust, basicranial region wide, jaws stout with strong symphysis. Lumbar zygapophyses cylindrical or revolute. No supratrochlear foramen on humerus. Manus and pes mesaxonic, claws fissured at the tip.

The Lower Eocene representatives of this family belong to three groups, (1) *Oxyæna*, large, predaceous types with powerful shearing molars; (2) *Palæonictis* and *Ambloctonus*, large, short faced types with robust teeth adapted for breaking (? bone-breaking) and shearing; (3) *Dipsalidictis* and *Prolimnocyon*, smaller and more primitive genera with tuberculosectorial molars. These three groups correspond in adaptation to the Felidæ, Hyænidæ and Viverridæ among modern carnivora.

*Oxyæna* is well known from the descriptions of Cope and Wortman, and while fairly abundant in the Lower Eocene the new material adds little to the morphology. *Palæonictis* and *Ambloctonus* are much scarcer, and of their skeletal construction very little is known. The new genus *Dipsalidictis* from the Clark Fork has the very primitive dentition of *Limnocyon* but lacks the progressive characters of the feet of that Middle and Upper Eocene genus, the feet being the most primitive known among Oxyænidæ.

<sup>1</sup> Matthew, 1909, Am. Mus. Mem., IX, 327.

<sup>2</sup> Except in *Prolimnocyon* infra.



Another new genus *Prolimnocyon* is structurally ancestral in dentition to *Limnocyon* and *Thinocyon* and is represented by a skull and several jaws from the Gray Bull horizon of the Wasatch. Its dental formula is that of

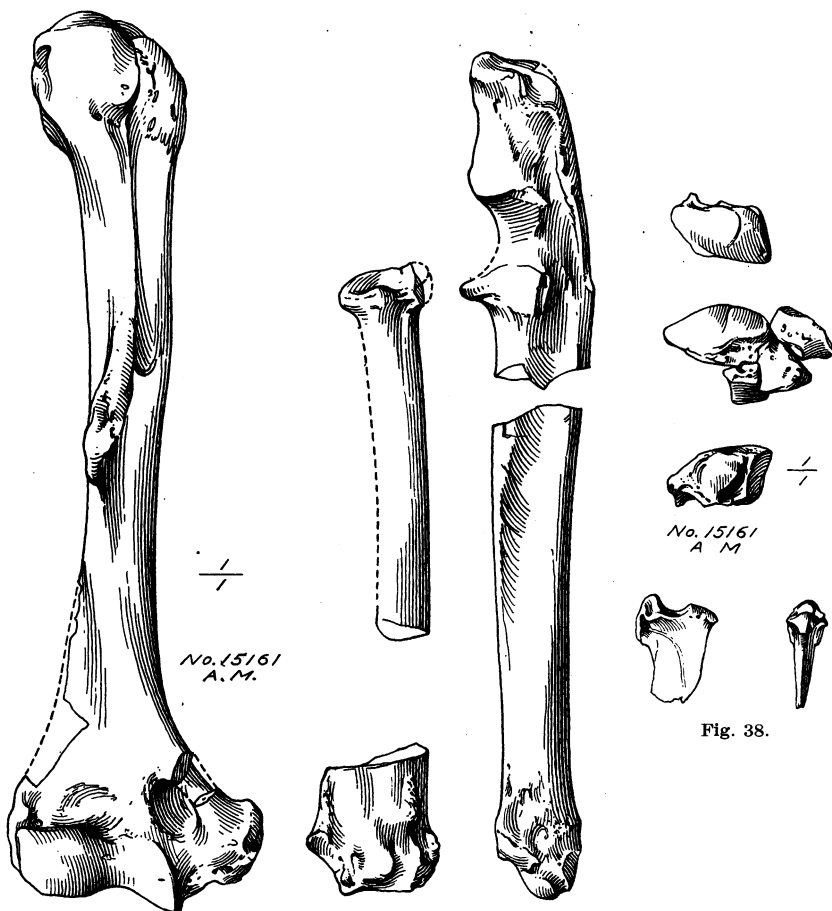


Fig. 37.

Fig. 37. *Vassacyon promicrodon*, humerus, radius and ulna, front views; from the skeleton No. 15161, Gray Bull beds, Big Horn Basin.

Fig. 38. *Vassacyon promicrodon*, carpal bones and ungual phalanx, natural size; above, scapholunar proximal view, dorsal view with magnum, unciform and cuneiform, distal view; below, ungual phalanx lateral and superior views. From skeleton No. 15161.

the early Hyænodonts, but it is typically Oxyænid in other respects, and indicates the approximation of these two families in the early Eocene.

The reference of *Ambloctonus* and *Palæonictis* to the Oxyænidæ (Mat-

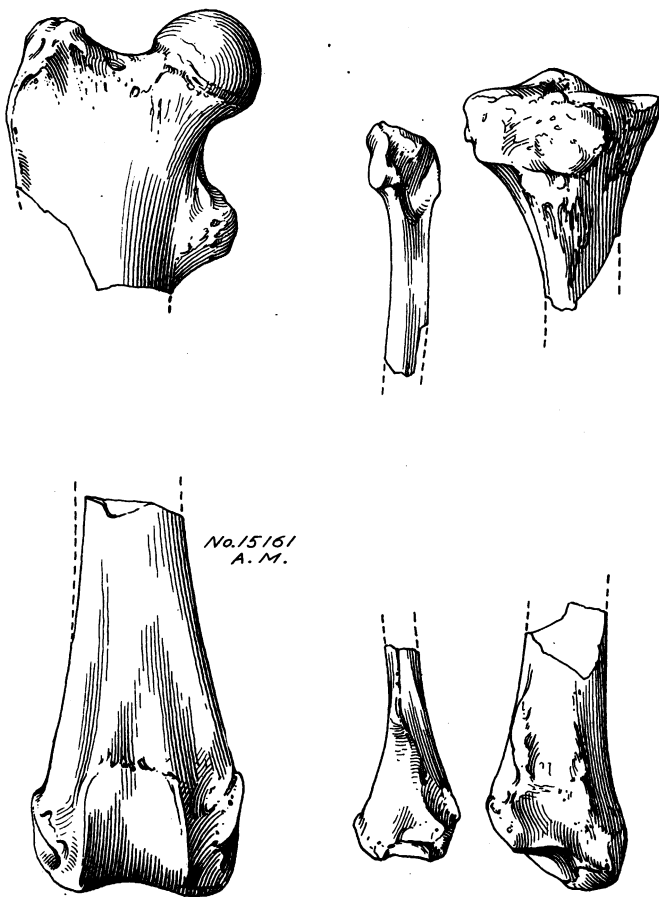


Fig. 39. *Vassacyon promicrodon*, hind limb bones, front views, natural size. From skeleton, No. 15161, Lower Gray Bull beds, Big Horn Basin.

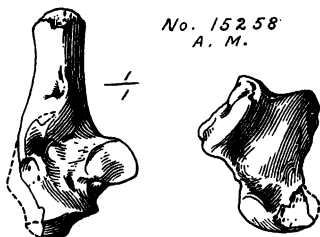


Fig. 40. *Vassacyon*, calcaneum and astragalus, superior views, natural size. No. 15258, Gray Bull beds, Big Horn Basin.

thew, 1909) is confirmed by a more careful study of their characters, with the additional material now at hand. Although the second lower molar is smaller than the first, it is the tooth which in conjunction with the first upper molar is progressively specialized as a shearing tooth. The fourth upper premolar and first lower molar, although large teeth, have very little shearing action, as is clearly shown by the wear of these teeth, and the successive species show a decided tendency to reduce these teeth wholly to the crushing (or bone-breaking?) function of the premolars. The same is true of *Patriofelis* and to a less marked extent of *Oxyæna* and the *Limnocyon* group.

In all the Oxyænidæ the carnassial angle is behind  $m^1$ ; that is to say, the outer line of the dentition is angulate at that point, the teeth in advance of it being extended posteroexternally, those behind it anteroexternally, a more or less pronounced pit (*Entodiastema* of von Ihering) for the reception of the lower carnassial being developed in the palate. In the Miacidæ the carnassial angle is behind  $p^4$ , in the Hyænodonts behind  $m^2$ . This is a much more reliable guide to the affinities of the genera than is the relative size of the teeth, and conforms to a variety of differential family characters of skull and skeleton.

The Oxyænid genera do not stand in any exact successional relationship. *Patriofelis* cannot be derived from *Oxyæna*, nor from *Palæonictis* or *Ambloctonus* but from some intermediate type agreeing with the last named genus in the premolars and zygomatic arches and with the first named in the molar teeth. *Palæonictis* and *Ambloctonus* are very closely allied but appear to be divergent or at all events distinct lines of specialization. *Oxyæna* is represented by a series of species in which the shear is progressively perfected and concentrated on  $m^1_2$ , premolars and molars showing a marked analogy to those of the Felidæ. The short head, deep arches, very short deep jaw, massive premolars, robust and much worn shearing teeth of *Patriofelis* and *Palæonictis* and *Ambloctonus* are analogous to the Hyænidæ, but not so closely. The smaller Oxyænids, *Limnocyon* and its allies, offer a broad analogy to the Viverridæ; and just as the Felidæ and Hyænidæ are structurally derivable from the Viverridæ, so are the larger and more specialized Oxyænidæ structural derivatives of the *Limnocyon* group. Of the two genera which represent this last group in the Lower Eocene, one, *Prolimnocyon*, has the most primitive dentition of any Oxyænid; the other *Dipsalidictis*, with the dentition of *Limnocyon*, has the primitive foot-structure of *Oxyæna*. But *Oxyæna* itself occurs in the Clark Fork horizon along with *Dipsalidictis*, so that the common ancestry of the genera was well down in the Paleocene.<sup>1</sup> Each genus includes one or more phyla of true genetic descent, so far as one may judge from the evidence.

<sup>1</sup> But the ancestral types have not been found, or at all events have not been recognized in the Puerco and Torrejon faunæ, and hence the family Oxyænidæ must be regarded as an immigrant group appearing in North America at the close of the Paleocene.

Key to Genera of *Oxyænida*.

- A. Two subequal shearing molars,  $m_1$  and  $m_2$ ;  $p^3$  without internal cusp or root;  $m^2$  transverse, unreduced.
  - 1.  $M^3_3$  present, small or vestigial.....*Prolimnocyon*.
  - 2.  $M^3_3$  absent, astragalar trochlea flat.....*Dipsalidictis*.
  - 3.  $M^3_3$  absent, astragalar trochlea grooved.....*Thinocyon*, *Limnocyon*.
- B.  $M_2$  as large or larger than  $m_1$ ;  $p^3$  with internal root and usually cusp.
  - 4.  $M^2$  transverse;  $m_2$  with distinct metaconid and heel.....*Oxyæna*.
  - 5.  $M^2$  absent;  $m_2$  with vestigial metaconid and heel.....*Patriofelis*.
- C.  $M_2$  smaller than  $m_1$ ;  $p^3$  with internal cusp.
  - 6.  $M^2$  small, not transverse; metaconid on  $m_2$ .....*Palæonictis*.
  - 7.  $M^2$  small, transverse; no metaconid on  $m_2$ .....*Ambloctonus*.

**Oxyæna** Cope 1874.<sup>1</sup>

*Type*, *O. lupina* from Wasatch of New Mexico.

The types of the three species described by Cope are from New Mexico, where the genus is fairly common. A number of topotypes obtained by Mr. Granger in 1912-13 serve to check the validity of these species and to compare them with the more numerous and better preserved specimens secured in the Big Horn Valley. The genus occurs also in the Lost Cabin stage represented by more progressive and larger species, and in the Clark Fork and Sand Coulée horizons is represented by more primitive species.

The progressive characters of *Oxyæna* are toward a higher predaceous specialization. The carnassial teeth  $m^1_2$  develop a more perfect shear on the trigon and the metaconid and heel of  $m_2$  tend to disappearance. The earlier species are more like *Limnocyon* and *Palæonictis* in various respects, and the divergence between the three phyla becomes emphasized later on. The geological horizon of the species of *Oxyæna* from first to last is in exact accord with their progressiveness.

Key to Species of *Oxyæna*.

- I.  $M_1 = m_2$ 
  - A. Trigonid of  $m_2$  broader than long, heel large.
    - 1. Size small.....*O. æquidens*.
- II.  $M_1$  smaller than  $m_2$ 
  - B. Trigonid of  $m_2$  slightly broader than long, heel large.
    - 2. Size small,  $p_1-m_2 = 59$  mm.....*O. transiens*.
  - C. Trigonid of  $m_2$  somewhat longer than broad, heel moderate.
    - 3. Size small medium,  $p_1-m_2 = 65-70$ .....*O. gulo*.
    - 4. Size large,  $p_1-m_2 = 80-85$  mm.....*O. forcipata*.
  - D. Trigonid of  $m_2$  considerably longer than broad, heel small.
    - 5. Size medium.....*O. lupina*.
    - 6. Size largest. Molar teeth insufficiently known.....*O. pardalis*.

<sup>1</sup> Cope, 1874, Rep. Vert. Fors. New Mex., p. —

The geologic level of these species is as follows:

	Wyoming	New Mexico	
Lost Cabin	<i>O. pardalis</i>	<i>O. lupina</i> ..... <i>O. forcipata</i> , ? <i>gulo</i>	Largo
Lysite	<i>O. forcipata</i> ?		
Gray Bull	<i>O. forcipata</i> , <i>O. gulo</i> .		Almagre
Sand Coulée	<i>O. transiens</i>		
Clark Fork	<i>O. æquidens</i> , <i>O. sp. in-</i> nom.		

**?*Oxyæna* sp. innom.**

To this genus should perhaps be referred No. 16068, fragmentary upper jaws, etc., from the Clark Fork horizon. The teeth differ from those of *O. forcipata* in greater transverse extension of  $p^4$  and approach *Palæonictis* in cusp construction. The specimen is too fragmentary for positive reference, but is evidently a larger animal than either *O. forcipata* or *P. occidentalis*. The canines are extremely robust, and much larger than in *Oxyæna* and the reference to this genus is very questionable.

***Oxyæna æquidens* sp. nov.**

*Type*, No. 16070, lower teeth of one individual from Clark Fork beds of Clark Fork Basin, Wyoming.

*Distinctive characters*: Trigonids of lower molars wider than long;  $m_{1-2}$  subequal in size; heels relatively large;  $p_4$  very robust with minute anterior basal cusp; canine robust with massive root. Size about that of *O. gulo*.

***Oxyæna transiens* sp. nov.**

*Type*, No. 16118, upper and lower jaws from the Sand Coulée horizon, Clark Fork Basin, Wyoming.

*Distinctive characters*: (1) trigonids of lower molars wider than long; (2)  $m_1$  smaller than  $m_2$ ; (3) premolars less robust than in *æquidens*, canine less massive; (4) metastyle of upper carnassial less extended than in any of the later species; (5) deuterocone of  $p^4$  without posterior flange; (6)  $p^3$  with internal root but no distinct internal cusp (deuterocone).

Characters 1, 4, 5, and 6 are distinctive from all the later species and in agreement with observed or inferential characters of *O. æquidens*; nos. 2 and 3 distinguish it from that species and are in accord with the later species.

Size smaller than *O. gulo*.

No. 16179 from a somewhat higher level in the Gray Bull beds of Clark Fork Basin agrees fairly well with the type but the size is somewhat larger, the lower molars more nearly equal, and  $p^4$  has the posterior flange of the deuterococone more developed. It appears to be transitional to *O. gulo*.

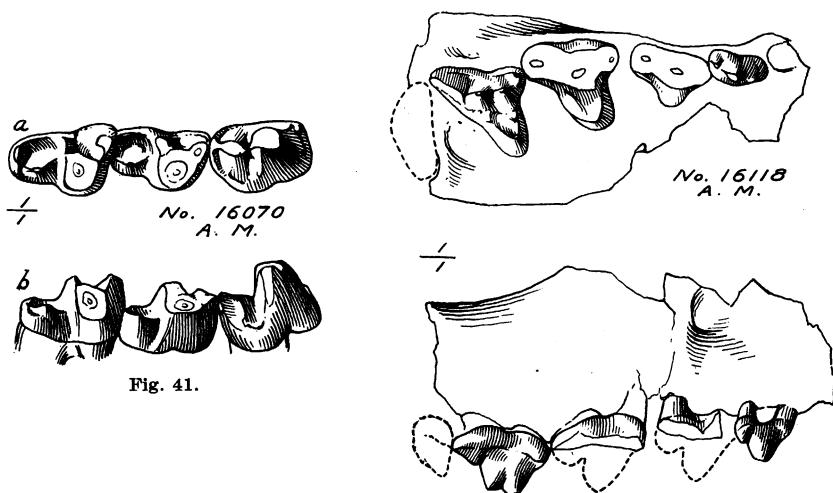


Fig. 41.

Fig. 42.

Fig. 41. *Oxyana æquidens*, lower teeth,  $p_4$ - $m_2$ , crown and outer views, natural size. Type specimen, Clark Fork beds, Clark Fork Basin.

Fig. 42. *Oxyana transiens*, upper jaw of type specimen, natural size, occlusal and outer views. Sand Coulée beds, Clark Fork Basin.

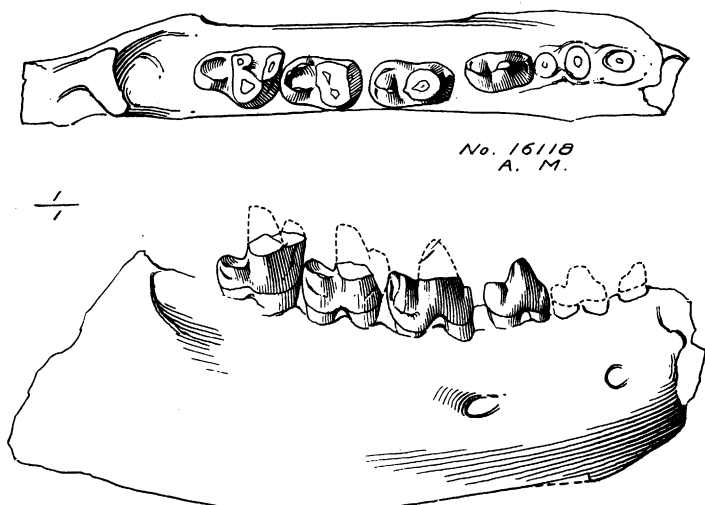


Fig. 43. *Oxyana transiens*, lower jaw, outer and occlusal views, natural size. Type specimen, Sand Coulée beds, Clark Fork Basin.

***Oxyæna lupina* Cope 1874.**

*Oxyæna lupina* COPE 1874, Rep. Vert. Foss. New Mex., p. 11; 1875, Syst. Cat. Eoc. Vert. New Mex., p. 123; 1877, Ext. Vert. New Mex., p. 101, pl. xxxiv, figs. 14-37, pl. xxxv, figs. 1-4.

*Syn.*, *Oxyæna huerfanensis* OSBORN 1897, Bull. A. M. N. H., Vol. IX, p. 255.

*Oxyæna morsitans* COPE 1874, l. c.

*Type*, U. S. Nat. Mus. No. 1049, upper and lower teeth and a few skeleton fragments, from Wasatch of New Mexico. Figured in 1877, l. c., pl. xxxiv, figs. 14-30.

*Distinctive characters*: (1) trigonids of lower molars longer than wide, metaconid and heel of  $m_2$  much reduced; (2)  $m_1$  smaller than  $m_2$  (in all specimens with the doubtful exception of the type); (3) premolars moderately compressed, anterior basal cusp of  $p_4$  well developed; canines moderately long; (4) metastyle of upper carnassial much elongate and  $m^2$  reduced in size; (5) deuterocone of  $p^4$  with posterior flange; (6)  $p^3$  with distinct internal root.

The large amount of additional material for comparison, including topotypes from the New Mexican Wasatch shows that this species is distinct and decidedly more progressive than the Big Horn specimens which have been referred to it by Osborn and Wortman. The metaconid and heel of  $m_2$  are much smaller, the shear more anteroposterior, the metastyle of  $m^1$  more extended, and  $m^2$  evidently more reduced. *O. huerfanensis* agrees with the type of *O. lupina*, although not with the incorrectly referred Big Horn specimens with which Osborn's comparisons were made.

Nos. 16219, 16755 and 16216, lower jaws from the New Mexican Wasatch, agree with *O. lupina*, except for slightly smaller size. The two former are from the upper faunal zone, the third from the top of the lower zone. A fourth specimen, No. 16218, consisting of milk and unworn permanent teeth and other fragments is more doubtfully referable; it is from the lower beds.

