Article VI. — THE FAUNA OF THE TITANOTHERIUM BEDS AT PIPESTONE SPRINGS, MONTANA.

By W. D. Matthew.

The American Museum Expedition of 1902 in western Montana had for object to make a further search in the Tertiary deposits of that region, where Mr. Earl Douglas has recently discovered many new and interesting fossil mammals. In the White River formation near Pipestone Springs, Mr. Douglas had found a very interesting micro-fauna, and our collections at the same locality, which Professor Osborn has kindly turned over to me for study and description, enable us considerably to extend the list. I am indebted to Mr. Douglas for the opportunity to examine the type specimens of his various species, as well as for the information concerning localities, etc., contained in the stratigraphic part of his very excellent memoir recently published on the White River of Montana.

The majority of the species are small or minute forms, not found in the Titanotherium Beds of South Dakota or Colorado, where the scanty fauna is almost entirely of large animals, — Titanotheres, Elotheres, and Rhinoceroses. A few small species have been described from Swift Current Creek, Canada, based on very fragmentary materials. The Pipestone Springs fauna is therefore of much interest, as it illustrates the direct precursors of the numerous small species of the Oreodon Beds. In the species from the three successive stages of the White River we have the most favorable opportunities for study of the details of evolutionary progress in a given race that are presented among fossil vertebrata; for the materials are abundant and complete, the succession is unquestionable, and the character of the beds, and hence the local conditions of deposition, very uniform, so that we get the same facies of the three faunas. It is doubtful how far, if at all, the Eocene deposits of the Rocky Mountain divide and foothills contain the same facies of their respective.
faunas as do the Oligocene deposits of the plains. They contain an important aquatic contingent, fish, crocodiles, and water-turtles being comparatively abundant. In the White River fauna all these are absent, except in the sandstone lenses,\(^1\) while a large element of it is apparently adapted to open grassy plains; this is not found in the Eocene faunas. But in the three zones of the White River a great part of their respective faunas appears to be in direct and exact genetic succession. We can therefore measure the amount and direction of change during the Oligocene epoch in many series.

The amount of evolution as thus measured appears small, but its direction somewhat constant. The species of the Titanotherium Beds are all distinct from their successors in the Oreodon Beds, but the difference is uniformly small. Between the Oreodon and Leptauchenia faunas the difference is often greater but less uniform, so far as present data go. Some genera run through the three horizons (e. g., *Cynodictis, Palæolagus, Mesohippus, Canopus, Leptomeryx*). Others have been found only in the two lower zones or in the two upper zones, while many are as yet known from one horizon only.

**Stratigraphy.** — Mr. Douglas refers all the Tertiary at this locality to one stage, correlating it with the Titanotherium Beds of South Dakota. We find, however, a lithologic distinction between the higher beds exposed north of the railroad, which resemble the Oreodon Beds of South Dakota, Colorado, and elsewhere, and the lower beds exposed south of the railroad, which resemble rather the Titanotherium Beds of some parts of South Dakota. Likewise on Thompson’s Creek, not far from the Pipestone locality, we were able to distinguish between the Oreodon Beds exposed near the head of a small northerly branch of the creek, and the Titanotherium Beds exposed on the main western branch. At

\(^1\) Mr. Douglas has recently discovered fish remains in strata which he refers to the White River epoch, so-called, in the Madison valley in Montana. But these strata are quite different in character from the beds in which White River mammals are found, apparently lacustrine or fluvialitic in origin, and a very thorough search on his part failed to reveal any mammals in them except a skull of the beaver *Stenocherus*. I do not understand that he considers them as of the same formation or origin as the mammal beds, but merely as of equal age. The discovery of fish in them, therefore, does not at all invalidate the fluvialitic-eolian hypothesis of origin of the White River formation maintained by Hatcher and myself. The same explanation probably applies to other reported occurrences of fish in the White River.
both localities the lithologic distinctions are confirmed by the fossils found.

The Titanotherium Beds are soft, easily weathering, banded clays, often sandy, crumbling to the usual weathered-clay surface, varying in color from dark reddish brown through buff to an almost greenish white. Cross-bedding is seen in the sandier layers. They are not unlike the Titanotherium Beds in South Dakota, but run to deeper and more contrasted coloring. At Pipestone Springs they dip quite steeply toward the north, lying up against the ancient crystalline rocks on the south side of the creek. We found in them the following fauna:

_Marsupialia._

Peratherium titanelix, sp. nov. Allied to _Peratheria_ of Middle Eocene and Oligocene.