***Oxyæna forcipata* Cope 1874.**

*Oxyæna forcipata* COPE, 1874, Rep. Vert. Foss. New Mex., p. 12; 1875, Syst. Cat. Vert. Soc. New Mex., p. 105, pl. xxxvi, xxxv, figs. 7-12, xxxvii, figs. 1-5; 1885, Tert. Vert., p. 318, pl. xxxivb, xxivc. OSBORN, 1892, Bull. A. M. N. H., Vol. IV, p. 109.

*Oxyæna lupina* OSBORN, 1892, Bull. A. M. N. H., Vol. IV, p. 108, fig. 9; WORTMAN; 1899, *ibid.*, Vol. XII, p. 140, pl. vii and text figs. 1 and 2; OSBORN, 1900, *ibid.*, Vol. XIII, p. 276, pl. xviii.

Not *O. lupina* of Cope.

*Type*, U. S. Nat. Mus. No. 1029, lower jaws from the Wasatch of New Mexico.

*Distinctive characters*: (1) trigonids of lower molars about as long as wide, metaconid and heel of  $m_2$  moderately large; (2)  $m_1$  smaller than  $m_2$ ; (3) premolars more robust than in *lupina*, less than in *æquidens*,  $p_4$  with distinct anterior basal cusp; (4) upper molars relatively larger than in *lupina*, carnassial metastyle less elongate;

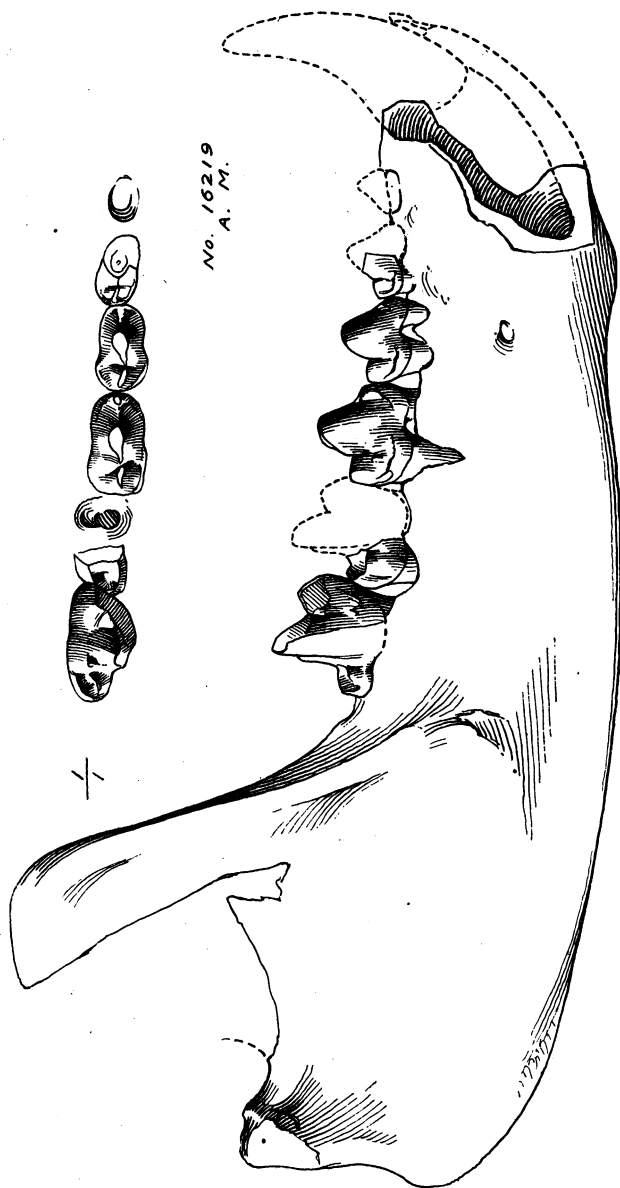


Fig. 44. *Oryzomys lupina*, lower jaw, outer view and crown view of teeth, natural size. Topotype, No. 16219, Largo beds, Wasatch formation, San Juan Basin, New Mexico.



(5) deuterocone of  $p^4$  with heavy posterior flange; (6) inner cusp of  $p^3$  more prominent than in *lupina*; (7) size larger than *lupina*, teeth more robust throughout, jaw deeper and more massive.

To this species are referred the larger specimens from the Gray Bull horizon in the Big Horn Basin, including the mounted skeleton described by

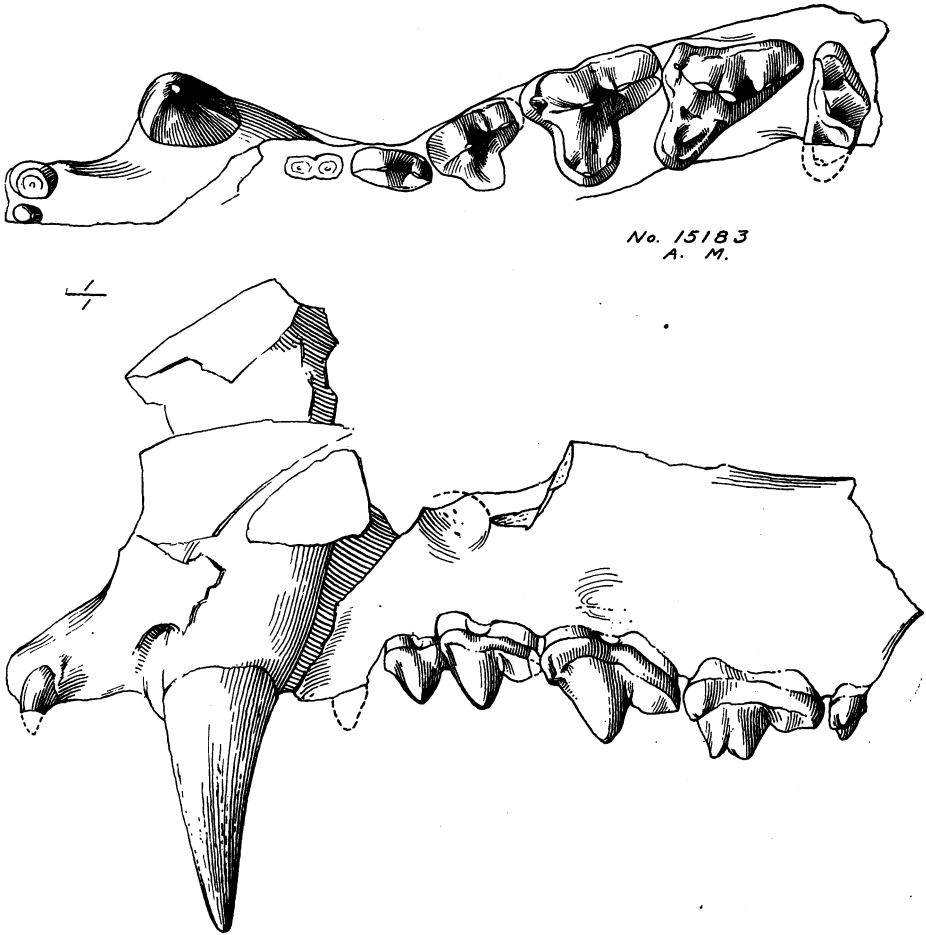


Fig. 45. *Oxyana forcipata*, upper jaw, outer and occlusal view, natural size. From No. 15183, Gray Bull beds, Big Horn Basin.

Wortman as *O. lupina*. Cope referred to *O. forcipata*, all the Big Horn Basin specimens in his collection, including parts of this same skeleton; our additional material confirms the reference. In addition to the skeleton

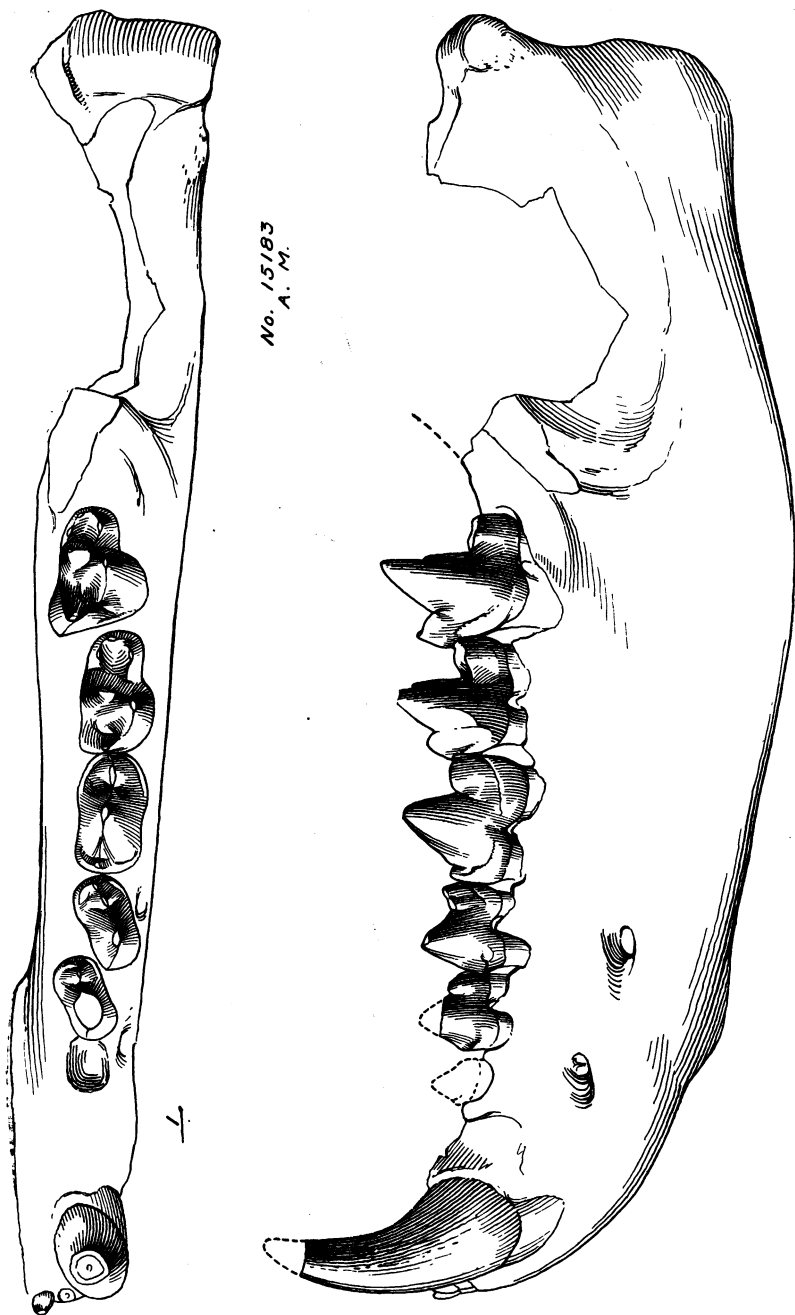


Fig. 46. *Oxyena forcipata*, lower jaw, external and superior views, natural size. No. 15183, Lower Gray Bull beds, Big Horn Basin.

A. M. No. 107, there is a considerable series of well preserved lower jaws, some of them associated with upper jaws, and a few with parts of the skeleton; and a larger number of fragmentary specimens. These vary considerably in size, in robustness of teeth and depth of jaw and various other characters.

***Oxyæna gulo* sp. nov.**

*Type*, No. 15199, upper and lower jaws; *paratypes*, Nos. 15725, upper and lower jaws, 15193, 15722, lower jaws. All from the Gray Bull horizon of the Big Horn Wasatch.

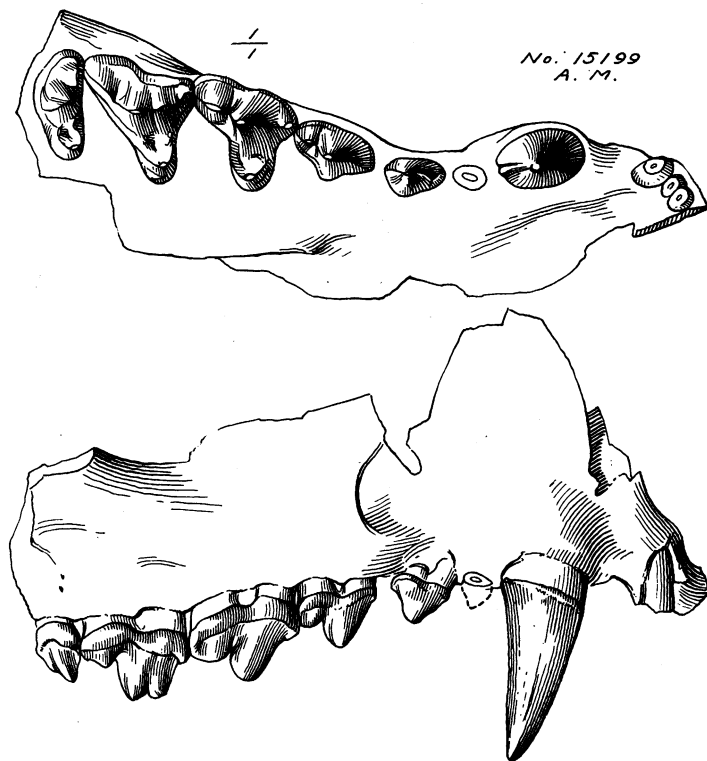


Fig. 47. *Oxyæna gulo*, upper jaw of type specimen, crown and outer views, natural size. Lower Gray Bull beds, Big Horn Basin.

*Distinctive characters*: (1) trigonids of lower molars about as long as wide, metaconids and heel of  $m_2$  moderately large; (2)  $m_1$  smaller than  $m_2$  (3) premolars moderately robust sometimes crowded and set transversely,  $p_4$  with high protoconid and no anterior basal cusp; (4)  $m^1$  wide transversely, metastyle little extended,  $m^2$  trans-

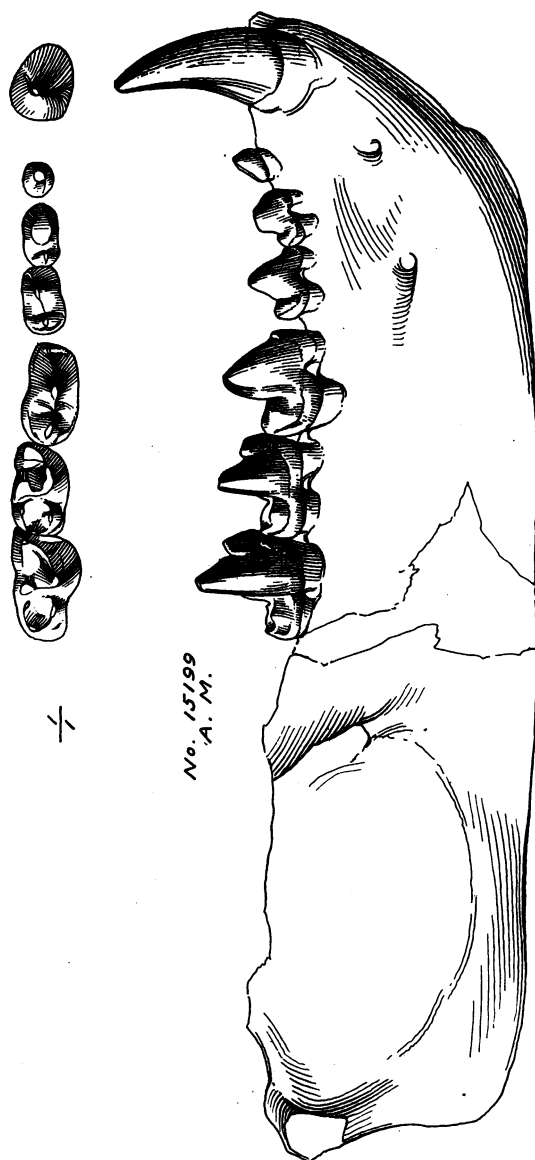


Fig. 48. *Oxyena gulo*, lower jaw, outer view, and crown view of teeth, natural size. From the type specimen, molar teeth partly restored from No. 15193. Gray Bull beds, Big Horn Basin.

versely wide; (5) slight internal flange on deutercone of  $p^4$ ; (6)  $p^3$  with no internal cusp; (7) size smaller than *O. forcipata*, averaging less than *lupina*, considerably larger than *transiens*.

This species is about as common as *O. forcipata* in the Big Horn Wasatch, and is readily distinguished from it in the characters, 3 to 7, cited above. It is larger and somewhat more progressive than *O. transiens* which appears to be ancestral. One or more of the specimens from New Mexico referred by Cope to *O. morsitans* may belong to this species but the type of Cope's species is clearly distinguished by the smaller metaconid and heel on the molars.

*Measurements.*

		15199	15725	15193
Upper teeth,	$i^1-m^2$	87.5		
" "	$c^1-m^2$	72.	81	
" premolars	$p^1-p^4$	41.5	42	
" molars	$m^1-2$	20.5	23	
Diameters of $p^4$	a-pxtr	$14.5 \times 13.5$	$15 \times 14$	
" "	$m^1$ "	$14 \times 14$	$16.5 \times 16.5$	
" "	$m^2$ "			
Lower teeth,	$c_1-m_2$	80	88	
" premolars	$p_1-p_4$	37.5	40.5	
" molars	$m_1-2$		28.5	25.5
$M_2$ anteroposterior			17	15.5
" transverse			11	9
" length of heel			5.5	5

***Oxyæna pardalis* sp. nov.**

*Type*, A. M. No. 15607, anterior portion of lower jaws with a large part of the skeleton, from the Lost Cabin Horizon, Big Horn Basin, Wyoming. *Paratype*, No. 15608, lower teeth from Lysite beds of Big Horn Basin, Wyo.

*Distinctive characters*: (1) trigonids of lower molars longer than wide, metaconid of  $m_2$  vestigial and heel much reduced; (2)  $m_2$  smaller than  $m_1$ ; (3) premolars moderately robust,  $p_4$  with distinct anterior basal cusp and exceptionally broad heel, canines more massive than *O. forcipata*; (7) size larger than *O. forcipata*, much larger than *O. lupina*.

The skeleton parts of the type of *O. pardalis* are in close agreement with *Oxyæna forcipata*. The limb bones, feet and many of the vertebræ are very well preserved, much more perfect and complete than in the skeleton of *O. forcipata* from the Gray Bull horizon of the Big Horn Basin described by Cope,<sup>1</sup> Osborn,<sup>2</sup> and Wortman.<sup>3</sup>

<sup>1</sup> Tertiary Vertebrata, p. 318, pl. xxivb, xxivc.

<sup>2</sup> Bull. A. M. N. H., Vol. IV, p. 108, fig. 9; *ibid.*, Vol. XIII, p. 276, pl. xviii.

<sup>3</sup> *ibid.*, Vol. XII, p. 140, pl. vii.

The specimen consists of complete pelvis, hind limbs and feet, lumbar and caudal vertebræ, fragments of the fore limbs and parts of fore feet, anterior part of lower jaws, fragments of upper teeth and lower molars.

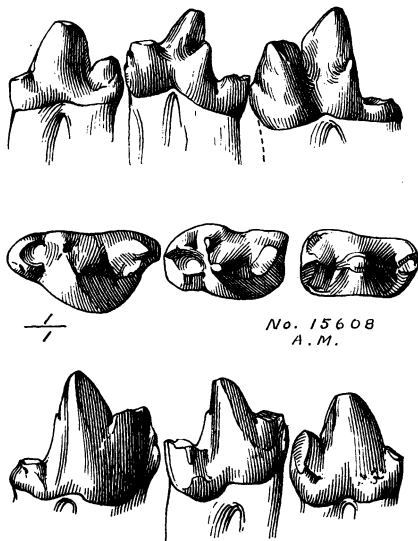


Fig. 49. *Oxyæna pardalis*, lower teeth, p4-m2 inner, crown and outer views, natural size. No. 15608, Lysite beds, Big Horn Basin.

With this individual were associated parts of hind limbs of two other individuals of the same species, a jaw and a few fragments of skeleton of *Sinopa*.

The scaphoid, centrale, magnum, unciform, trapezoid, trapezium cuneiform and pisiform are preserved in the carpus. The centrale lies beneath the scaphoid, completely separating the trapezoid from it; dorsally the centrale projects beneath the lunar as well. The articulation between centrale and scaphoid is rugose, foreshadowing the union of these two bones; the lunar-scaphoid facet is also but less clearly of the same character. The unciform is about the same in height as in breadth, and has a broad lunar articula-

tion, not distinct from that for the cuneiform except dorsally. The magnum is small, with narrow proximal keel, small dorsal surface. The trapezium is large, with a proximal internal peg extending beneath the trapezoid; its facet for mc.I is large, but nearly flat.

The femur has a third trochanter, rather obscure; the shaft is bowed outwardly, considerably flattened and ridged on the external border both above and below the trochanter. The tibia is one-fifth shorter than the femur, the cnemial crest is very slight, the internal malleolus thick and massive, the trochlea nearly flat and very oblique.

The astragalus has a broad, nearly flat trochlea, the inner crest obscure, the outer crest a sharp ridge with a solid angle of 90° separating the trochlea from the fibular facet. The fore and aft motion of the tibia on the astragalus is quite narrowly limited by the astragalar foramen behind, and the neck of the astragalus in front. At the front of the trochlea the facet is sharply curved upwards to receive the front of the tibia in flexion, and on the inner slope of the neck is a well defined facet for the internal malleolus in flexion. The neck is very oblique, the head broad and flat. The navicular is wide,

and of little height. The mesocuneiform is somewhat oblique but lacks the extreme obliquity of *Vulparus*; the entocuneiform is deep, high and not wide, the first digit has a slightly saddle-shaped facet, but does not seem to have been at all opposable.

The symmetry of the digits is not fully mesaxonic; mt.V is intermediate in length between mt. IV and I. The metapodials are rather short and spreading; the proximal and median phalanges are much broader than in *Miacidæ*, somewhat asymmetric but not excavated. The ungual phalanges are strongly curved, uncompressed, and rather deeply fissured at the tips.

The lumbar, posterior dorsal and anterior caudal vertebræ have deeply concave zygapophyses. The pelvis is moderately expanded above the iliac bar; the ischium is long and broad with the spine expanded into a considerable plate. The sacrum appears to consist of but two coössified vertebræ, the third in this young individual being still separate, although of sacral type.

### **Palæonictis.**

A number of upper and lower jaws of this genus were obtained in the Big Horn Wasatch, and a few skeletal fragments, but nothing to supply much information as to the skeleton, and nothing as good as the fine specimen of *P. occidentalis* obtained by Wortman in 1891 and described in the Museum Bulletin in 1892. As shown clearly in the 1891 specimen the second lower molar of *Palæonictis* is a reduced copy of the first, with tricusped trigonid, and fairly large basin heel. The second upper molar is a small rounded one-rooted tooth, not transverse.

The species of *Palæonictis* and *Ambloctonus* are readily distinguished from those of *Oxyæna* by the more massive premolars, transverse width of upper  $p^4$ ,  $m^1$  with higher and more pointed cusps but less perfect shear, the smaller trigonid and larger heel of  $m_1$  and reduction of  $m_2^2$ .  $M^1$  is developed as a carnassial as in *Oxyæna*, but to a less extent. In this feature lies an obvious reason for associating these genera with *Oxyænidae* and not with the *Eucreodine* group. While in *Palæonictis* the second upper molar is vestigial, in *Ambloctonus* it is transverse, and in other respects this genus links the better known *Palæonictis* to *Oxyæna*.

### **? Palæonictis sp.**

To *Palæonictis* may be referred with much hesitation a specimen from the Gray Bull beds, No. 15217, consisting of the greater part of the hind foot, three caudal vertebræ and a few other fragments. It is of larger size

than would be indicated by the associated fragments with the closely related genus *Ambloctonus*, not much smaller than *Patriofelis*. Both astragali are present, and compare with the Bridger and Washakie species of *Limnocyon*. The trochlea is distinctly grooved, narrower transversely and more concave and elongate antero-posteriorly than in *Oxyæna*, *Patriofelis* or *Dipsalidictis*; the neck is rather short and the head wide but of considerable depth towards its external side. The calcaneum is not preserved; the navicular is broad and of little height but considerable dorso-ventral depth with a heavy inferior hook projecting beneath the cuneiforms. The mesocuneiform is small, much like that of *Oxyæna*; the entocuneiform deep dorso-ventrally, with heavy inferior hook, large navicular facet and deep facet for mt. I. Of the metatarsals mt. III-V of the right side are complete, III and IV of nearly equal length, V one-fifth shorter, and somewhat stouter in shaft. They are of moderate length, comparable to *Oxyæna* in proportions, although much larger. The phalanges are much longer than in *Oxyæna*, their combined length one fourth greater than that of the metatarsal while in *Oxyæna* the metatarsal is as long as the three phalanges, and in *Patriofelis* it is longer. The second phalanx is not flattened as in *Oxyæna*; the ungual is larger, longer, less curved, somewhat more compressed, and with a deep but narrow fissure.

Three vertebrae from the middle caudal region indicate a long, heavy tail.

This specimen belongs to the Pseudocreodi as indicated by the fissured unguals, not flattened as in Mesonychidae. It is very clearly distinguished from *Oxyæna* and *Patriofelis*, and approximates *Limnocyon* in the proportions of the phalanges. There is no known Lower Eocene Creodont to which it could belong except *Palæonictis*, and its ascription to any known species of that genus involves wide difference from *Ambloctonus* in size of skeleton relative to skull. If not *Palæonictis* it is an otherwise unknown Oxyænid or less probably an unknown Hyænodont.

### ***Palæonictis occidentalis* Osborn.**

*Palæonictis occidentalis* OSBORN 1892, Bull. A. M. N. H., Vol. IV, p. 104, pl. iv.

*Type*, No. 110, front of skull and lower jaws from the Gray Bull beds, Big Horn Basin, Wyoming.

*Distinctive characters*: Premolars  $\frac{4}{4}$  m<sup>2</sup> small, rounded; m<sub>2</sub> with strong metaconid, and small basin heel.

The last mentioned character distinguishes the species from *P. gigantea* of the Suessonian.

To this species I refer a number of upper and lower jaws, Nos. 15211, 15213-6, 16178, from the Systemodon zone of the Big Horn Wasatch. The genus has not been found in New Mexico nor later than this zone.



**Ambloctonus** Cope 1875.

*Generic characters:* Premolars and  $m^1$  very like *Palæonictis*;  $m^2$  small, two-rooted transverse;  $m_2$  with no metaconid. Heel of  $m_1$  progressively trenchant; heel of  $m_2$  progressively reduced. Zygomata wide and deep, as in *Palæonictis* and *Patriofelis*.

Although not observed by either Cope or Wortman there is no doubt of the presence in the type of *A. sinosus* of a small transverse molar behind

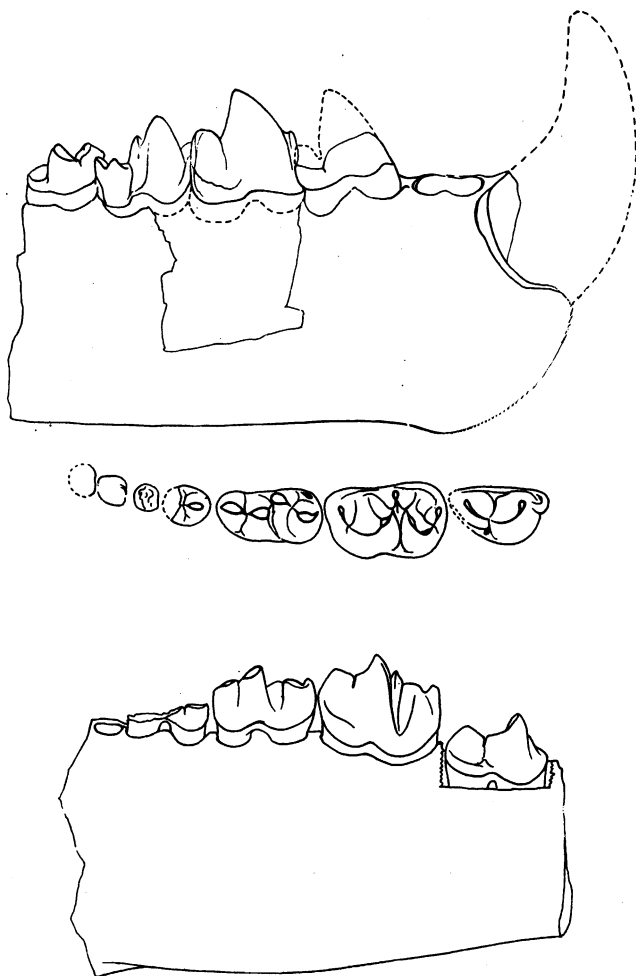


Fig. 50. *Ambloctonus*, lower jaws; above, *A. priscus*, permanent dentition, outer view, below *A. hyenoides*, milk premolars and  $m_1-2$ , outer view and crown view of teeth. All natural size.

$m^1$ . Cope misinterpreted the upper teeth, an error corrected by Wortman in 1892. The genus is nearly allied to *Palæonictis*, distinguished by the more shearing type of the posterior teeth. Two species are represented in our collection, one from the Clark Fork and lower Gray Bull levels, decidedly more primitive, the other from the Lysite or Lost Cabin, distinctly more progressive than the type species.

The transverse  $m^2$  is preserved in the more primitive species. The tooth may have been absent in the more progressive *A. hyænoides*.

### ***Ambloctonus priscus* sp. nov.**

*Type*, No. 15212, fragmentary skull and jaws, etc., from the Gray Bull horizon three miles north of Otto in the Big Horn Basin, Wyoming. Paratypes Nos. 16116, 16117, upper and lower jaws from Clark Fork horizon, Clark Fork Basin, Wyoming.

*Specific characters*: Smaller than *A. sinosus*, teeth less robust, heel of  $m_2$  much less reduced, with three cusps enclosing a basin.

The type is a young individual with unworn teeth, and  $m^2$  not yet erupted. No. 16116 supplies the characters of this tooth.



Fig. 51. *Ambloctonus priscus*, upper teeth, type specimen, natural size, external and crown views.

There are four lower premolars, much crowded, the first one-rooted, the others two-rooted;  $p_2$  is set obliquely in the jaw.  $P_4$  has two postero-internal cingular cusps, absent in *Palæonictis*, but is otherwise like that

genus, as are the other premolars in number and form.  $M_1$  is constructed as in *Palæonictis occidentalis*, but the heel is higher.  $M_2$  differs in the absence of metaconid, but is quite as large as in *P. occidentalis*. The upper teeth compare closely with that species except for  $m^2$  which in the type is buried in the jaw but in No. 16116 is a small transverse two-rooted tooth with a moderately large parastyle, little extended, a strong paracone, vestigial metacone, and compressed transversely trenchant protocone. The zygomatic arches are deep, wide and short, the sagittal crest thick and low.

Fragments of the humerus and ulna indicate a construction similar to *Oxyæna* but shorter and thicker proportions, and a relatively larger head.

### **Ambloctonus sinosus** Cope 1875.

*Ambloctonus sinosus* COPE 1875, Syst. Cat. Vert. Eoc. New Mex., p. 7 (Apr. 17); 1877, Ext. Vert. New Mex. Rep. U. S. G. S. 100th Mer., p. 91, pl. xxxiii; OSBORN & WORTMAN, 1892, Bull. A. M. N. H., Vol. IV, p. 106, fig. 8.

*Type*, U. S. Nat. Mus. No. 2329, fragmentary upper and lower jaws and a few fragments of skeleton.

A careful examination of the type specimen shows two small transversely set alveoli behind  $m^1$ , indicating a small transverse  $m^2$ . The second lower molar has no metaconid, but the heel is a distinct high-pointed cusp with a heavy cingulum internal to it.

The second specimen referred by Cope to *A. sinosus* is considerably larger than the type, and the second molar appears to have no heel. I have therefore transferred it to *A. hyænoides*.

### **Ambloctonus hyænoides** sp. nov.

*Type*, No. 16215, a lower jaw with  $dp_{3-4}$  and  $m_{1-2}$  from the upper horizon of the New Mexican Wasatch. *Paratype*, U. S. Nat. Mus. No. 5377, lower jaw with  $p_4-m_2$  considerably worn, from the Wasatch of New Mexico. No. 16853, jaw fragment with  $dp_4-m_1$  from Lost Cabin horizon at head of Whistle Creek, Big Horn Basin, is also referred here.

*Specific characters*: About one seventh larger than *A. sinosus*;  $m_2$  without heel.

The molar teeth in the type are unworn, and show the peculiar construction very well. The three cusps of the trigonid on  $m_1$  are united by a sharp curving crest, the high hypoconid is also developed as a curved crest, a small crest projecting towards it from the metaconid separated by a narrow cleft and the inner heel cusp has disappeared. The tooth is essentially composed of two crescents concave inwardly. The second molar is com-

posed of but two cusps,  $pa^d$  and  $pr^d$ , which form a high crescent like that of the trigonid of  $m_1$ , differing in the absence of metaconid and heel. A strong internal and posterointernal cingulum is the only trace left of the heel.

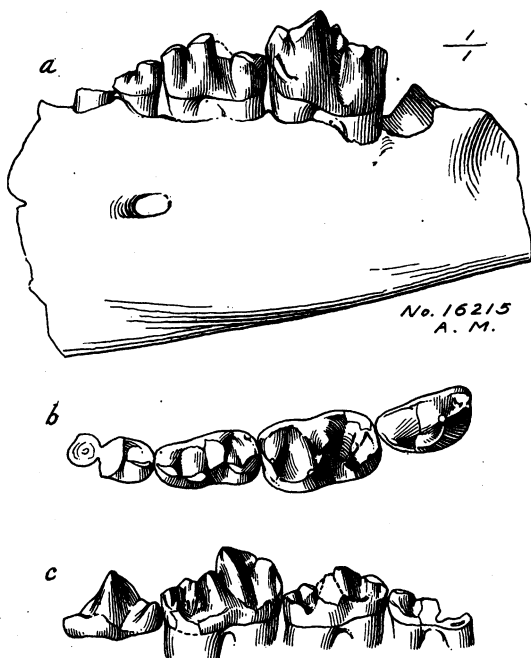


Fig. 52.

Fig. 52. *Ambloctonus hyanoides*, lower jaw, outer view, and crown and inner views of teeth,  $dp_3-4$ ,  $m_1-2$ , natural size. Type specimen, upper (Largo) horizon, Wasatch formation, San Juan Basin.

Fig. 53. *Ambloctonus hyanoides*, jaw fragment from the Big Horn Basin, Wyoming, Lost Cabin beds. Natural size, external view and crown view of last milk molar and first true molar.

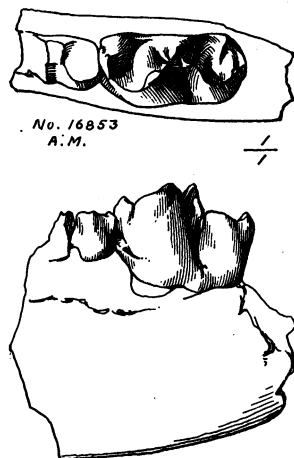


Fig. 53.

The paratype shows that the shearing action on  $m_1$  was imperfect;  $m_2$  in spite of its smaller size, appears to be the real carnassial or principal shearing tooth, as  $m^1$  certainly is in the upper jaw. The cusp-construction of  $m_2^1$ , similar in many respects to that of  $\frac{P^1}{m_1}$  of the *hyaena*, together with the large robust crowded premolars, suggest the specific name.

### ***Ambloctonus coloradensis* (Matthew 1909).**

*Patriofelis ulta* OSBORN 1897, Bull. A. M. N. H., Vol. IX, p. 256; 1900, *ibid.*, Vol. XIII, p. 278, fig. 8.

*Patriofelis coloradensis* MATTHEW 1909, Bull. U. S. G. S., 361, p. 96; Mem. A. M. N. H., Vol. VI, p. 432.

*Type*, A. M. No. 2691, lower jaws, from the upper beds, "Bridger" of the Huerfano Basin.

A reëxamination of this specimen suggests that its affinities are close with *A. sinosus*. It is somewhat smaller and less robust, and is recorded as from a later level, associated with *Tillotherium*. For these reasons it is better retained for the present as a distinct species.

### ***Patriofelis* (*Protopsalis*).**

*Protopsalis* is transitional from *Oxyæna* to *Patriofelis* proper, but is in all respects more like the Bridger genus, despite its retention of a small heel on  $m_2$ . It has not usually been considered as deserving of generic separation.

### ***Patriofelis tigrinus* (Cope 1880).**

*Protopsalis tigrinus* COPE 1880, Amer. Nat., Vol. XIV, p. 745; 1885, Tertiary Vertebrata, p. 322, pl. xxvb, figs. 1-7; (*Patriofelis*) WORTMAN 1894, Bull. A. M. N. H., Vol. VI, p. 130; OSBORN, 1900, *ibid.*, Vol. XIII, p. 278, fig. 7.

*Type*, A. M. No. 4805, part of lower jaw and a few fragments of skeleton, from the Lost Cabin horizon in the Wind River Basin, Wyoming.

Two fragmentary specimens from the same horizon as the type, Nos. 14778-9, were secured by the Expedition of 1909 in the Wind River basin. As in the type, the second lower molar has a vestigial metaconid, and small but distinct heel.  $P_4$  is massive, with strong anterior cusp and broad heel cusp.  $P^4$  has a strong anteroexternal cusp and the deuterococone is less extended inwardly than in *Oxyæna*. In all these features the teeth agree with *Patriofelis*.

### ***Dipsalidictis* gen. nov.**

*Type*, *D. platypus*, infra.

*Generic Distinctions*: deuterococone on  $p^4$  only;  $m^2$  transverse, unreduced,  $m^3$  absent;  $m_1$  and  $m_2$  subequal, tuberculosectorial with large basin heels,  $m_3$  absent;  $P_1$  one-rooted; antero-external cusp of  $p^4$  prominent; no fibulo-calcaneal facet; astragalus with flat wide trochlea, limited anteroposteriorly, inner crest not defined, neck short, head wide and flat, not deep.

This genus has the dentition much as in *Limnocyon*; but the tarsus is more platyarthran than in *Oxyæna* or *Patriofelis*, much more than in *Limnocyon*. The dentition differs from that of *Limnocyon* only in the one-rooted first premolar and distinct protostyle, and except for the very marked

difference in the tarsus, I should not be disposed to separate it from that genus. It may prove to be an ancestral stage of *Limnocyon* but as the evidence stands at present this is doubtful. The single species is known only from the Clark Fork beds; in the later horizons of the Lower Eocene no

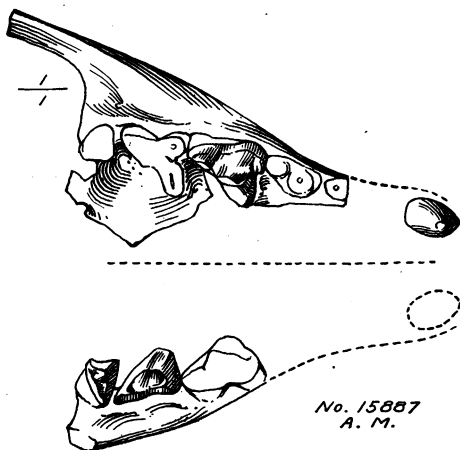


Fig. 54.

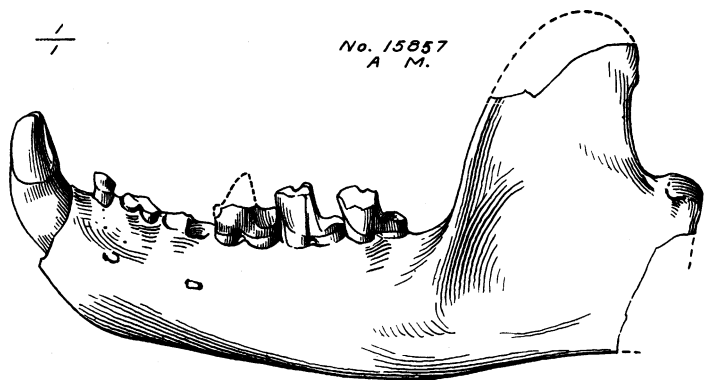


Fig. 55.

Fig. 54. *Dipsalidictis platypus*, upper jaws of type, palatal view, natural size. Clark Fork beds.

Fig. 55. *Dipsalidictis platypus*, lower jaw of type, natural size, external view. Clark Fork beds, Clark Fork Basin, Wyoming.

intermediate forms are known to occur while *Prolimnocyon* is fairly common. Which if either of these genera should be regarded as more directly ancestral to *Limnocyon* and *Thinocyon*, is not clear.

***Dipsalidictis platypus* sp. nov.**

*Type*, No. 15857, upper and lower jaws and considerable part of skeleton from Clark Fork beds, 3 miles north of Ralston, Big Horn Basin, Wyoming.