_Insectivora._

Apternodus mediævus, g. et sp. nov. Allied to _? Centracodon_ of Middle Eocene.
Micropternodus borealis, " " Allied to _? Centetodon_ of Middle Eocene.
Ictops acutidens _Douglas_ { More primitive than any Middle Oligocene Leptictid.

	thomsoni, sp. nov. }

_Creodonta._

Pseudopterodon minutus (Douglas) Intermediate between the Oligocene _Hyænodon_ and Middle Eocene _Sinopa._

? _Hyænodon_ sp.

_Carnivora Fissipedia._

Bunælurus infelix, sp. nov. Somewhat more primitive than Middle Oligocene species.
Cynodictis paterculus, sp. nov.

_Rodentia._

Ischyromys veterior, sp. nov. Somewhat more primitive than Middle Oligocene species.
Cylindrodon fontis _Douglas._
Sciurus vetustus, sp. nov.
Gymnoptychus minor (Douglas).

	" minimus, sp. nov.
Palæolagus temnodon *Douglas.* More primitive than Middle Oligocene species.

"Palæolagus."

More primitive than Middle Oligocene species.

*Perissodactyla.*

Mesohippus westoni *Cope.* More primitive than Middle Oligocene species.

Hyracodon sp.

? Canopus sp.

Titanotherium sp.

*Artiodactyla.*

Stibarus montanus sp. nov.

Bathygenys alpha *Douglas.*

Limnenetes sp. div.

Leptomeryx mammifer *Cope.*

? esulcatus *Cope.*

Leptotragulus profectus sp. nov. Advanced species of an Eocene genus.

*Lizards and Tortoises,* sp. div.

Two species are reported by Mr. Douglas of which we obtained no further evidence: *Sciurus jeffersoni* Douglas, ? *Agriochæræs maximus* Douglas.

The Oreodon Beds are buff clays, somewhat harder than the Titanotherium Beds, finer, not sandy, more calcareous, and not unlike the Oreodon Beds of Dakota and Colorado. They were very barren so far as we could discover, and the only determinable fossils found at Pipestone Springs were: *Palæolagus haydeni, Eumys elegans, Mesohippus bairdii,* ? *Poëbrotherium.*

These are all characteristic species of the Oreodon Beds in South Dakota, Colorado, etc.

The fauna from the Titanotherium Beds is a quite remarkable one. Not a single species is identical with those of the Oreodon horizon; all are either new, or have been described by Douglas from the same locality, or by Cope from the same horizon at Swift Current Creek. The majority of the species, however, belong to genera of the Oreodon Beds, and these, though fairly distinct, are not widely divergent from their successors. We find that the Pipestone Beds are much nearer to the Oreodon horizon than to the upper Uinta or Diplacodon Beds. Fourteen genera are in common with the
later horizon, while there is but one Uinta genus (*Leptotragulus*) and that represented by a rather divergent species. This contrast is partly explained by the fact that the known White River fauna is a very large one, while that from the Uinta is comparatively small; partly also by considerations of geographical distribution of the Oligocene mammals and by different conditions of deposition in the Uinta and White River beds. But, making allowance for all these, there seems still to be a considerable gap between the Diplacodon and Titanotherium faunas, while the latter is much closer to the Oreodon fauna. It shows some marked differences, however:

(1) There are two new insectivore genera of the primitive section (*Zalambdodonta*) of the order, which has hitherto been practically unknown in a fossil state, unless the Eocene species reported by Professor Marsh shall prove to belong to it.

(2) All the rodents are sciuromorphs or lagomorphs. Myomorpha, more abundant than sciuromorpha in the Oreodon Beds, have not yet appeared. They are unknown in the Eocene, except *Protoptychus*, a form of doubtful affinities.

(3) The only Creodont from the Oreodon Beds is the highly specialized *Hyaenodon*. At Pipestone Creek we have a more primitive type, intermediate between *Hyaenodon* and *Sinopa*. At Swift Current Creek occurs *Hemipsalodon (=?Pterodon)*, also less specialized than *Hyaenodon*. (*Hyaenodon* itself occurs also in the Titanotherium Beds.)

(4) *Oreodon* is not found, and two or three more primitive genera (*Bathygenys, Limnenetes, ? Agriochcerus*) take its place.