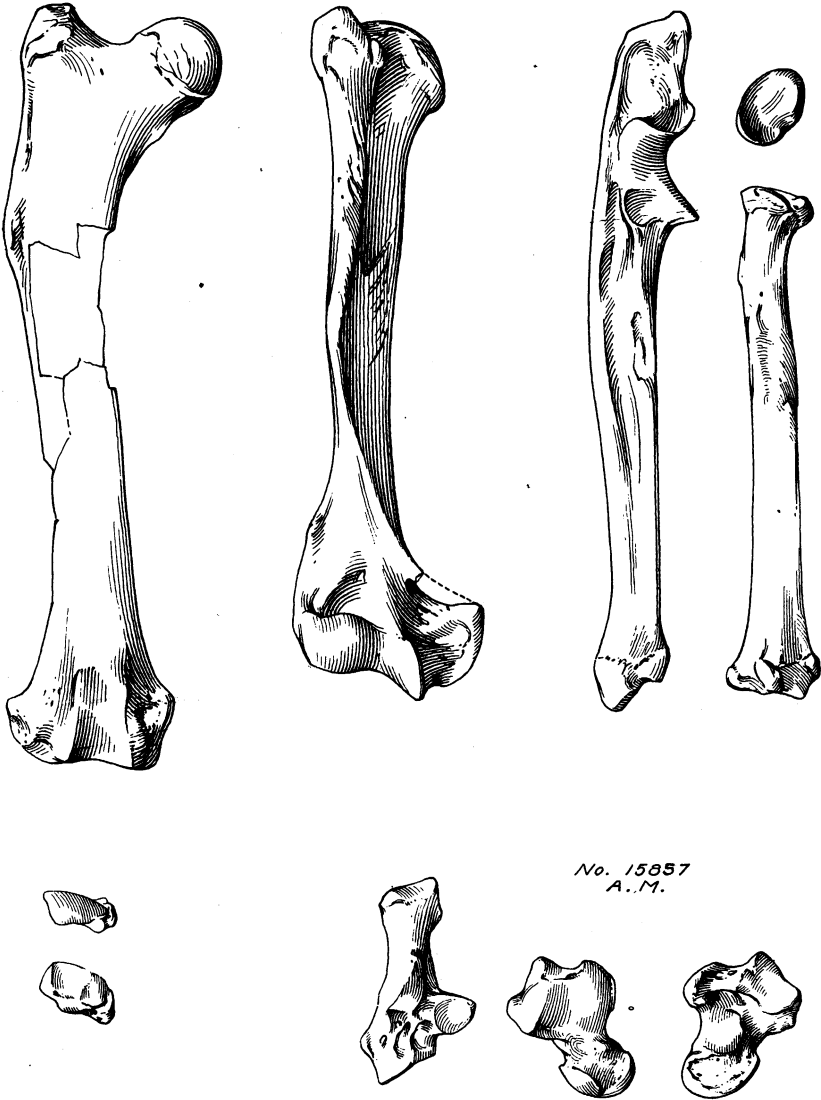


Fig. 56. *Dipsalidictis platypus*, limb and footbones of type skeleton, natural size; anterior views of femur, humerus, ulna, radius; head of radius; dorsal and distal views of scaphoid; dorsal view of calcaneum; superior and inferior views of astragalus. Clark Fork beds, Clark Fork Basin, Wyoming.

The jaws are somewhat fragmentary, the teeth considerably worn and many of them missing or broken; a few fragments of the cranium, a number of broken vertebræ, most of the limb-bones, both scaphoids and cuneiforms, the astragalus and calcaneum, and various fragments of other parts are preserved.

The skull fragments show a prominent preglenoid crest (absent in *Limnocyon*, present in *Oxyæna*), postglenoid foramen as usual in Creodonts, rather high sagittal crest, as in *Limnocyon*.

The limb bones are nearly equal in length to those of *L. verus* but much slenderer. The distal roll of the humerus is more obliquely set, the shaft is more slender, the deltoid crest less heavy and ends somewhat more abruptly. The head of the radius is round-oval instead of flattened oval as in *L. verus*. The distal end of the radius is wider, not so deep (dorsoventrally) and the shaft less curved and much more slender. The distal end of the ulna is more expanded, the shaft thinner, the olecranon shorter. The femur is much lighter in the shaft, patellar trochlea somewhat shorter, condyles not so deep or heavy. Tibia and fibula have more slender shafts, distal end of fibula less massive, and lacking calcaneal facet; distal trochlea of tibia much more oblique.

The astragalus has a singularly primitive aspect, with shallow body, flattened trochlea short and wide and with no internal crest, and the very obliquely set wide flat head. The calcaneum is much straighter than in *Limnocyon*, the peroneal tubercle less prominent, fibular facet wholly absent, cuboid facet less oblique.

The scaphoid has the proximal facet extended over the entire superior surface making a sharp crest with the centrale and trapezium facets (the trapezoid probably barely touches the scaphoid). The hook of the scaphoid is not at all prominent. The cuneiform is of comparatively small height, the hook small. The pisiform has a long neck, head little expanded.

The data indicate a wide, low carpus and tarsus, primitive plantigrade feet, with limited motion in the proximal joint (tarso-crural, carpo-antebrachial).

#### Measurements of Type.

Lower teeth, c-m <sub>2</sub> .....	54.2
“ “ m <sub>1-2</sub> .....	18.2
“ “ p <sub>4</sub> length.....	9.1
“ “ m <sub>1</sub> “.....	8.1
“ “ m <sub>2</sub> “.....	8.7
P <sup>3</sup> to m <sup>2</sup> length.....	31.4
M <sup>1-2</sup> length.....	12.7
P <sup>3</sup> diameters (a <sub>1</sub> -p x tr.).....	8.7 × 4.2



P <sup>4</sup> diameters (a <sub>1</sub> -p x tr.)	10.4 × 8.9
M <sup>1</sup> " "	9.0 × 9.8
M <sup>2</sup> " "	4.6 × 9.9
C <sup>1</sup> " "	6.6 × 5.5
Jaw, length, canine to condyle	91.5
" depth beneath p <sub>2</sub>	17.7
" " behind m <sub>2</sub>	19.7
Humerus, length	92.5
" diameter of proximal end	21.0
" diameters of middle of shaft	14.1 × 7.3
" width of distal end	25.2
Ulna, length	92.9
" diameters of mid shaft	8.5 × 4.7
" width of distal end	10.7
" length of olecranon from upper border of radial facet	24.2
Radius, length	68.0
" diameters of prox. end	11.0 × 7.8
" " " mid. shaft	6.0 × 5.1
" " " dist. end	13.0 × 8.6
Femur, length	100.9
" diameter of head	11.8
" width of proximal end	26.0
Astragalus, diameters of body	14.3 × 10.8
" width of neck	8.3
" diameters of head	10.4 × 4.5
" diameters of tibial facet	10.3 × 10.4
Calcaneum, length	27.5

### **Prolimnocyon** gen. nov.

*Generic characters:* This genus differs from all previously known Oxyænidae in retaining a small or vestigial m<sub>3</sub>. Unlike the Hyænodonts the second upper molar is transverse, the carnassials being m<sub>1</sub><sup>2</sup>; m<sub>2</sub><sup>3</sup> are quite small. The Oxyænid characters are also shown in the thick, heavy jaw with solid symphysis, and in the broad, low occiput with wide and rather short basicranial region.

The genus is represented by at least two species in the Gray Bull horizon of the Wasatch, of small size, comparing with *Thinocyon* of the Bridger. The small last molar varies in proportionate size, but in all of them it is much smaller than m<sub>2</sub>, two-rooted, with high protoconid, small paraconid, small or no metaconid, and rather long compressed basin heel. A more progressive species is found in the Lost Cabin beds.

#### *Key to Species of Prolimnocyon.*

- M<sub>1-3</sub> = 14-16. M<sub>3</sub> small, two-rooted, metaconid usually distinct . . . . . *P. atavus*.  
M<sub>1-3</sub> = 21. M<sub>3</sub> larger, two-rooted, no metaconid, jaw deep . . . . . *P. robustus*.  
M<sub>1-3</sub> = 15. M<sub>3</sub> one-rooted . . . . . *P. antiquus*.

**Prolimnocyon atavus** sp. nov.

*Type*, No. 16816, part of lower jaw and fragments of skeleton from the Gray Bull horizon of the Big Horn Wasatch. Nos. 16815-8, 15165-15172, 15720 and a number of other specimens from the same horizon and locality, are referable to the species. No. 16111, a jaw fragment from the lower Sand Coulée horizon in Clark Fork Basin, is smaller and perhaps a primitive mutant.

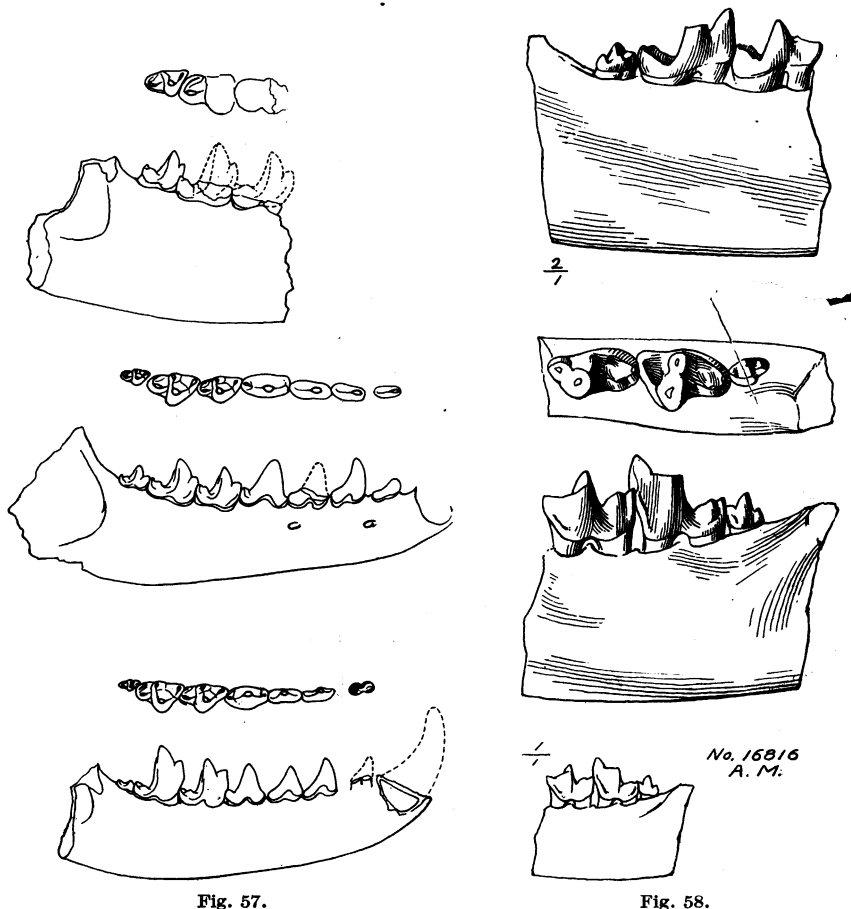


Fig. 57.

Fig. 58.

Fig. 57. *Prolimnocyon*, lower jaws, natural size, from Gray Bull beds of Big Horn Basin. Upper figure is No. 16168, type of *P. robustus*; the two lower Nos. 15166, 15172, referred to *P. atavus*, but doubtfully conspecific.

Fig. 58. *Prolimnocyon atavus*, part of lower jaw with  $m_{1-3}$  inner, superior and outer views, enlarged to two diameters, with outline of natural size. From the type specimen No. 16816, Gray Bull beds, Big Horn Basin.

The molar and premolar teeth are much as in *Thinocyon*.  $P_4$  has a strong anterior basal cusp, the anterior premolars are rather short and high;  $p_2$  has

roots connate. The heels of the molars are also like those of *Thinocyon*, compressed, narrow and bordered by two subequal crests. In most species of *Sinopa* the heels are relatively broader and usually larger; but I can find no constant generic distinctions in the construction of the molars.

Upper and lower teeth of the same individual are preserved in Nos. 15240 and 15246, and No. 15171, a crushed and imperfect skull, shows the upper teeth and a few cranial characters of interest. The remainder of the speci-

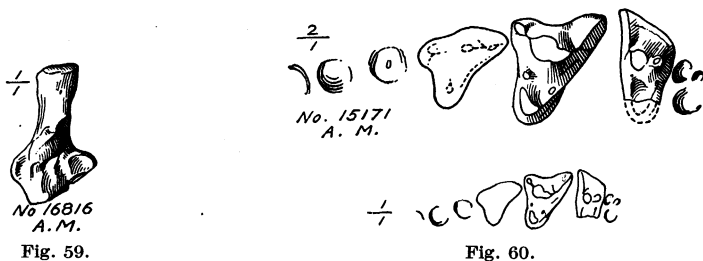


Fig. 59. *Prolimnocyon atavus*, calcaneum of type specimen, natural size, dorsal view.

Fig. 60. *Prolimnocyon atavus*, upper teeth, from skull No. 15171, crown view, enlarged to two diameters and natural size. The outline of  $p^4$  is taken from No. 15246. Gray Bull beds, Big Horn Basin.

mens are all lower jaws, fragments of the skeleton being associated with the type only.

In the skull,  $m^2$  is transverse, nearly as wide as  $m^1$ , the metacone vestigial, parastyle long and curved.  $M^3$  is represented by two alveoli which indicate a tooth one-half or one-third the transverse width of  $m^2$ .  $M^1$  is much like the corresponding tooth in *Sinopa*, but with *me* and *pa* more closely connate.  $P^4$  is 3-rooted triangular, smaller than  $m^1$ ;  $p^3$  has also a small internal root. The skull is too poorly preserved to show many important data; the interorbital width is large, as in *Limnocyoninae*, without the frontal fossa characteristic of *Hyænodonts*; the occiput is broad, and the general proportions agree fairly well with *Thinocyon*.

The sacrum is narrow, although wider than in *Thinocyon*; the sacral ribs are much narrower than in *Sinopa* or *Tritemnodon*. The anterior zygapophyses on the first sacral vertebra are nearly flat; in *Thinocyon* they are considerably more concave, in *Tritemnodon* they are about semi-cylindrical. The head of the tibia shows a low cnemial crest. The calcaneum has a rather short tuber, a small fibular facet, moderate peroneal process, cuboid facet nearly as wide as it is deep, and moderately oblique.



Fig. 61. *Prolimnocyon atavus*, lower jaw, outer view, natural size. No. 15169; outlines of  $p_3$  and  $m_{2-3}$  restored from Nos. 15246, 16816. Gray Bull beds, Elk Creek, Big Horn Basin, Wyoming.

***Prolimnocyon robustus* sp. nov.**

A considerably larger species is indicated by a part of a lower jaw, No.

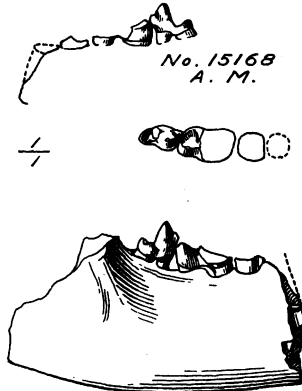


Fig. 62. *Prolimnocyon robustus*, lower jaw fragment, type specimen, external view with crown and inner views of teeth, all natural size. Lower Gray Bull beds, Big Horn Basin.

15168, from the Big Horn Basin, Gray Bull beds. The larger size, deeper jaw, less relative reduction of  $m_3$  indicate its distinctness.

***Prolimnocyon antiquus* sp. nov.**

Type, No. 14768, lower jaw with teeth mostly broken off, from the Lost Cabin horizon in the Wind River Basin.

*Distinctive Characters:* Size of *P. atavus* or slightly larger;  $m_3$  one-rooted.

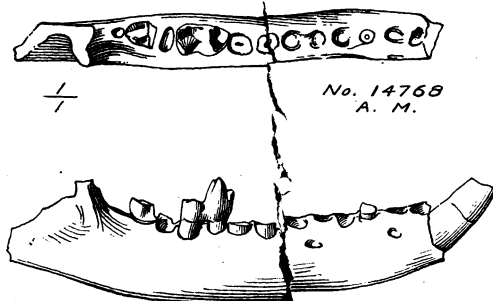


Fig. 63. *Prolimnocyon antiquus*, lower jaw, superior and external views, natural size. Type specimen, Lost Cabin beds, Wind River Basin.

This species is represented only by the type and doubtfully by No. 2971, but the small round alveolus for  $m_3$  is so clearly distinct from anything in

the Gray Bull horizon that I do not doubt its validity. The second specimen shows the unworn premolars and  $m_1$ , very similar in characters to those of *Thinocyon*, but in absence of the posterior molars it is not certainly determinate.

A fourth species, which I have placed under *Sinopa* (*S. mordax*) is undoubtedly related to this genus, and when better known may have to be transferred to it. It shows several characteristic Oxyænid features, but  $m_3$  is only a little smaller than  $m_2$  and has a well developed metaconid.

### HYÆNODONTIDÆ.

*Sinopa* (*Stypolophus*) is perhaps the most abundant Creodont genus in the Lower Eocene and practically the only representative of the family at this time. The more specialized *Tritemnodon* is first represented in the Lost Cabin beds by a marginal species, *T. whitæ*, retaining several characters of *Sinopa*. The hyænodonts of the Lower Eocene evidently approach the Oxyænidæ, the two groups being derivable from a common source. This is especially seen in the two-rooted  $p_1$ , of several of the species, and in the heavy jaw and *Limnocyon*-like premolars of *S. mordax*.

#### ***Sinopa* Leidy.**

The Lower Eocene species of this genus were revised by Matthew in 1901 chiefly on the basis of Wyoming specimens. The new collections from New Mexico and Wyoming have supplied a large series of specimens for comparison. These serve to modify the earlier conclusions in some degree.

The species are for the most part not very sharply distinguished from each other or from those of the Bridger horizons.

Three new species are here described, and all but one of the described species of the Lower Eocene are validated or confirmed by reference to them of additional and more complete specimens, topotypes where possible. I must confess some doubt however, as to whether all the forms here described are entitled to specific rank on the standards used in this revision; or on the other hand whether some may not include two or more species which more complete material would show to be distinct. It is also possible that more than one genus is included. *Prototomus* Cope 1874, may have to be revived to include *S. viverrina* and probably *S. ? secundaria* when these species are better known. Professor Scott in his recent book appears disposed to

revive *Stypolophus* (type *S. pungens*) and include in it all the Lower Eocene species, limiting *Sinopa* to the middle Eocene. He gives no hint of reason for this procedure, nor am I able to imagine any justification for it. The Lower Eocene species are distinguished from their successors by a number of skull and skeleton differences which might conceivably be regarded as generic, although I do not regard them as such. But the name *Stypolophus* could not be used for them, as its type species is middle Eocene, and closely allied to *S. rapax*, type of *Sinopa*.

*Key to Species of Sinopa.*

- I. Heels of  $m_{1-2}$  broad-basined, equalling trigonid in diameter. *Pa* and *me* of  $m^{1-2}$  well separated. Premolars robust with rugose enamel,  $p_1$  one-rooted.
  - A. Molar shears of similar type, heel of  $m_3$  broad, *me* of  $m^3$  well developed.
    - a. Trigonids of molars robust, not high.
      1.  $M_{1-3} = 29$ ; no diastema behind  $p_2$ .....*S. major*.
    - b. Trigonids of molars of moderate height.
      2.  $M_{1-3} = 26$  mm.; a diastema behind  $p_2$ .....*S. grangeri*.
      3.  $M_{1-3} = 28$  mm.; no diastema behind  $p_2$ .....*S. shoshoniensis*.
      4.  $M_{1-3} = 25$  mm.; " " " ".....*S. rapax*.
      5.  $M_{1-3} = 20$  mm.; " " " ".....*S. pungens*.
  - B. Carnassials,  $\frac{m^2}{m_3}$ , more specialized with shear more anteroposterior; anterior molars with shears little developed. Heel of  $m_3$  narrow, metacone of  $m^3$  vestigial.
    6.  $M_{1-3} = 31$  mm.....*S. opisthotoma*.
- II. Heels of  $m_{1-3}$  narrow-basined; trigonids high, and broader than heels. *Pa* and *me* of upper molars more connate. Premolars higher with smooth enamel,  $p_1$  two-rooted, compressed.
  7.  $M_{1-3} = 29$  mm.; diastema behind  $p_2$ .....*S. hians*.
  8.  $M_{1-3} = 25-26$  mm.; no diastema behind  $p_2$ .....*S. strenua*.
- III. Smaller species of intermediate type, but nearer to division ii.
  9.  $M_{1-3} = 21.5$  mm.; premolars more robust, symphyseal region shorter and deeper,  $m_{\frac{1}{2}}$  less reduced.....*S. multicuspis*.
  10.  $M_{1-3} = 20-22$  mm.; premolars and molars narrower and more compressed, symphyseal region shallow and elongate,  $m_{\frac{1}{2}}$  more reduced.....*S. vulpecula*.
  11.  $M_{1-3} = 17$  mm.; premolars with slender acute cusps, a considerable diastema behind  $p_2$ .....*S. ?secundaria*.
  12.  $M_{1-3} = 18.7$  mm.; heels larger than in the three preceding species.  
*S. minor*.
  13.  $M_{1-3} = 14$  mm., smaller than any preceding.....*S. viverrina*.
- IV. Jaw heavy, symphyseal region massive, symphysis close, premolar construction approaching *Limnocytoninae*.
  14.  $M_{1-3} = 21$  mm.;  $m_3$  somewhat reduced.....*S. mordax*.

***Sinopa mordax* sp. nov.**

*Type*, No. 16157, lower jaws, from the Gray Bull horizon, Clark Fork Basin, Wyoming.

*Distinctive characters*:  $M_3$  smaller than  $m_1$  and slightly smaller than  $m_2$ ;  $p_4$  with strong anterior basal cusp; canine stout with massive root; jaw thick and heavy especially at symphysis.  $M_{1-3} = 22$  mm.

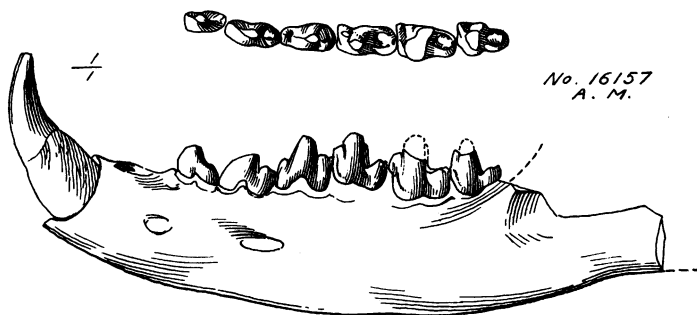


Fig. 64. *Sinopa mordax*, lower jaw, type specimen, natural size, outer view and crown view of teeth. Gray Bull beds, Clark Fork Basin.

The characters of this species show a marked approximation to the Oxyænidæ, and especially to *Prolimnocyon*. It serves to emphasize further the near approximation of Oxyænidæ and Hyænodontidæ in the lower stages of the Wasatch.

***Sinopa opisthotoma* Matthew 1901.**

*Sinopa opisthotoma* MATTHEW 1901, Bull. A. M. N. H., Vol. XIV, p. 28, fig. 9.

*Type*, A. M. No. 99, upper and lower jaws from the Wasatch of the Big Horn Basin, Wyoming, probably Gray Bull horizon.

*Distinctive characters*:  $M_{1-3} = 31$  mm.;  $m^2$  and  $m_3$  relatively large with shear more antero-posterior than in other species. Lower premolars without anterior basal cusps; posteroexternal cusps of upper premolars weak or absent. The enamel of premolars and molars is rugulose with anastomosing vertical ridges.

*Pa.* and *me* well separated on  $m^1$  and  $m^2$ , heels of  $m_{1-2}$  broad basined; a small *me* on  $m^3$ , heel of  $m_3$  narrow and elongate.

Thirteen specimens from the Gray Bull Wasatch of the Big Horn Basin are referable to this species. It is about as large as *S. hians*, but of very distinct type.

***Sinopa shoshoniensis* sp. nov.**

*Type*, No. 16158, a lower jaw from the Gray Bull beds of Clark Fork Basin, Wyoming. Paratype, No. 15745, lower jaws and fragments of upper jaws, from lower

Gray Bull Beds, Big Horn Basin. Nos. 15742, 15515, 15734, 15743, lower jaws, and three unnumbered jaws from the Shoshone River in the Big Horn Basin are referred to this species.

*Distinctive characters:* Slightly smaller than *hians* and *opisthotoma*. Heels of all lower molars large. Surface of enamel rugose striated vertically, canines heavily

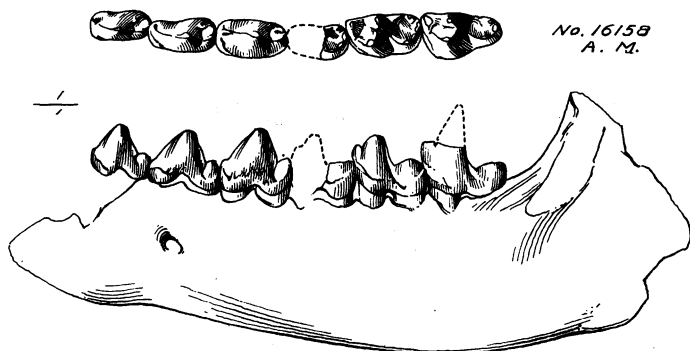


Fig. 65. *Sinopa shoshoniensis*, lower jaw, type specimen, natural size, outer view and crown view of teeth. Gray Bull beds, Clark Fork Basin, Wyoming.

grooved. Premolars robust without anterior basal cusps. Heel of last lower molar broader and shear of trigonid more transverse than in *opisthotoma*.  $M^2$  nearly as large as  $m^1$ ,  $p^3$  with strong inner cusp. Posteroexternal cusps of pms small, anteroexternal rudimentary.

This species is nearly related to *opisthotoma*, but distinguished by the typical proportions of the molar shears; it is evidently allied to the typical group of *Sinopa* (*S. rapax*, *pungens* and *grangeri*) of the Middle Eocene, and may well be ancestral to it.

### ***Sinopa strenua* (Cope 1875).**

*Prototomus strenuus* COPE, 1875, Syst. Cat. Eoc. Vert. New Mex., p. 10; (*Stypolophus*), 1877, Ext. Vert. New Mex., p. 117, pl. xxxix, fig. 11; (*Sinopa*) MATTHEW 1901, Bull. A. M. N. H., Vol. XIV, p. 26.

*Sinopa hians* (Cope), MATTHEW 1901 l. c. Not *Stypolophus hians* of Cope.

*Type*, U. S. Nat. Mus. No. 1023, lower jaws with  $p_4$ - $m_3$  r. and l., much damaged and buried in matrix.

*Distinctive characters:*  $m^1$ - $s$  = 22 mm.;  $m_1$ - $s$  = 24-26 mm.; heels of molars small, trigonids high; jaw long and slender anteriorly,  $p_1$  two-rooted,  $p_2$  not spaced. Enamel smooth.

A number of specimens from the Gray Bull horizon of the Big Horn Wasatch agree fairly well with the type of *S. strenua*. No. 15234, anterior half of skull and lower jaws, and No. 2850 upper and lower jaws with frag-



ments of skull and skeleton show the dentition well preserved. The species appears to be related through *S. hians* and *T. whitia* to the *Tritemnodons* of the Bridger formation.

Nos. 4782, 14773-5, upper and lower jaws from the Lost Cabin horizon

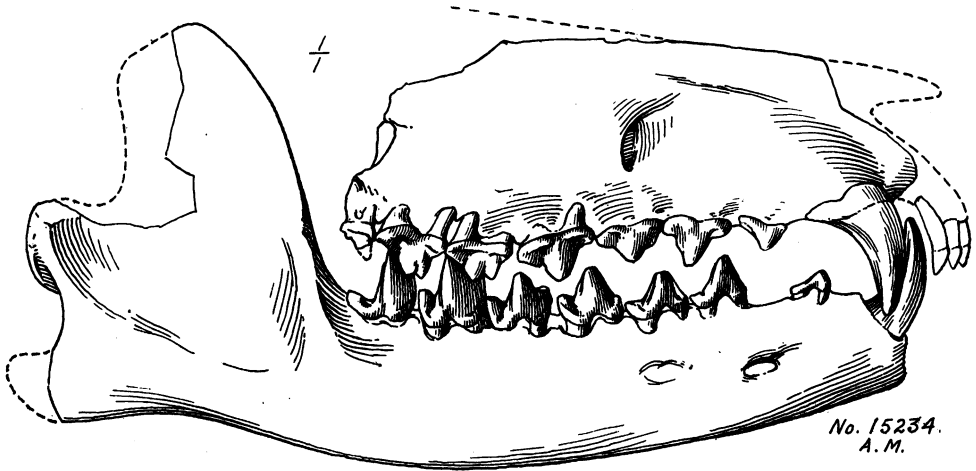


Fig. 66. *Sinopa strenua*, front of skull and lower jaw, natural size. No. 15234, upper Gray Bull beds, Big Horn Basin.

of the Wind River, agree in most respects with the Gray Bull specimens and with the type of the species, but are somewhat smaller and the metacone of  $m^2$  vestigial while it is distinct in the Gray Bull form.

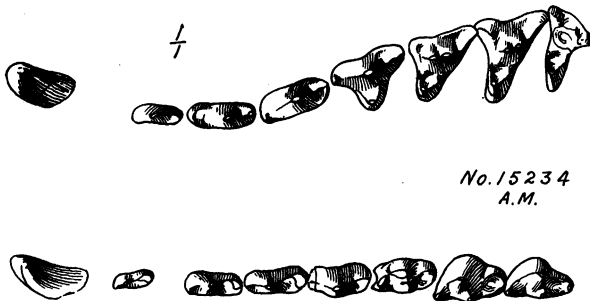


Fig. 67. *Sinopa strenua*, upper and lower dentition, crown views, natural size. From No. 15234.

### ***Sinopa hians* (Cope 1877).**

*Stypolophus hians* COPE 1877, Ext. Vert. New Mex., p. 72, pl. xxxviii, figs. 12-30; (*Sinopa*) MATTHEW 1901, Bull. A. M. N. H., Vol. XIV, p. 25 (in part).

*Type*, U. S. Nat. Mus. No. 1111, numerous fragments of skeleton in bad preservation.

*Distinctive characters:*  $m^1-3 = 25$ ,  $m_{1-3} = 29$  mm.; heels of molars small, trigonids high, enamel nearly smooth, jaw long anteriorly deeper and more massive than in *S. strenua*,  $p_1$  two-rooted,  $p_2$  spaced,  $p_{3-4}$  with distinct anterior basal cusps, molars increasing but little from  $m_1$  to  $m_3$ . Posteroexternal cusps of  $p^3$  and  $p^4$  strong, antero-external cusps minute or absent. Metastyle of  $m^1$  moderately extended;  $m^2$  wide transversely, its antero-posterior diameter comparatively small,  $pr$  and  $me$  of equal height and rather closely connate,  $ps$  and  $ms$  subequal, extending more externally than in other species. Parastyle of  $m^3$  much extended externally, paracone high, metacone almost vestigial.

This species is close to *T. whitæ* on the one hand, to *S. strenua* on the other, representing an intermediate stage in character of teeth, but larger than either species.

No. 16214, lower jaws and fragments of the skeleton from the top of the Almagre horizon of the New Mexican Wasatch agrees fairly well with the fragmentary jaws of the type specimen, and is taken as a topotype. No. 16821, upper and lower jaws with parts of skull and skeleton from the upper level of the Gray Bull horizon of the Big Horn Wasatch, agrees with the topotype. The distinctive characters above noted are chiefly based on these two specimens, the type having no teeth preserved.

No. 12776, upper and lower jaws from the Lost Cabin beds in the Wind River Basin is also referred here.

A comparison of No. 16821 with *Tritemnodon agilis* shows a close agreement in details of skeleton construction, so far as comparison can be made, but the Wasatch species is more primitive in the following particulars.

The astragalar trochlea is less grooved, its inner crest less defined, and it is more limited posteriorly, the astragalar foramen more distinct. The head of the astragalus is wider and of somewhat less depth. The astragalo-calcaneal facet is wider. The calcaneo-cuboid facet is wider; the calcaneo-fibular facet less extended backwards, the tuber calcis somewhat heavier. The astragalar facet of the tibia is somewhat flatter and more oblique, the internal malleolus has a more prominent posterior tuber and less prominent anterior crest. The third trochanter of the femur is considerably further down upon the shaft. The skull and jaws are more robustly proportioned, with a remarkably long sagittal crest great overhang to the occiput, long postorbital region and contracted brain-case. We have no good skull of *T. agilis* in the collection, but *S. hians* differs in these skull features from *T. whitæ* and more markedly from Wortman's reconstruction of *T. agilis* or from *Sinopa grangeri* of the Bridger.

The above specified differences also separate *S. hians* from the Middle Eocene species of *Sinopa* (*S. rapax*, *grangeri*). It appears therefore that the evolution of the Hyænodonts from Lower to Middle Eocene was in part parallel progressive.

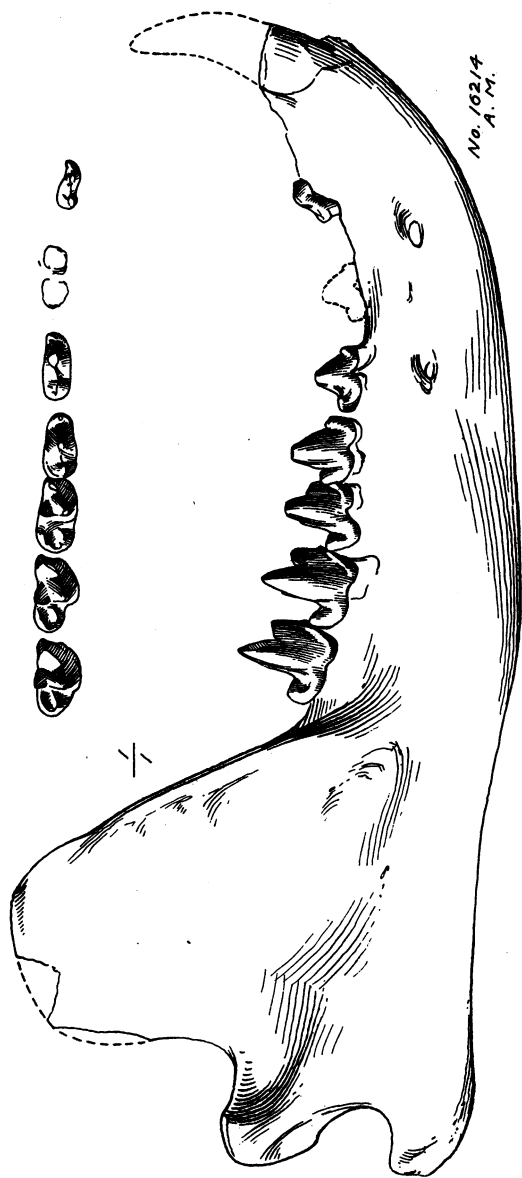


Fig. 68. *Sinopa hians*, lower jaw, outer view and crown view of teeth, natural size. No. 16214. topotype, top of Almagre beds, Wasatch of San Juan Basin, New Mexico.

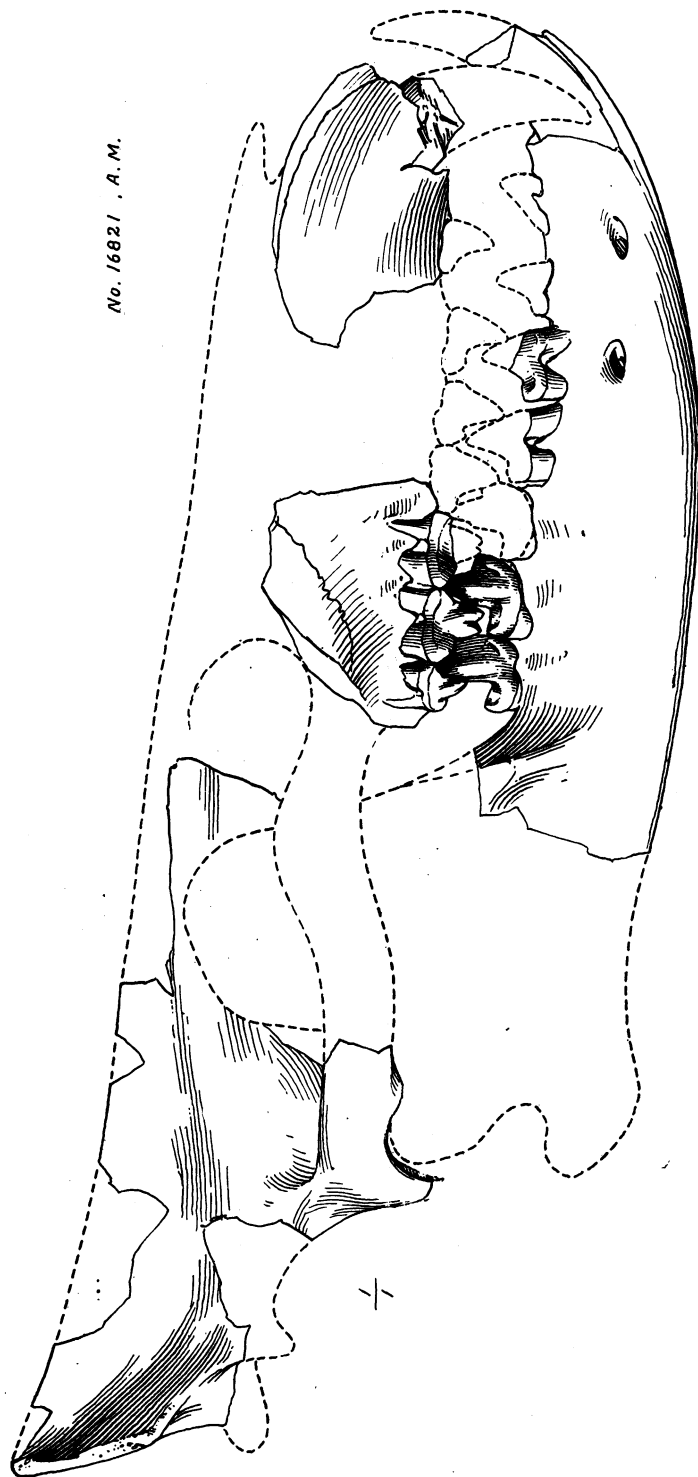


Fig. 69. *Sinopa hians*, reconstruction of skull and lower jaws, natural size, from fragmentary skeleton No. 16821. Upper Gray Bull beds, Big Horn Basin.

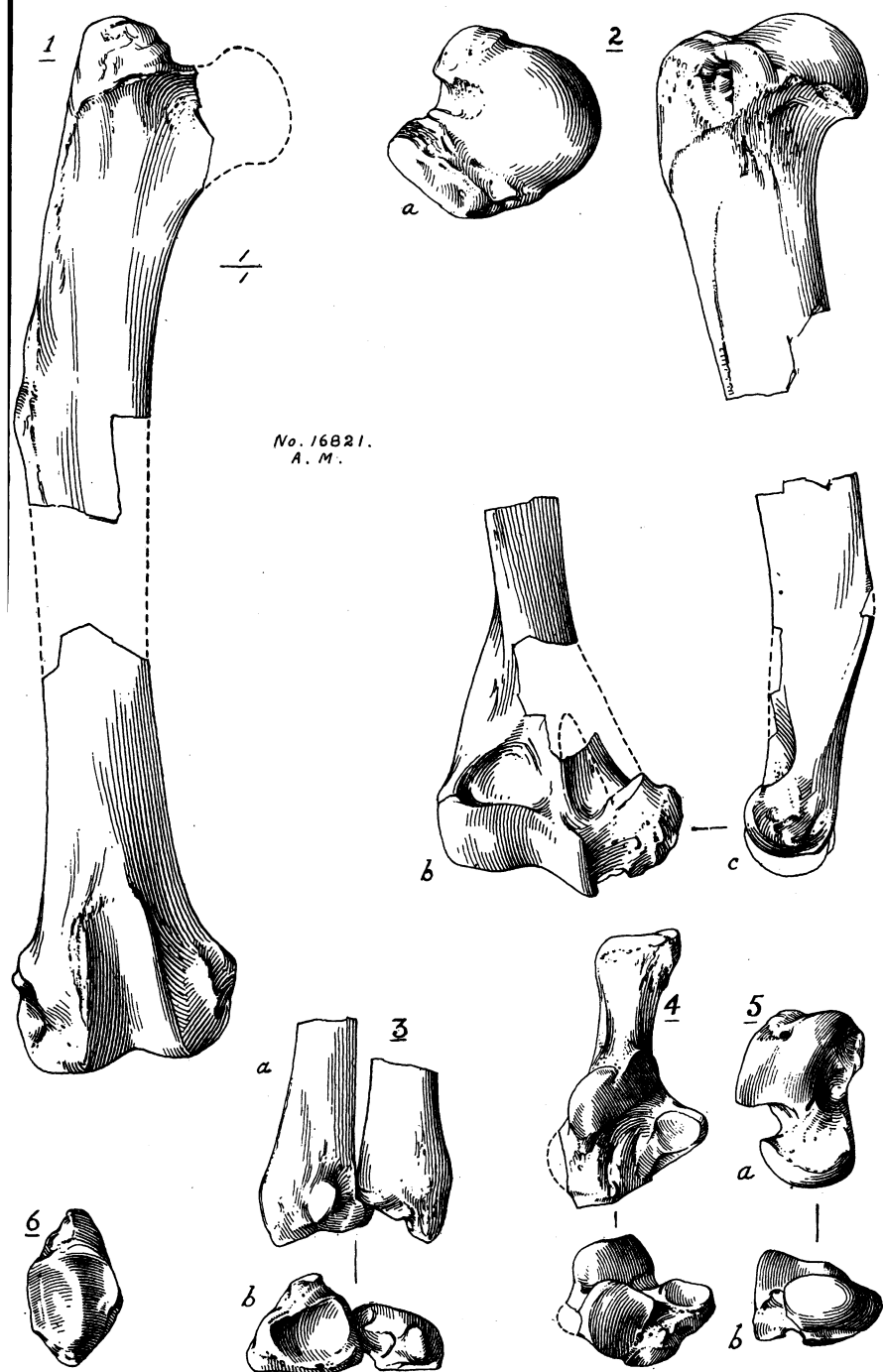


Fig. 70. *Sinopa hians*, parts of limb and foot bones. 1, femur, front view; 2, *a*, *b*, *c*, humerus, proximal, anterior and external; 3*a*, *b*, distal ends of ulna and radius, anterior and distal views; 4, calcaneum, dorsal and distal; 5*a*, *b*, astragalus, superior and distal views; patella, posterior view. All natural size, from the fragmentary skeleton, No. 16821.