(5) *Hypertragulus*, common in the Middle and Upper Oligocene, is not found, while *Leptomeryx* of the Lower and Middle Oligocene is abundant and large.

(6) In place of *Poebrotherium*, the camel of the Oreodon Beds, is found a brachyodont form, apparently the Eocene genus *Leptotragulus*.

From the above facts we would infer that the Pipestone Beds are at the base of the Oligocene, but above the Eocene, accepting Osborn's correlation of the White River formation

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1 If *Gymnoptychus* be considered a sciuromorph, as it was by Professor Cope and is by Dr. Hay.
with the Oligocene, and of the Uinta with the Upper Eocene. They are probably of approximately the same age as the White River beds of Swift Current Creek, Canada, with which they have three species in common, probably a fourth ("Palæolagus turgidus" from Swift Current Creek probably is P. brachyodon),—a fair proportion out of so limited a fauna.

**DESCRIPTIONS OF SPECIES.**

**MARSUPIALIA.**

*Peratherium titanelia*, spec. nov.

Type, No. 9603, a lower law with \( p_3 \) and \( m_{2-4} \) and alveoli of the remaining teeth except incisors.

This species is about the size of *P. huntii* of the Oreodon Beds, and resembles it in the rather short premolar region, the premolars and canine small, close together without any diastemata.

The molars are similar to those of typical *Peratheria* from the Phosphorites, but the premolars are very distinct, crowded, and reduced antero-posteriorly, the cusps recurved instead of symmetrical as in *Peratheria* from the Phosphorites, and in *P. fugax* of Cope. The anterior part of the jaw is rather short and deep and the canine directed more upward than in *P. fugax*.

**Measurements.**

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length ( p_3 - m_4 )</td>
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<tr>
<td>Length ( m_{2-4} )</td>
<td>4.2</td>
</tr>
<tr>
<td>Depth jaw under ( m_2 )</td>
<td>1.9</td>
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**INSECTIVORA.**

*Apternodus mediævus*, gen. et spec. nov.

Type, No. 9601, posterior half of a lower jaw with two complete molars and the root of another.

Molars composed of high trigonid and minute basal talonid. Protoconid high, sharp, and triangular, paraconid and metaconid subordinated. Dentition probably \( \text{i, c, p, m}_3 \).

Talonid a small sharp cusp on \( m_3 \); on \( m_2 \) it is a minute posterointernal basal cusplet. The third molar a little smaller than the second; both are two-rooted, the anterior root wider transversely.
The cusps are all high, sharp, trigonal in cross-section, the whole tooth subtriangular with transverse and longitudinal diameters about equal and vertical diameter considerably exceeding either. The heel is much smaller than in Centetidae, the protoconid higher and larger in proportion than in any other Insectivore or Chiropter.

No. 9608, a lower jaw without teeth, broken off in front at about the same point as the types, but with the condyle complete, appears to belong to the same species. The condyle is widely expanded transversely, on a level with the bases of the molars. The angle in the type specimen is extended into a rather long and stout flattened process with a sharp medial ridge on the internal side. The coronoid is broken off in both specimens, but was evidently high, stout, placed mostly external to the toothrow, and directed upwards instead of backwards.

No. 9607, the anterior part of a lower jaw, with one premolar preserved and the roots of other teeth, is provisionally referred to this species. The premolar is either the third or fourth; it is stout, two-rooted, composed of a round-conical protocone and small postero-internal basal cusp. The anterior root is wider than the posterior. The premolar in front of this was apparently similar but smaller, and was preceded by a small one-rooted premolar, and this by a larger tooth, probably a canine. Behind the premolar are roots of two teeth, one of which was probably m₂, the other certainly a molar, judging from comparison of the corresponding parts of the jaw in the three specimens.

The dentition is then probably c₁ p₃ m₃, but may be c₁ p₄ m₃. The weight of the anterior part of the jaw and doubtful
indications of a large alveolus lead to the suspicion that one or more of the incisors was enlarged.

No. 9612, part of a lower jaw with the roots of the last two molars, is also referred here.