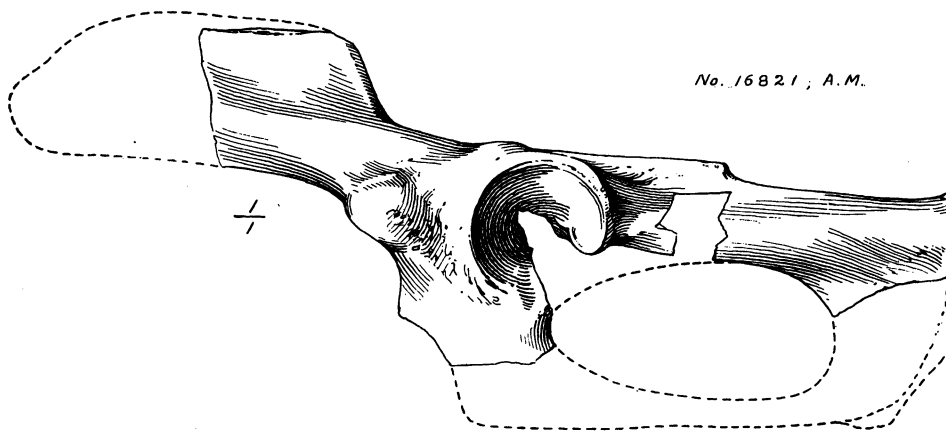


Fig. 71. *Sinopa hians*, pelvis of fragmentary skeleton No. 16821, natural size, left side view.

### ***Sinopa multicuspis* (Cope 1875).**

*Prototomus multicuspis* COPE, 1875, Syst. Cat. Vert. Eoc. New Mex., p. 10; (*Stypolophus*), 1877, Ext. Vert. New Mex., p. 116, pl. xxxix, figs. 12-14; (*Sinopa*), MATTHEW 1901, Bull. A. M. N. H., Vol. XIV, p. 27.

Type, U. S. Nat. Mus. No. 1021, upper jaw,  $p^4-m^3$  from the New Mexican Wasatch.

*Distinctive characters:*  $M^{1-3} = 19$  mm.;  $m_{1-3} = 21$  mm. Jaw rather short, premolars all two-rooted,  $p_2$  spaced. Enamel smooth, molars subequal in size, heels rather small. A deuterocone on  $p^3$ .

To this species are referred a number of upper and lower jaws from the Lost Cabin, Lysite and Gray Bull horizons, Nos. 4782, 14773-5 from Lost Cabin zone, 16819-20 from upper Gray Bull or Lysite, 15239, 16156, from Gray Bull zone. In No. 16820 numerous fragments of the skeleton are associated with the upper and lower jaws.

### ***Sinopa vulpecula* sp. nov.**

*Type*, No. 15606, lower jaw from Lost Cabin horizon in Big Horn Basin, Wyoming.

*Distinctive characters:* Size of *S. multicuspis*, but  $m^1$  relatively small, premolars higher, more compressed, accessory cusps smaller, jaw slender and elongate anteriorly with considerable diastemata before and behind  $p_1$ .

Nos. 15744, lower jaws, and 73, upper jaw fragment with  $m^{1-2}$ , both from the top of the Gray Bull beds in the Big Horn Basin supplement the



No. 15239  
A. M.

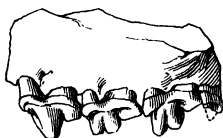


Fig. 72.



No. 16854  
A. M.  
Fig. 74.

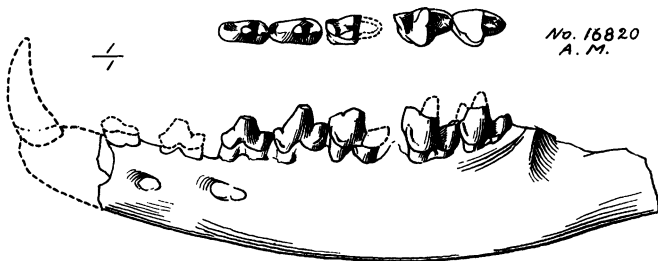


Fig. 73.

Fig. 72. *Sinopa multicuspis*, upper jaw, outer view, and crown view of teeth, natural size. No. 15239, lower Gray Bull beds, Big Horn Basin. The third molar is completed from another individual.

Fig. 73. *Sinopa multicuspis*. Lower jaw, outer view, and crown view of teeth, natural size. From fragmentary skeleton No. 16820, upper Gray Bull or Lysite beds, Big Horn Basin.

Fig. 74. *Sinopa ? vulpecula*, upper teeth, natural size, crown view, No. 16854, Lysite beds, Big Horn Basin.

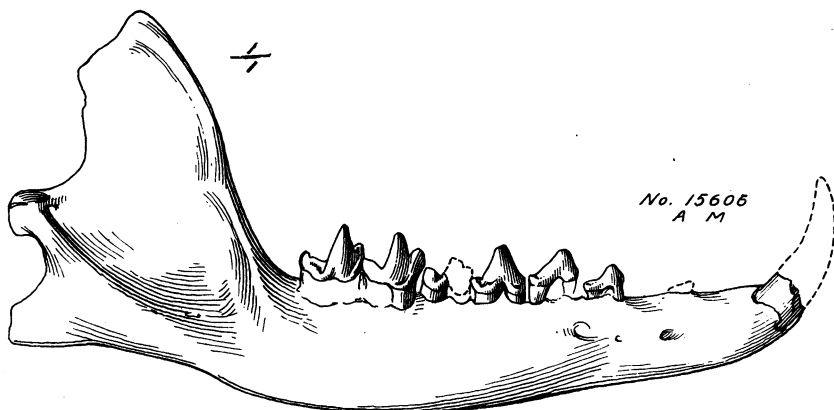


Fig. 75. *Sinopa vulpecula*, lower jaw, external view natural size. No. 15606, type specimen. Lost Cabin horizon, Big Horn Basin. Found in association with type of *Oxyana pardalis*.

characters of the type; a number of more or less fragmentary jaws are referable to this species, but add little or nothing to the stated characters. The species evidently belongs to the *strenua* group and is closely allied to *S. multicuspis*.

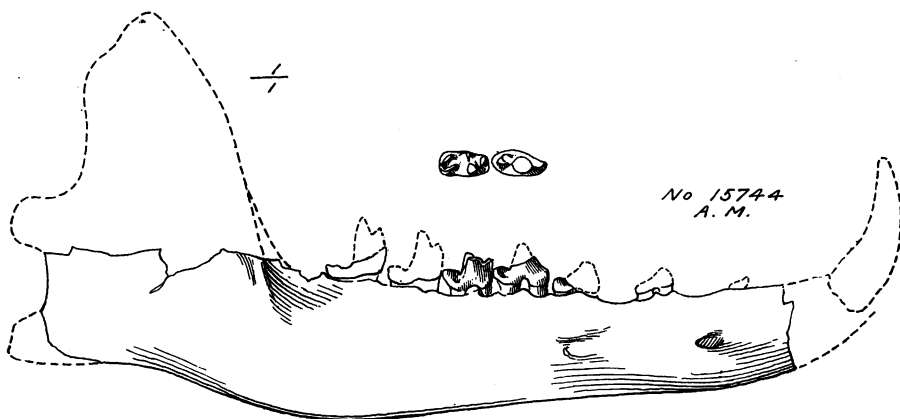


Fig. 76. *Sinopa vulpecula*, lower jaw, outer view, and crown view of  $p_4$ - $m_1$ , natural size. No. 15744, top of Gray Bull beds, Big Horn Basin.

### *Sinopa secundaria* (Cope 1875).

*Prototomus secundarius* COPE, 1875, Syst. Cat. Vert. Eoc. New Mex., p. 9; (*Stylophus*) 1877, Ext. Vert. New Mex., p. 115. Not figured.

*Type*, U. S. Nat. Mus. No. 1025, two fragments of lower jaw preserving the heels of  $p_4$  and  $m_2$ , and other associated fragments of bones, from the Wasatch of New Mexico.

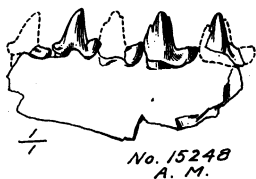


Fig. 77. *Sinopa cf. secundaria*, lower jaw fragment, external view, natural size, with molars and last two premolars more or less broken. Upper Gray Bull beds, Big Horn Basin.

The type is practically indeterminate. It appears to be smaller than *S. multicuspis* and *vulpecula*. There is some evidence of a species in the Big Horn Basin of about this size, and distinguished by the peculiarly acute high pointed premolars and the considerable diastema behind  $p_2$ . No. 15248 from the upper Gray Bull, parts of the jaws with  $p_3$ - $m_3$  more or less broken, and

other less distinctive specimens of jaws, etc., may be compared with *S. secundaria*, although too fragmentary for definite reference.



Sinopa viverrina Cope 1874.

*Prototomus viverrinus* COPE 1874, Rep. Foss. Vert. New Mex., p. 13; 1875, Syst. Cat. Vert. Eoc. New Mex., p. 9; (*Stypolophus*) 1877, Ext. Vert. New Mex., p. 112, pl. xxxviii, figs. 1-11; (*Sinopa*) MATTHEW 1901, Bull. A. M. N. H., Vol. XIV, p. 27.

*Type*, U. S. Nat. Mus. No. 1022, palate and fragments of skeleton from the New Mexican Wasatch.

*Distinctive characters*:  $M^{1-3} = 14$  mm. No deuterocone on  $p^3$ ; deuterocone of  $p^4$  small, submedian.

This species does not appear to be represented in our collections. Two or three fragments of lower jaws formerly thought to belong to it are now known to be *Prolimnocyon*. It is clearly distinguished from all the larger species by the characters of the premolars, which are suggestive of the smaller *Limnocyoninae*.

Sinopa, sp. incert.

A number of specimens are not satisfactorily referable to any of the above described forms, but they are too incomplete for diagnosis of new species.

Two lower jaws from the Sand Coulée beds are about the size of *S. ?secundaria*, but do not agree very closely in other respects either with it or with each other. The same is true of several fragments of jaws from the Gray Bull horizon.

Geological Range of Lower Eocene Species of Sinopa and Tritermnodon.

	Clark Fork		Big Horn			Wind R.		New Mex.	
	Sand Coulée	Gray Bull	Gray Bull	Lysite	Lost Cabin	Lysite	Lost Cabin	Lower	Upper
hians				*		*			*
strenua			*	*		?	*	?	
whitiae					?		*		
opisthotoma			*						
shoshoniensis		*	*						
multicuspis				*	*			?	
viverrina					?			?	
mordax		*							
vulpecula				*	*				
secundaria			*						*
sp. indet.	*								

***Tritemnodon whitiae* (Cope 1882).**

*Stypolophus strenuus* COPE 1881, Bull. Hayd. Sur. No. VI, p. 192 (not *S. strenuus* Cope 1874); *S. whitiae* COPE 1882, Proc. Am. Phil. Soc., Vol. XX, p. 161; Tertiary Vertebrata, p. 292, pl. xxvb, figs. 8-14.

*Distinctive characters:*  $M_{1-3} = 22.5$ ; molars compressed, with small heels, enamel smooth; no metacone on  $m^3$ ; small inner heel on  $p^3$ .

*Type,* A. M. No. 4781 lower jaw and part of skeleton from the Lost Cabin horizon of the Wind River Basin.

A partial skull and lower jaws No. 4782 from the same horizon and locality has been fully described and figured by Cope. I have seen no additional specimens positively referable. It is approximately intermediate in tooth characters between *S. hians* of the Lysite and *T. agilis* of the Lower Bridger, although smaller in size than either.

**MESONYCHIDÆ.**

This family is typically represented in the Lower Eocene by the genus *Pachyæna* which includes a number of larger and smaller species, and is fairly common. The Paleocene genus *Dissacus* also survives into the Gray Bull horizon, and the peculiar little *Hapalodectes* occurs in the Lysite and Lost Cabin levels.

In discussing the Bridger Mesonychidæ in 1909, the writer pointed out their aberrant character among Creodonta and resemblances to Artiodactyla which ought not to be hastily attributed to parallelism. This and other considerations have led Dr. Gregory to view the Artiodactyls as derivatives of some ancient Creodonta near the Mesonychidæ. The skeleton characters of *Dissacus* and *Pachyæna* do not however, lend much support to the argument for this view. *Pachyæna* shows the artiodactyloid characters in a diminished degree, *Dissacus* still less. The skeleton of *Triisodon* is hardly known, but there is a very considerable gap between it and *Dissacus* in the construction of the teeth — partly bridged by *Microclænodon*. If all these genera are to be included in the one family, it must be regarded as one of very ancient differentiation, but its abnormal characters (for a Creodont) appear to be all adaptive to some peculiar mode of life.

I may repeat that the alleged carrion-eating habits<sup>1</sup> are not at all indi-

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<sup>1</sup> Scott, 1913, Land Mammals of the Western Hemisphere, pp. 560-561. Exception must also be taken to Professor Scott's statements that *Pachyæna* "retained the epicondylar foramen of the humerus and pentadactyl feet" and that *Dissacus* had sharp claws. It is also doubtful whether the typical species of *Dissacus* had five functional digits.

cated by the adaptive features of the teeth. The cusps are blunt-pointed and were subjected to an extreme degree of wear by the nature of the food; but the long slender and rather weak jaw is quite unsuited to crushing bones, and the entire lack of shearing teeth is equally unsuited to cutting flesh or tendons. The hyæna, usually regarded as a typical carrion-eater, has teeth of wholly different character, paralleled by *Patriofelis* among the Creodonts. The Mesonychid teeth may perhaps have been adapted to crushing fresh-water molluscs or some similar food that would involve a great deal of wear of the cusps without entailing any great strength of jaw. They certainly are not suited either for bone-crushing or flesh-cutting, nor do they appear suitable for omnivorous or frugivorous habits; they are neither pig-like nor bear-like, and the hoof-like claws are not consonant with digging nor the snout with rooting habits.

I do not know of any parallel adaptation among modern mammals, but the Fayum *Apterodon* shows a notable approach to the Mesonychid style of teeth. In this genus, however, if Andrews's association of the skeletal parts be correct, the limbs indicate some degree of natatorial adaptation, while in the Mesonychidæ the adaptation appears to be progressively cursorial. This is not inconsistent with the suggestion of feeding on fresh water molluscs; the Mesonychidæ show the cursorial adaptation only in the smaller phyla, which would presumably be inoffensive animals requiring means of escape from carnivorous enemies, while *Apterodon* if of similar food adaptation might readily become aquatic.

#### *Key to Genera of Mesonychidæ.*

- A. Molars  $\frac{3}{3}$ ; metaconids well developed, paraconids smaller, especially on  $p_4$  and  $m_3$ ; pollex complete in *D. saurognathus*..... *Dissacus*.
- B. Molars  $\frac{3}{3}$ ; metaconids vestigial; paraconids large on  $p_4$ - $m_3$ ; pollex vestigial.  
*Pachyæna*.
- C. Metaconids absent, paraconids large on  $p_4$ - $m_3$ .
  - 1. Molars  $\frac{3}{3}$ ; limbs and feet slender, pollex vestigial..... *Synoplotherium*.
  - 2. Molars  $\frac{2}{3}$ ; limbs and feet very slender, pollex vestigial or absent..... *Mesonyx*.
  - 3. Molars  $\frac{2}{3}$ ; limbs and feet short robust, pollex unknown..... *Harpagolestes*.
- D. Molars  $\frac{3}{3}$ ; metaconids small, paraconids large on  $m_{1-3}$  teeth highly compressed; skull and skeleton unknown..... *Hapalodectes*.

#### *Dissacus* Cope 1881.<sup>1</sup>

Type, *D. navajovius* from the Torrejon of New Mexico.

*Generic distinctions:* Metaconids distinct on  $m_{1-3}$ ; paraconids weaker especially on  $m_3$ ; pollex (?) complete; humerus with entepicondylar foramen.

<sup>1</sup> Amer. Nat., Vol. XV, p. 1018.

This genus is characteristic of the *Torrejon*, where it is represented by two species, *D. navajovius* Cope and *saurognathus* Wortman. A third species, *D. europæus*, is recorded from the Cernaysien of France. A small species from the Wasatch was referred to the genus by Osborn and Wortman in 1892, but Matthew in 1909 separated it as a distinct genus *Hapalodectes*. True *Dissacus* does, however, appear to be represented by three specimens from the northern Wasatch, one from the Clark Fork, two from the Gray Bull beds. The first represents an undescribed species, the others I cannot separate by any specific distinctions from *D. navajovius* of the Torrejon.

The European species, *Plesidissacus europæus* Lemoine, was refigured by Boule in 1903 and referred to Cope's genus. The type is part of a lower jaw with  $p_4-m_2$ , and agrees with *D. navajovius* in size and such characters as can be observed in the figure. It is retained as a distinct species upon Boule's authority.

*Key to Species of Dissacus.*

- A. Larger species with robust molars, massive jaw, powerful canines and heavy jaw condyles. Limbs robust, feet spreading, pollex complete.
  - 1.  $M_{1-3} = 57$  mm.; paraconids large on  $p_4-m_2$ ;  $m_1$  smaller than  $m_2$ ;  $m_3$  with small paraconid and reduced heel. . . . . *D. saurognathus*.
- B. Smaller species with more compressed molars, canines and jaw condyles smaller and jaw more slender. Limbs slender, feet compressed.
  - 2.  $m_{1-3} = 33$  mm., paraconids small on all teeth;  $m_1$  smaller than  $m_2$ , heel of  $m_3$  long. . . . . *D. navajovius*.
  - 3.  $M_{1-3} = 38$  mm., paraconids somewhat larger,  $m_1$  as large as  $m_2$ , heel of  $m_3$  reduced. . . . . *D. navajovius longævus*.
  - 4. Molars intermediate in size between *D. navajovius* and *saurognathus*, paraconids more reduced than in either, metacone of  $m_3$  vestigial. . . . . *D. prænuntius*.

***Dissacus navajovius longævus* mut. nov.**

*Type*, 15732, a lower jaw with  $p_4-m_3$ , from the Gray Bull beds of Shoshone River in the Big Horn Basin.

*Distinctive characters*:  $M_{1-3} = 38$  mm.,  $m_1$  as large as  $m_2$ ,  $m_3$  smaller with reduced heel, paraconids larger than in *D. navajovius*.

The type consists of a nearly complete left ramus. A second specimen, No. 15229, comprises parts of the lower jaws of a young individual with milk premolars and  $m_{1-2}$ . On account of the individual variation among specimens from the Torrejon referred to *D. navajovius*, I regard this as representing rather a progressive mutant than a distinct species. Although the metaconid is not more reduced than in the Torrejon specimens, the proportions of the molars and size of the paraconid constitute an approach towards *Pachyæna*.

The milk dentition has not hitherto been known in this genus. The first premolar is one-rooted, and belongs apparently to the permanent series. The appearance of the first permanent premolar with or shortly after the succeeding milk premolars has also been observed by Wortman in *Hyænodon*.  $Dp_2$  is small, compressed, two-rooted, with indistinct heel;  $dp_3$  and  $dp_4$  are narrow elongate compressed teeth with large anterior cusps (paraconids) and long trenchant heels, both paraconid and heel being relatively much larger than in the true molars, while the protoconid is small. They differ widely from the corresponding teeth in *Pachyæna gigantea* (see p. 97) both in proportions and the development of paraconid and heel; the milk dentition of the smaller species of *Pachyæna* is not known.

***Dissacus prænuntius* sp. nov.**

*Type*, No. 16069, upper and lower teeth and fragments from Clark Fork Beds, Wyoming.

*Distinctive characters*: Smaller than *D. saurognathus*; larger than *D. navajovius*; paraconids of molars much smaller than in either species; metacone of  $m^3$  vestigial.