This remarkable little jaw is quite unlike any described species of Insectivore or Chiropter, except, perhaps, Marsh's Centracodon. So far as anything can be determined from his brief description, the last molar of Centracodon is like the second molar of Apternodus. Centracodon has four premolars. Although the short, deep jaw would appear to ally it rather with the Chiroptera, yet as the tooth without talonid is quite unknown in this order, while it does characterize a section of the Insectivora, I leave it provisionally in the latter group, without attempting to assign it to any especial family. Its nearest relatives are most probably the little Eocene Insectivora from the Bridger Basin, described by Professor Marsh in 1872. With the probable exception of these Eocene types and of a single South American species, no fossil Insectivores of the Zalambdodont division have hitherto been described, although according to the Tritubercular theory this, as the more primitive section, should have been more abundant in ancient times.

**Measurements.**

<table>
<thead>
<tr>
<th>Tooth</th>
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<td>M2-3</td>
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</tr>
<tr>
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<td></td>
<td>2.0 mm</td>
</tr>
<tr>
<td></td>
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<td>M4</td>
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<td></td>
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<tr>
<td></td>
<td>2.9 mm</td>
</tr>
<tr>
<td>Depth</td>
<td>3.5 mm</td>
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**Micropternodus borealis**, gen. et spec. nov.

Type, No. 9602, a lower jaw with p3-m3 and alveoli of the anterior teeth.

Dentition 3.1.3.3. Molars somewhat like those of Centetes in composition, with high trigonid and small, low talonid. Trigonid very wide transversely with prd considerably overtopping pad and me4. Talonid with sharp posterior margin and low median ridge. Molars and especially premolars, short, high, and recurved; p4 sub-molariform, with
small anterior and internal trigonid cusps and strong basal heel. $P_3$ much smaller and simpler, with small heel and no other accessory cusps. $P_2$ is small and one-rooted, canine small, incisors small, subequal. No diastemata except a slight one behind $p_2$. Jaw rather deep in front. Second molar slightly larger than the first, third much smaller.

Like the preceding genus, this must be placed among the Zalambdodonta, with no very near relatives among living species, although it is not so strikingly different from modern types. Its nearest allies are also quite probably some of the very inadequately described Insectivora from the Bridger Basin, but neither it nor $Apterodus$ can be considered as possibly congeneric with any of the Bridger species, if Marsh's descriptions are correct.

**Measurements.**

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
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</thead>
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<tr>
<td>Lower jaw, $m_3$ to incisive alveoli</td>
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<td>Lower teeth $p_3-m_1$</td>
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<td>Lower molars $m_{1-3}$</td>
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<tr>
<td>Lower molar, $m_1$ longitudinal, at base</td>
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<tr>
<td>&quot; &quot; &quot; &quot; transverse</td>
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</tr>
<tr>
<td>&quot; &quot; &quot; &quot; height of crown</td>
<td>2.7</td>
</tr>
</tbody>
</table>

**Ictops acutidens** Douglas.

A fragmentary skull and jaws, with some limb-bones of one individual, and the upper and lower molars of another, confirm and extend the characters of this species as indicated by Douglas.

The distinctions from previously described species are:

Dimensions fifteen per cent. less than any of the Leptictidae from the Oreodon Beds. First upper premolar one-rooted, two-rooted in *I. dakotensis* and *bullatus* and in *Leptictis haydeni*. Supra-temporal crests widely separated anteriorly and convergent posteriorly, instead of close together and parallel as in all the later species. Upper molars and $p^4$ more
constricted between the inner and outer cusps than in any described Leptictid; cusps somewhat higher and last molar less reduced than in any later species.

No. 9604, a fragmentary skull and jaw, with humerus, radius, two phalanges, and a caudal vertebra, exhibits most of the permanent dentition well preserved.

Upper jaw. — Incisors not known. Canine of moderate size, compressed, somewhat ridged externally, with no indication of the incipient heel seen in Palaeictops. P1 one-rooted, smaller than canine. P2 two-rooted, compressed, with small posterior basal cusp or heel. P3 three-rooted, with strong, well-separated de, higher but less separated tr, and minute antero-external basal cusp; the protocone much overtopping the other cusps. P4 molariform, but tr not yet as high as pr, de equalling pr in height, small hy, and strong protostyle. First and second molars with pa and me of equal size, hy better developed than in p4, a small protostyle on m1. M3 with reduced me and rudimentary hy. All molars and p4 wide transversely, with some constriction between inner and outer cusps. M3 smaller than m2 and m3, but not so much reduced as in the later species.