This species is represented by but a single individual. The reduction of the anterior basal cusps on  $p_4$  and on the molars preserved would seem to be a primitive character, preserved on  $m_3$  in *D. saurognathus* and *navajovius*, but not on  $p_4$ - $m_2$ . In the present species the paraconid is much more reduced on  $p_4$ , and is quite small on two incomplete molars which are, probably but not certainly,  $m_2$  right and left. The first upper molar is decidedly smaller than the  $m^1$  of *D. saurognathus*,<sup>1</sup> about equally larger than the corresponding tooth in *D. navajovius*, and closely resembles the  $m^1$  of *Pachyæna*. The distal end of the humerus, the patella, tuber calcis and two phalanges indicate a species scarcely exceeding *D. navajovius* in size of limbs and feet, although the teeth are so much larger.

***Pachyæna* Cope 1874.<sup>2</sup>**

*Type*, *P. ossifraga* from Wasatch of New Mexico.

*Generic characters*: Molars  $\frac{3}{3}$ ; metaconids vestigial; paraconids large on  $p_4$ - $m_3$ ; pollex much reduced, probably vestigial.

Although originally described from a New Mexican specimen this genus is practically limited to the Gray Bull horizon of the Big Horn Wasatch. No additional specimens have been found in New Mexico nor in the later

<sup>1</sup>  $M^2$  of Osborn and Earle's figure.

<sup>2</sup> Rep. Vert. Foss. New Mex., p. 13.

horizons of the Wyoming Wasatch. It has not been found in the Clark Fork beds, and a single tooth is the only representative from the Sand Coulée beds. Dr. Loomis, however, reports finding it in the upper levels of the Big Horn Wasatch.

From the Gray Bull beds a number of skulls, jaws and skeletons all in a

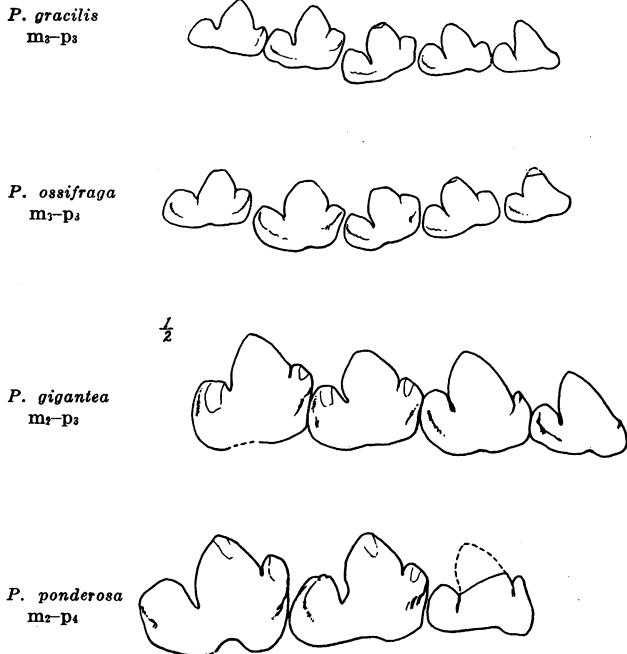


Fig. 78. *Pachyæna*, lower teeth of four species, outer views, half natural size. All from Gray Bull beds, Big Horn Basin, Wyoming.

more or less fragmentary condition have been secured by the various expeditions, and the osteology of the type species is fairly well known from the material now at hand. Three well distinguished species are represented, which agree approximately both in size and proportions with the three generic types of the Middle Eocene — *Harpagolestes*, *Synoplotherium* and *Mesonyx*. It seems probable that these three species of *Pachyæna* are ancestral to the three Bridger genera, but in the absence of intermediate links it cannot be regarded as proven.

The tetradactyl manus and pes sharply distinguish this genus from *Dissacus saurognathus*. In 1909 I stated with regard to *P. ossifraga* that: "The number of digits is not certainly known, but the structure of limb bones and foot bones as well as of the teeth is so much more like that of *Mesonyx* than of *Dissacus*, that there is little doubt that the feet were

tetradactyl and digitigrade. Wortman, following Cope's erroneous determination of the humerus belonging to this species, regards it as pentadactyl."<sup>1</sup> This inference is now proven correct by the fore and hind feet of *P. ossifraga* herein described. The character is probably generic, although it remains inferential for the large *P. gigantea*. *Dissacus navajovius* on the other hand may have been tetradactyl. The limb and foot bones are incompletely known but indicate proportions much more slender and feet more compressed than in the large species.

***Pachyæna gracilis* sp. nov.**

*Type*, No. 15729 lower jaws; paratype No. 15729, teeth and part of skeleton: both from the Gray Bull beds of the Big Horn Basin, Wyoming.

*Distinctive characters*: Total length of jaw = 244 mm.; canines and condyle much smaller, cheek teeth somewhat smaller and less robust than in *P. ossifraga*. Skeleton one-fourth smaller throughout, limbs somewhat more slender.

The most obvious difference from *P. ossifraga* lies in the much smaller jaw, scarcely two-thirds the length of Cope's species, with relatively thin and shallow ramus, short symphysis, small and slender canines, and small condyles. The cheek teeth are little less in length, but they are more compressed, with less robust cusps. The paratype shows the limbs and feet to be smaller than in *P. ossifraga*, and somewhat more slender; the feet do not, however, attain the slender proportions of *Mesonyx* but are more like *Synoplotherium*. The astragalus is like that of *P. ossifraga*, slightly wider and shorter necked. Metacarpal II and metatarsal II are like those of *P. ossifraga*, and indicate that both pollex and hallux were reduced to small vestigial nodules.

*Measurements of P. gracilis.*

	No. 15728
Lower jaw, incisive alveolus to condyles.....	244
“ “ depth at $p_2$ .....	32
“ “ “ “ $m_3$ .....	36
“ “ length of dentition, $i_1-m_3$ .....	155
“ “ “ “ $p_1-m_3$ .....	132
“ “ “ “ $m_1-3$ .....	60
$P_3$ diameters a.-p. $\times$ tr.....	$16.8 \times 7.5$
$P_4$ “ “ .....	$19.3 \times 8.4$
$M_1$ “ “ .....	$19.8 \times 8.8$
$M_2$ “ “ .....	$21.3 \times 9.3$
$M_3$ “ “ .....	$20.5 \times ?$
	No. 15729
Upper canines, length incl. root.....	82.5
“ “ diameters, a.-p. $\times$ tr.....	$17.1 \times 11.7$

<sup>1</sup> Mem. Am. Mus. Nat. Hist., Vol. VI, p. 491.

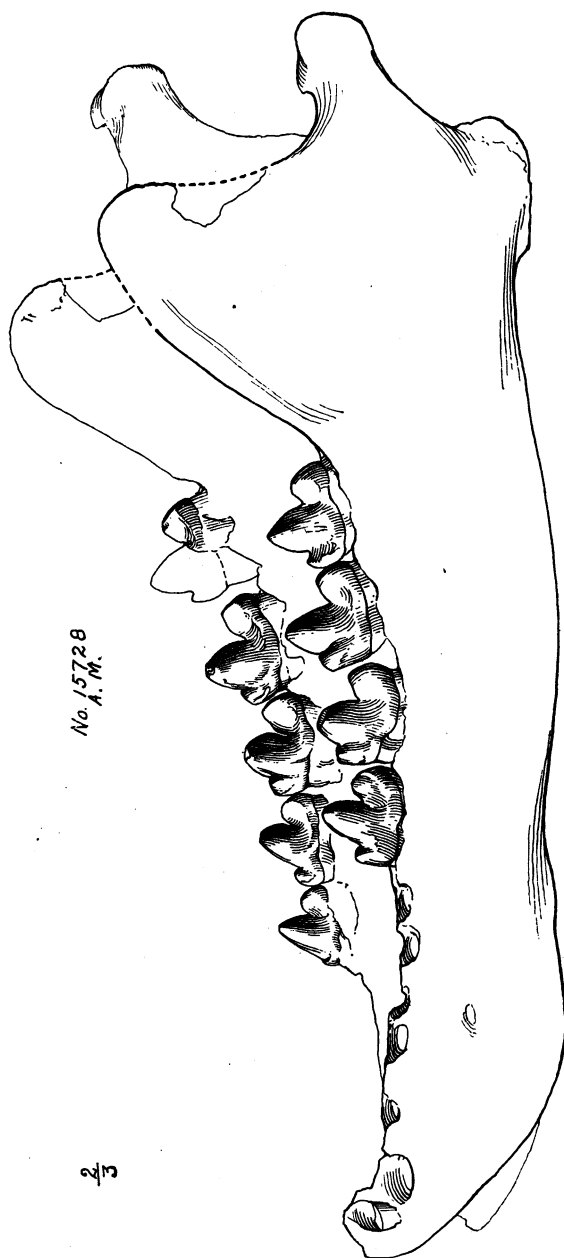


Fig. 79. *Pachyena gracilis*, type specimen, lower jaw, two-thirds natural size. Gray Bull beds, Big Horn Basin.



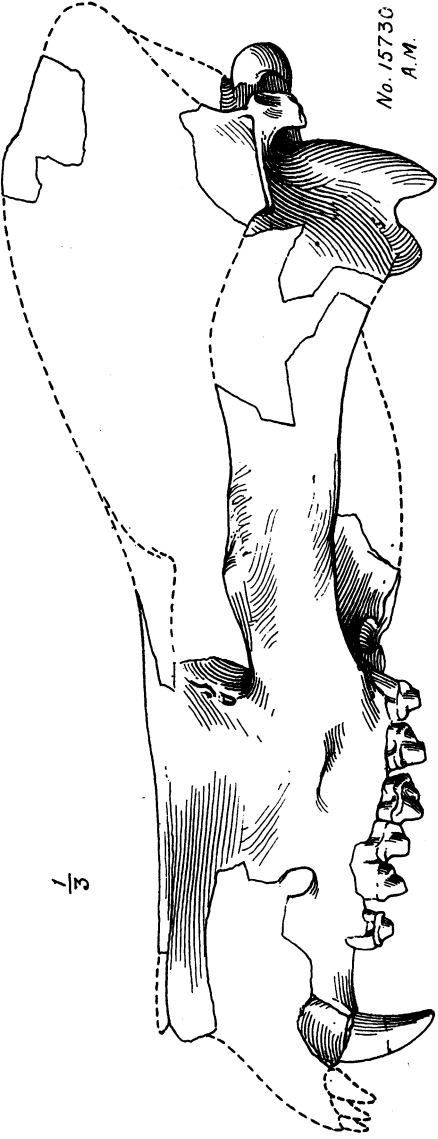


Fig. 80. *Pachyaena ossifraga*, skull, one-third natural size, No. 15730, lower Gray Bull beds, Big Horn Basin.

***Pachyæna ossifraga* Cope 1874.**

*Syn.*, *P. intermedia* Wortman 1899.

*Pachyæna ossifraga* COPE 1874, Rep. Vert. Foss. New Mex., p. 15; 1877, Ext., Vert. New Mex., p. 94, pl. xxxix, fig. 10; (*Mesonyx*) 1882, Pal. Bull. 34, Proc. Am. Phil. Soc., XX, p. 165; 1885, Tertiary Vertebrata, p. 362, pl. xxviii a, xxviii b, xxviii c, xxviii d.

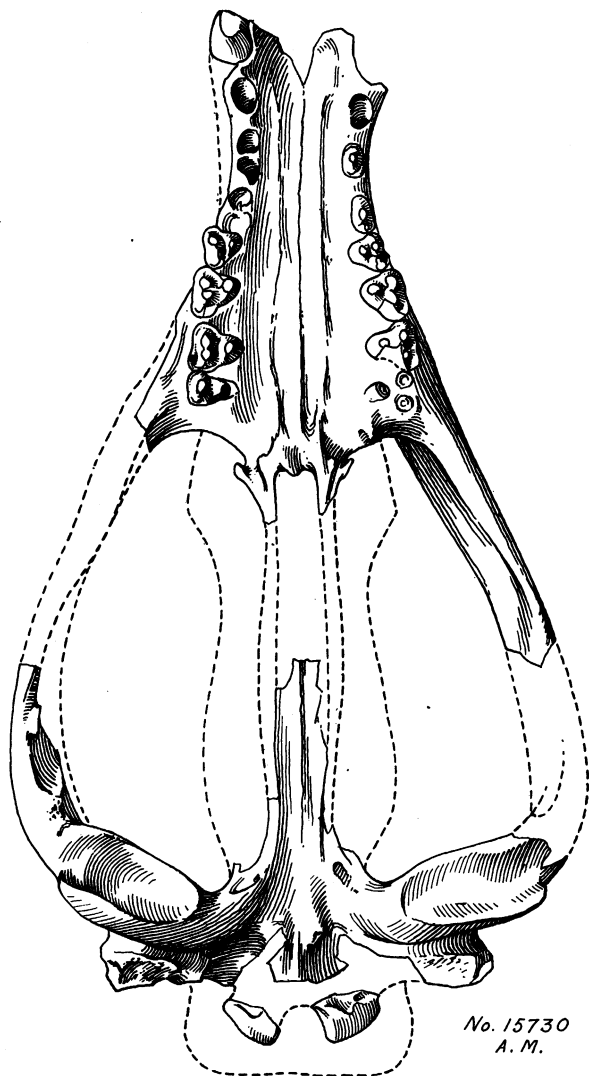


Fig. 81. *Pachyæna ossifraga*, palatal view of skull, one-third natural size. No. 15730, Gray Bull beds, Big Horn Basin.

*Pachyaena ossifraga* OSBORN (& WORTMAN) 1892, Bull. Am. Mus. Nat. Hist., Vol. IV, p. 112, fig. 11B; MATTHEW 1909, Mem. A. M. N. H., vol. IX, p. 489, 491, text fig. 91.

*Pachyaena intermedia* WORTMAN 1899, *ibid.*, Vol. XII, p. 147; MATTHEW 1909, *l. c.* (type only).

Type, U. S. Nat. Mus. No. 1096, an upper molar ( $m^1$ , 1.) from the New Mexican Wasatch. Metatype, No. 4262 an incomplete skull, jaws and parts of skeleton from the Big Horn Wasatch.

Type of *P. intermedia*, No. 2854 an upper jaw fragment with  $m^{2-3}$  from the Big Horn Wasatch.

*Distinctive characters:* Size medium, lower jaw 360 mm. in total length. Skull and jaws elongate, canines massive, condyles heavy. Limbs long and moderately slender, feet digitigrade tetradactyl. Metacones of upper molars moderately reduced,  $m^3$  smaller than  $m^1$  but variable in size.

A skull, No. 15730, and a skeleton, No. 16154, from the Gray Bull beds are referred to this species. Both are fragmentary and incomplete but the bone well preserved and uncrushed, and they add considerable to what has hitherto been known of the morphology of *Pachyaena*. A number of upper and lower jaws and jaw fragments are also referable.

*Pachyaena intermedia* of Wortman I am unable to separate specifically from *P. ossifraga*, although it is somewhat smaller than the skull and skeleton described by Cope (A. M. No. 4262) and the last molar slightly more reduced. It agrees more nearly with the skull and skeleton Nos. 15730, 16154, which in turn agree closely with the type of *P. ossifraga*. No. 4262 is a more robust individual, and the series of upper and lower jaws referred to the species show all kinds of intermediate conditions between these extremes. The hind limb referred to *intermedia* by Matthew in 1909 is undoubtedly of a distinct species from *ossifraga*; but it belongs not to *intermedia*, but to the smaller species *P. gracilis* described above.

The skull, No. 15730, as restored, is of very peculiar proportions. The mesocranial region is greatly elongate, the distance between  $m_3$  and the postglenoid process exceeding the distance from canine to  $m_3$ ; the glenoid articulations are very large, project far downward, and are, for a carnivore, set far back. The anterior border of the orbit is above the posterior end of  $m^3$ . The posterior nares open a little behind  $m_3$ , are very narrow and constricted, the pterygoid plates set near together. The proportions of the skull resemble those of *Harpagolestes* rather than *Mesonyx*. In the Cope skull (No. 4262) the posterior part has been telescoped and crowded together by crushing so that these proportions are not brought out. The skull of *H. macrocephalus* as figured by Wortman appears to be of about the same proportions except that the face is shorter and broader.

The feet in No. 16154 are nearly as progressive as those of *Synplo-*

*therium* and *Mesonyx*. The trapezium and entocuneiform are reduced to about the same extent, and as in those genera have small facets for the first digit, which in the hind foot is clearly a small nodule indicated by a pit for its reception on mt. II. In the fore foot the pollex was probably also a vestigial nodule, as the facet for its articulation on the trapezium is quite small. The second metacarpal has much heavier shaft than the third or fourth, while the fifth is decidedly shorter than the fourth with about the

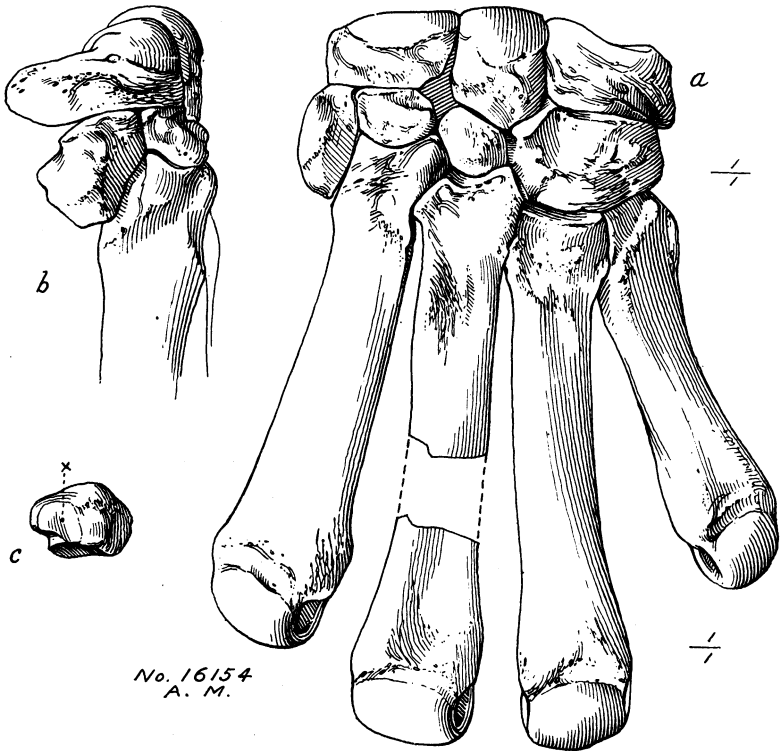


Fig. 82. *Pachyæna ossifraga*, fore-foot bones, natural size, a, proximal view of manus, b, inner view, c, distal view of trapezium showing the small facet for vestigial pollex. From skeleton No. 16154, Gray Bull beds of Big Horn Basin.

same weight of shaft. In the hind foot the fifth digit is much smaller than the others, but its length is not preserved, the second has a somewhat heavier shaft than the third and fourth. The distal ends of the metapodials and the phalanges show the same features as *Mesonyx*. The most obvious primitive character is the relative shortness and breadth of the astragalus and flatness of its trochlea.