Lower jaw. — Dental series continuous without diastemata. Three small incisors. Canine small, incisiform, somewhat larger than incisors. P1 one-rooted, p2 two-rooted, p3 two-rooted, compressed, with anterior and posterior cusps and small heel. The lower molars are not preserved in this specimen. In No. 9605 m2 and m3 are preserved; the trigonid is high, composed of two equal well-separated cusps, talonid much lower, bearing three posterior cusps, external, internal, and postero-median respectively, well separated from the trigonid but not from each other. M3 is a little longer than m2, but
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much narrower, especially the talonid, in which the hypoconulid is situated more behind the hypo- and entoconid instead of nearly between them.

The skull is wider between the eyes than those from the Oreodon Beds, the postorbital constriction less pronounced. The temporal crests begin on the posterior third of the frontal bones, eleven millimeters apart, and converge rapidly on the posterior half of the parietals.

The humerus is disproportionately smaller and more curved than in *I. dakotensis*, the deltoid crest is not so wide nor does it extend so far down. The radius is likewise strongly curved, its distal end bearing two ill-separated subquadrate facets for scaphoid and lunar, the scaphoid facet the wider of the two. Two rather long and slender phalanges are preserved, one somewhat compressed laterally. The caudal vertebra associated is from the middle part of the series and indicates a large, long tail.

This species is in some, but not in all respects intermediate between *Palaictops* and the Leptictidæ of the Oreodon Beds. The last molar is more reduced than in *P. bicuspid*, less than in any later Leptictid. The first premolar is one-rooted, as in *P. bicuspid*, while in the later species it is two-rooted. On the other hand, the molars are more compressed and more constricted medially, and the size is smaller than in either the Wind River species or those from the Oreodon Beds; and the temporal crests are further apart than in the later species, while in the earlier one they are united into a sagittal crest.

**Ictops thomsoni**, spec. nov.

Two upper jaws, Type, No. 9606, Cotype, No. 9606a, indicate a species closely allied to *Ictops acutidens*, but distinguished by smaller size, more compressed teeth, and other characters of less importance. The metacone on all the molars is decidedly smaller than the paracone; in *I. acutidens* they are nearly, and in other Leptictidæ quite, equal in size on m1-3. The protocone on p4-m3 is more
compressed antero-posteriorly, and the constriction between it and the outer cusps is more marked than in *I. acutidens*. The hypocone is smaller on m¹ and m², absent on m³ and p⁴. The tritocone of p⁴ is smaller than in *I. acutidens*.

All these distinctions are exaggerations of the differences between *I. acutidens* and the Leptictidae of the Oreodon Beds, but none of them ally it to *Palaictops*, in which the molars and premolars (except p¹) are fully as complicated as in the species of the Oreodon horizon.

The species is named in honor of Mr. Albert Thomson of the American Museum Expedition of 1902, who discovered the type specimens of this as well as those of four other new species described in this article.

**Comparative Measurements.**

<table>
<thead>
<tr>
<th></th>
<th>I. thomsoni Type</th>
<th>I. acutidens Type and 9625</th>
<th>I. dakotensis Type</th>
<th>I. julius Type</th>
<th>Monodelus, No. 9316</th>
<th>Leptictis Type</th>
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<tbody>
<tr>
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<tr>
<td>&quot; transverse</td>
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<td>3.5</td>
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<tr>
<td><strong>Lower molar-premolar series</strong></td>
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<td>E. 20.0</td>
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<tr>
<td>&quot; height</td>
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<td>3.7</td>
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</table>

¹ Measurements from Leidy's figure.

**CREODONTA.**

**? Pseudopterodon minutus (Douglas).**

*Hyænodon minutus* Douglas.

No. 9623, the upper jaw of a small Creodont of the family Hyænodontidae is referred provisionally to Schlosser's genus, and may be identified specifically with the lower molar on which Mr. Douglas based his species "*Hyænodon*" minutus. This upper jaw, however, cannot be referred to *Hyænodon*, as
the first molar shows a sharp antero-internal angle and small antero-internal cusp. It is not very close to Schlosser's type, and if, as Scott believes, *Pseudopterodon* is founded on milk teeth of *Hyænodon*, then our species represents an undescribed genus, which may well stand ancestral to *Hyænodon*, being directly intermediate between that genus and *Sinopa*.