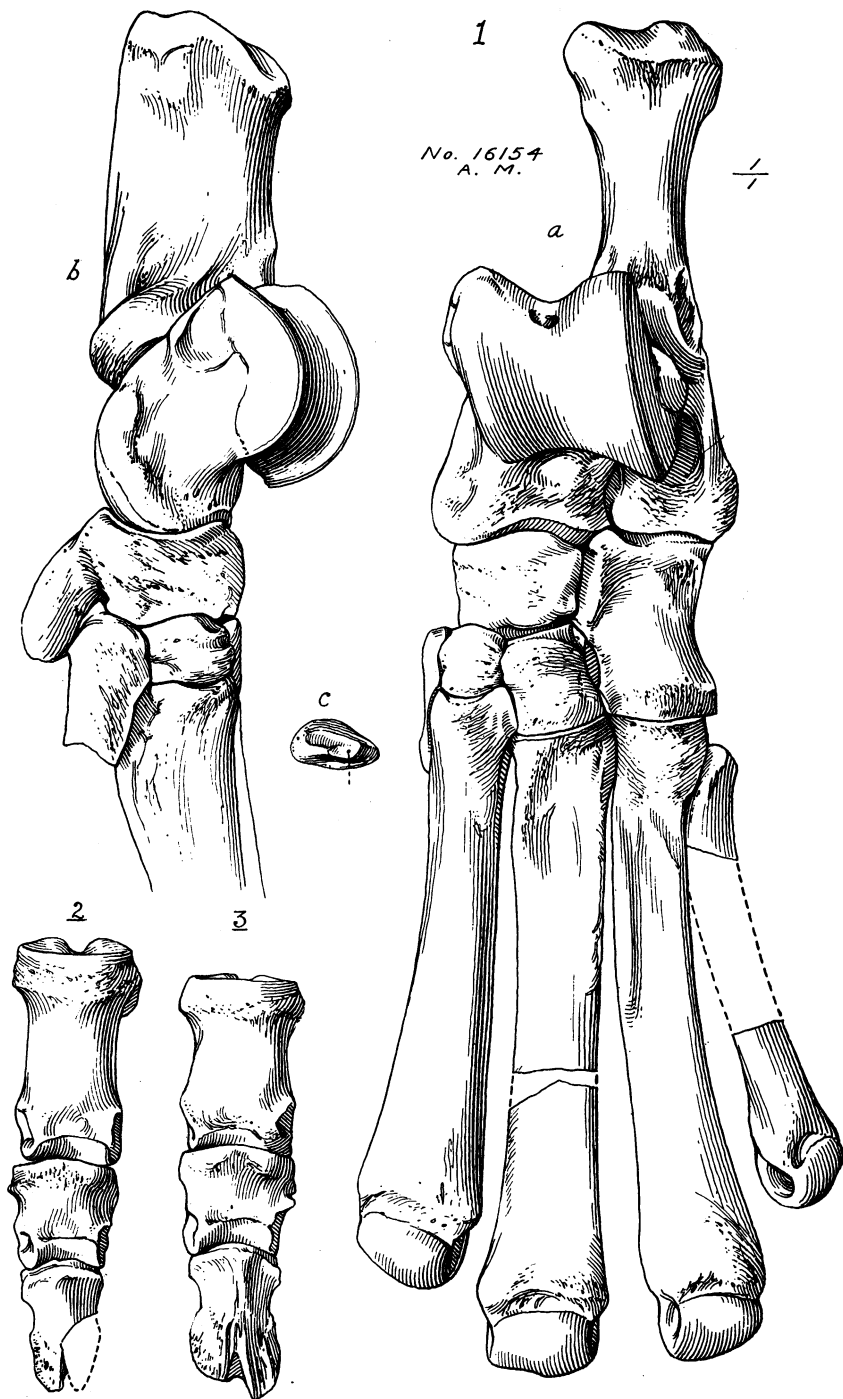


Fig. 83. *Pachyana ossifraga*, foot bones, natural size; 1, a, dorsal view of pes, b, inner view, c, distal view of trapezium showing small facet for *mt. 1*; 2, phalanges of hind foot; 3, phalanges of fore foot. Skeleton No. 16154, Gray Bull beds, Big Horn Basin.

## Measurements.

	No. 15730
Skull (as restored) length, canine to condyles.....	410
“ “ “ width across arches.....	230
“ depth at end including m <sup>2</sup> .....	103.5
Palate, width “ “ “ “.....	91.1
“ distance of posterior nares behind m <sup>3</sup> .....	24.3
“ width of posterior nareal opening.....	17.2
Glenoid articulation, diams. (a. p. × tr.).....	31. × 52.5
Zygomatic arch, depth at middle.....	44
Upper teeth, c-m <sup>3</sup> .....	158
“ premolars, p <sup>1-4</sup> .....	76
“ molars m <sup>1-3</sup> .....	53
“ canine, diameters (a.-p. × tr.).....	22. × 17.
“ p <sup>2</sup> “ “.....	12.5 × 8.5
“ p <sup>3</sup> “ “.....	14.5 × 9.0
“ p <sup>4</sup> “ “.....	15.8 × 14.5
“ m <sup>1</sup> “ “.....	19.5 × 16.9
“ m <sup>2</sup> “ “.....	18.7 × 19.4
“ m <sup>3</sup> “ “.....	13.8 × 15.1
	No. 16154
Scapula, diameters of glenoid cavity.....	35. × 23.5
Humerus, diameters of proximal end.....	58.5 × 45.
“ “ distal end.....	32. × 34.5
Radius, circumference of shaft.....	47.0
“ diameters of proximal end.....	17.8 × 28.8
“ “ distal.....	23. × 34.5
Ulna, length of olecranon.....	56.3
“ diameters of olecranon.....	31. × 10
Fore foot, total length (approx.).....	150
“ “ width of carpus.....	48.8
“ “ length of mc. II.....	70.2
“ “ “ “ “ IV.....	72.7
“ “ “ “ “ V.....	56.9
“ “ diameters of 1st phalanx, digit II, length × width.....	25.8 × 16.8
“ “ “ “ 2nd “ “ “ “ “.....	15.9 × 15.4
“ “ “ “ ungual “ “ “ “ “.....	18.7 × 12.7
Femur, diameter of head (caput).....	30.7
“ diameters of distal end (crushed).....	42 × 54
“ total length.....	258.0
Tibia, diameters of head.....	56.4 × 50.4
Fibula, diameters of distal end.....	21.6 × 15.4
Tibia, diameters of distal end.....	24.5 × 34
Astragalus, length.....	38.5
“ width of body.....	32.3
“ “ trochlea groove.....	19.3
Calcaneum, length.....	66.9
“ diameters of tuber calcis.....	21.7 × 10.5

Cuboid, length.....	29.
“ width of proximal end.....	20.7
Navicular, width.....	13.4
“ height.....	14.7
“ depth (including hook).....	28.2
Metatarsal II, length.....	80.
Hind foot, total length (approx.).....	232.

***Pachyæna gigantea* Osborn 1892.<sup>1</sup>**

*Type*, No. 72, upper teeth,  $p^{2-4}$   $m^{2-3}$ ;  $p^3$ - $m^1$ . from the Wasatch of the Big Horn Basin, Wyoming.

*Distinctive characters*: Length of jaw about 450 mm., very robust and massive, teeth much larger and more massive than in *P. ossifraga*; upper molars wider transversely, metacones more connate,  $m^3$  unreduced.

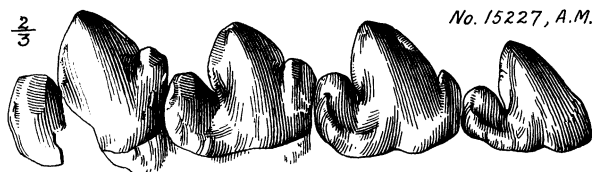


Fig. 84. *Pachyæna gigantea*, lower teeth,  $p^3$ - $m^2$ , two-thirds natural size. No. 15227, Gray Bull beds, Big Horn basin.

To this species were referred in 1901 a fragmentary skeleton, No. 2959, and a weathered skull and jaws No. 2823. Two additional specimens are now referred, nos. 15227, upper and lower teeth, 15226 young lower jaws with milk dentition.

The fourth upper premolar of the type belongs, I suspect, to the milk dentition; it is much more worn than the teeth preceding or following it, and the tooth which I identify as  $p^4$  in other individuals is quite different in proportions and construction. The lower milk teeth are well shown in No. 15227.  $P_1$  belongs to the permanent series but appears only a little later than the succeeding milk premolars.  $Dp_2$  is a very small tooth, two-rooted, compressed, with distinct heel.  $Dp_{3-4}$  have nearly the same cusp construction as their permanent successors, but are much smaller and more compressed and the paraconid is rudimentary on  $dp_3$ , strong on  $dp_4$ . They are readily distinguishable from permanent teeth of a smaller species by the rectangular outline. They are not nearly so elongate as the milk premolars of *Dissacus*, the protocones much larger in proportion to the anterior and posterior cusps.

The sagittal crest in this specimen is very high, although the animal was so young.

<sup>1</sup> Osborn (& Wortman) 1892, Bull. A. M. N. H., vol. IV, p. 113, figs. ii, 12.

## Measurements.

	Type, No. 72	No. 2959	No. 15227	No. 15226
P <sup>1</sup> , diameters a.-p. × tr.				
P <sup>2</sup> "	18.4 × 15.4			
P <sup>3</sup> "	20.3 × 17.2			
P <sup>4</sup> "		22.8 × 23.5	24.4 × 24.6	
M <sup>1</sup> "	26.0 × 25.8		25.4 × 27.1	
M <sup>2</sup> "	26.4 × 30.7	26.8 × 26.6	? × 28.5	
M <sup>3</sup> "	25.9 × 25.4	22.5 × 27.8		
Dp <sup>4</sup> "	23.0 × 20.6			
C <sub>1</sub> "		30.8 × 21.8		
P <sub>1</sub> "				10.7 × ?
P <sub>3</sub> "		25.0 × 15.1	25.6 × 14.8	
P <sub>4</sub> "			28.9 × 16.4	
M <sub>1</sub> "		28.7 × 15.3	30.0 × 17.5	
M <sub>2</sub> "		32.2 × 15.3	31.4 × 18.1	
M <sub>3</sub> "		30.0 × 13.9		
Dp <sub>2</sub> "				10.2 × 4.7
Dp <sub>3</sub> "				18.3 × 8.9
Dp <sub>4</sub> "				23.9 × 11.0
Astragalus, diameters		57.0 × 56.4		
" width of trochlea		32.8		

***Pachyaena gigantea ponderosa* subsp. nov.**

*Type*, No. 15228, upper jaw, lower teeth, astragalus and lunare, from Gray Bull beds of Big Horn Basin.

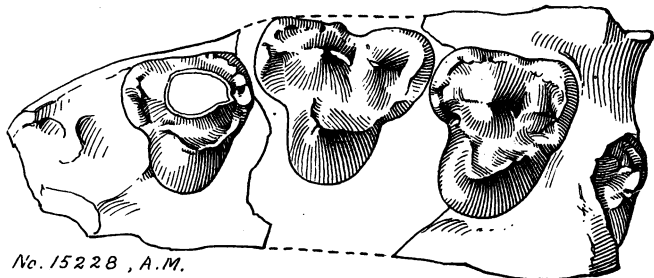


Fig. 85. *Pachyaena gigantea ponderosa*. Upper teeth of type specimen, two-thirds natural size. Gray Bull beds, Big Horn Basin.

*Distinctive characters*: M<sup>1-3</sup> = 85 mm. M<sup>1-2</sup> larger, m<sup>3</sup> smaller than in *gigantea*. Astragalus one tenth broader.

Although closely allied to *P. gigantea*, the larger size of the teeth and greater reduction of m<sup>3</sup> constitute a marked approach to *Harpagolestes*, and



it seems advisable to name this form on this account and because it is the largest Lower Eocene creodont.

An upper and lower molar No. 15259 from the lower Gray Bull valley are referred to this species.

Measurements.

	Type No. 15228	No. 15259
P <sup>3</sup> diameters, a.-p. × tr.....	22.5 × 17.3	
P <sup>4</sup> " " .....	26.3 × 26.8	
M <sup>1</sup> " " .....	34.8 × 34.7	
M <sup>2</sup> " " .....	29.0 × 33.3	31.7 × 34.7
M <sup>3</sup> transverse diameter.....	22.6	
P <sub>4</sub> diameters, a.-p × tr.....	26.7 × 17.2	
M <sub>1</sub> " " .....	33.9 × 19.3	
M <sub>2</sub> " " .....	42.7 <sup>1</sup> × ?	35. × 18.6
Astragalus, diameters (width × length).....	60.0 × 61.6	
" width of trochlea.....	32.9	
Lunare, diameters (width × height).....	25.3 × 26.0	
" depth (dorso-plantar).....	37.0	
Proximal phalanx, length.....	39.0	
" width of shaft.....	21.0	

This genus is represented in the Soissonais by a species which Dr. Boule<sup>2</sup> finds indistinguishable from *P. gigantea* on the materials available for

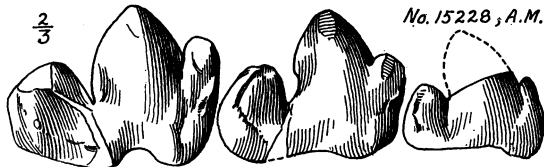
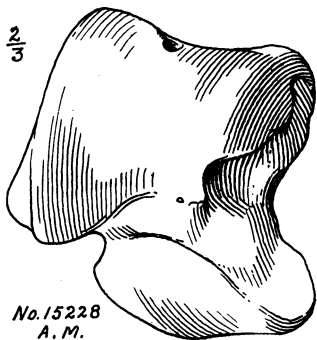


Fig. 86. *Pachyaena gigantea ponderosa*, lower teeth of type specimen, p<sub>4</sub>-m<sub>3</sub>, two-thirds natural size. Gray Bull beds, Big Horn Basin.

comparison. Dr. Trouessart gave the specimen the name of *P. boulei* two years later,<sup>3</sup> but without specifying any distinctions, or reasons for separating it from *P. gigantea*. Boule's figures show it to be very closely allied to our species, and so far as comparisons can be made, indistinguishable. I presume that Dr. Trouessart's separation of *P. boulei* is based upon the improbability, real or supposed, of the same species occurring in Europe and North America; an argument which to my mind may properly be used to

<sup>1</sup> Increased by crushing of the tooth.  
<sup>2</sup> 1903. *Le Pachyaena de Vaugirard*. Mem. Soc. Geol. Tr., Vol. X, fasc. 4, Mém. no. 28, pp. 1-16, pl. I, II (xiv, xv).  
<sup>3</sup> 1905, *Catalogus Mammalium*, Quinq. Suppl., p. 163. This is the only reference that I have been able to find.

retain a species already made, although not to make a new one. On this ground therefore I retain Trouessart's species although a careful comparison of Boule's figures and description fails to reveal any valid specific characters.



No. 15228  
A. M.  
Fig. 87. *Pachyæna gigantea ponderosa*, astragalus, superior view, two-thirds natural size. From the type specimen.

The Fayûm "*Pachyæna*." Schlosser has referred to "*Pachyæna* oder *Palæonictis*?" a scapholunar bone from the Fayûm Oligocene; a reference which I criticized in reviewing his preliminary paper, on the ground that:

(1) In *Pachyæna* the scaphoid and lunar were certainly separate, nor is there any evidence nor probability that they were united in *Palæonictis*.

(2) Both genera are of Lower Eocene age, and belong to families of Creodonta of which no trace has been found in the Fayûm fauna or the Oligocene Epoch, and in which the scaphoid and lunar were never united

so far as we know.

(3) On the other hand, we know that the Hyænodonts were represented by several genera in the Fayûm and are the only Carnivora positively known in this fauna;

(4) The Hyænodonts are the only family of Creodonta known to survive into the Oligocene, and in *Hyænodon* at least the scaphoid and lunar were sometimes united.<sup>1</sup>

From the above facts of record I concluded that "the probabilities, therefore, are greatly in favor of this scapholunar representing a large Hyænodont."

In Dr. Schlosser's final memoir he replies to the above criticism at some length, and figures the bone in question. He has somewhat shifted his ground, attempting to prove that it is a descendant of *Pachyæna* or *Palæonictis*, the argument being that it does not agree in form with the *Hyænodon* scapholunar illustrated by Wortman,<sup>2</sup> and does not agree in size with the radius that Schlosser attributes to *Pterodon*, and that the other known genera are too small.

Apparently Dr. Schlosser regards this as a complete answer to my

<sup>1</sup> That is, according to recorded statements of Cope and Wortman. I do not desire to be understood as indorsing this assertion.

<sup>2</sup> 1902, Amer. Jour. Sci., XIII, 136, fig. 91. Wortman's figure is very different in form and proportions from the conjoined scaphoid, lunar and centrale in our *Hyænodon* skeletons, but is not unlike the scapholunar of *Daphenus*, to which genus I suspect that the bone really belongs although found with fragments of jaws and bones of *Hyænodon crucians*.

criticism, and considers that he has "stilled my doubts" as to the propriety of his reference of the specimen under consideration. But he gives no morphologic reasons at all for referring the bone to the Oxyænidae or Mesonychidae rather than to the Hyænodontidae. In default of such evidence the argument stands untouched. It is more probable that the bone represents an unknown or indeterminate genus of a family that: (1) does occur in the Oligocene; (2) does occur in the Fayûm fauna, and is the only Carnivore family known from that fauna; and (3) is recorded as occasionally uniting the scapholunar, than that it belongs to an undescribed genus of families that: (1) do not occur in the Oligocene but become extinct in the Eocene, so far as known; (2) are quite unknown to the Fayûm fauna; and (3) never unite the scaphoid lunar or centrale in any of the genera.

It is quite evident from the figure that this scapholunar is not *Hyænodon*. I am well acquainted with the osteology of this genus, and while I have never seen among many skeletons studied, any instance of a united scapholunar, yet the form of the individual bones of the carpus would result in case of union of scaphoid lunar and centrale in a bone with distal facets of widely different type from those of the Fayûm specimen, which differs from the corresponding bones of *Pachyæna* in substantially all the same points that separate it from *Hyænodon*.

It is not so clear that the bone is not *Pterodon* or *Apterodon*. Its failure to agree in size with the limb bones assigned by Schlosser and Andrews to various species of these genera would be conclusive as to those particular species if there were any certainty that these limb bones were correctly referred in all cases. But there is practically no association of jaw and limb parts among these Fayûm carnivora and the references have been made upon agreement in general characters, proportionate numbers, and relative size. Such arbitrary references are more often wrong than right; as a result of the study of associated specimens of single individuals we have learned in this museum that they are wholly untrustworthy. But even if all these bones were correctly referred, disagreement with them would not prevent the scapholunar from belonging to some other species or genus of Hyænodonts. Its relative size it must be remembered is no criterion. I showed in 1909 among the Miacidæ a variation in size of teeth relative to limbs of 300% between different genera.

It is and was quite obvious to me that Dr. Schlosser's real reasons for assigning this bone to "*Palæonictis* or *Pachyæna*," are the fact that these two genera occur in the early Eocene of Europe, and his theory that a large part of the Fayûm fauna is derived by immigration from the north — a theory in which I very readily concur. If these genera of the Lower Eocene of Europe left descendants in the Lower Oligocene of Africa it would doubt-

less be an additional argument for this theory. But I do not think the theory should be bolstered by unsound evidence, and as such I am compelled to regard this reference.

Briefly, the bone is not *Hyænodon* nor closely related thereto, but it might represent some other genus of Hyænodonts, known or unknown, or, less probably, some genus of Miacidæ or of Fissipedia or some other Creodont or Pinniped family. Since there are no clearly defined characters at present known distinctive of the carpal bones in the several families, as such, of Creodonts and early Carnivora, it is not possible to refer this bone with certainty to any one family. The probabilities stand as stated above.

One thing however may be stated with certainty. The bone is not *Pachyæna*, *Dissacus*, *Mesonyx* or *Synoplotherium*, nor is there any valid evidence for referring it to *Palæonictis*.

### **Hapalodectes** Matthew 1909.<sup>1</sup>

*Type*, *H. leptognathus* from the Wasatch, Wyoming.

*Generic characters*: Dentition  $\overline{7}0.1.4.3$ ; jaw slender, teeth highly compressed, metaconids small, paraconids well developed on  $m_1$ - $m_3$ , talonids high, sharp, trenchant.

The species referred to this genus are represented by lower jaws only, the upper dentition, skull and skeleton being unknown. They are of much smaller size than other Mesonychidæ, and the knife-like teeth are unworn in any of the specimens. They do not show any indications of shearing action.

*H. compressus* Matthew is distinguished by the more slender jaw and somewhat greater compression of the teeth, characters more marked in referred specimens from the Lost Cabin horizon than in the type which is from the Lysite.

Seven lower jaws altogether are referred to the genus, two probably Gray Bull, one from Lysite of the Big Horn, three from Lysite of the Wind River Basin, and one from the Lost Cabin horizon of the Wind River. They show a progressive slenderness of jaw and greater compression of the teeth.

### [**Hapalodectes leptognathus** (Osborn 1892).

*Dissacus leptognathus* OSBORN (& WORTMAN) 1892, Bull. Am. Mus. Nat. Hist., Vol. IV, p. 112, fig. 10; (*Hapalodectes*) MATTHEW 1909, Mem. A. M. N. H., vol. IX, p.

<sup>1</sup> U. S. G. S. Bull. 361, p. 93.

*Type*, No. 78, part of lower jaw with  $p_4-m_3$ .

*Specific characters*:  $P_4-m_3 = 23.8$ ; depth of jaw at  $m_3 = 13$ .

The type is from the Wasatch of the Gray Bull River, Big Horn Basin, exact horizon unrecorded but almost certainly from the Gray Bull level. Another jaw fragment from the Big Horn Basin, level unrecorded, was referred to the species by Osborn, but shows no teeth.

***Hapalodectes compressus* Matthew-1909.**

*Hapalodectes compressus* MATTHEW 1909, *Mem. A. M. N. H.*, Vol. IX, p. 499, pl. xlv, fig. 5, text fig. 101.

*Type*, No. 12781, lower jaw from Lysite horizon of Cottonwood Creek, Wind River Basin. Paratype No. 12782 from same level and locality.

*Specific characters*:  $P_4-m_3 = 22$ ; depth of jaw at  $m_3 = 11.4$ .

No. 14748, a lower jaw from the Lost Cabin beds of Alkali Creek is more clearly differentiated than the type from *H. leptognathus*, the lower jaw having a depth of only 9 mm. and the molars still more compressed, the canine very long and slender. Another jaw from the Lysite of Buffalo Basin in the Big Horn Valley agrees more nearly with the type.