The animal was a little smaller than *Cynohyænodon cayluxi* Filhol. $P_3$ is two-rooted, slightly compressed, set a little transversely in the jaw, moderately high, with small anterior basal cusp and heel. $P_4$ is three-rooted, the internal root well separated, median, supporting a strong internal buttress to the protocone and a basal cingulum, but no defined cusp. The antero-external cusp is of moderate size, the postero-external developed into a short cutting blade. $M_2$ is three-rooted, the inner root anterior and well separated, bearing a wide buttress ridge and a small internal cusp, which is worn off in the specimen. Only the front part of the tooth is preserved. $M_2$ was larger than $m_2$ and similar to it, judging from the character and position of the two anterior alveoli which indicate it on the specimen.


An upper premolar of singular character which I am unable to refer to any described species of Carnivore or Creodont. It has two roots, the posterior one broadened inwardly so as to support a median internal buttress to the protocone. The protocone is very high, its height exceeding the antero-posterior length of the tooth; somewhat compressed posteriorly, with a well-distinguished posterior cusp and small posterior cingular cusp. Cingulum obsolete except at anterior and posterior ends of tooth. Appears to be the third or, perhaps, second upper premolar of some *Hyænodont*, but not of *Hyænodon* or *Pterodon*.

CARNIVORA (Fissipedia).

*Cynodictis paterculus*, spec. nov.

Two lower jaws and parts of others, Nos. 9616, 9619, repre-
sent this species. Of these I take No. 9616 as type. Compared with a quite large series of specimens, including the types of *C. gregarius* and *C. lippincottianus*, these specimens show certain constant differences, chiefly in the construction of \( m_2 \). This tooth is proportionately larger and longer, the heel larger and wider, and the proto- and metaconids are raised above the paraconid, instead of being nearly on a level with it, as they usually are in *C. gregarius*. The shear of \( m_1 \) is somewhat more transverse, and \( m_3 \) is a little less reduced. The size is that of *C. gregarius*.

The above characters are slight distinctions indeed, but their constancy in the very considerable series of specimens compared makes them valid specifically. In *Procynodictis vulpiceps* of the Uinta, the shear is more transverse, but \( m_2 \) is smaller and its heel more reduced than in *C. gregarius*.

*Measurements.*

<table>
<thead>
<tr>
<th></th>
<th>Type, No. 9616</th>
<th>Cotype, No. 9618</th>
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<tbody>
<tr>
<td>( P_1-m_3 )</td>
<td></td>
<td>35 mm.</td>
</tr>
<tr>
<td>( M_1-m_3 )</td>
<td>18 mm.</td>
<td>17</td>
</tr>
<tr>
<td>( M_1 ) longit</td>
<td>9.5</td>
<td>9.</td>
</tr>
<tr>
<td>&quot; transverse</td>
<td>4.5</td>
<td>4.2</td>
</tr>
<tr>
<td>&quot; height of ( p_4 )</td>
<td>7.</td>
<td></td>
</tr>
<tr>
<td>( M_2 ) longit</td>
<td>5.5</td>
<td>5.2</td>
</tr>
<tr>
<td>&quot; transv.</td>
<td>3.5</td>
<td>3.3</td>
</tr>
<tr>
<td>( M_3 ) longit</td>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>&quot; transv.</td>
<td>2.5</td>
<td></td>
</tr>
</tbody>
</table>

*Buvalurus infelix*, spec. nov.

No. 9620, part of a lower jaw with \( p_4-m_1 \) and the stump of \( m_2 \), represent this species, which is with difficulty distinguishable from *B. lagophagus*. The protocone of \( m_1 \) is more rounded, the shear a little more transverse than in Cope's species. The fourth premolar appears to be stockier and longer than in the type of *B. lagophagus*, but it is not fully formed in the jaw in that specimen, so the comparison is questionable; the protocone is stout and round, with a small
postero-external cusp, and external basal cingulum rising to a small heel behind. The second molar is a minute crownless stump.

**Measurements.**

<table>
<thead>
<tr>
<th>Tooth</th>
<th>Longitudinal</th>
<th>Transverse</th>
</tr>
</thead>
<tbody>
<tr>
<td>P4-m2</td>
<td>10.2 mm.</td>
<td></td>
</tr>
<tr>
<td>P4</td>
<td>4.1</td>
<td>1.9</td>
</tr>
<tr>
<td>M1</td>
<td>5.9</td>
<td>2.3</td>
</tr>
<tr>
<td>Depth of jaw beneath m1</td>
<td>6.</td>
<td></td>
</tr>
</tbody>
</table>

A larger Musteline is indicated by part of a jaw, No. 9621, with p4 and the roots of the front teeth in it. It is about the size of *Cynodictis paterculus*, but the premolars are higher, shorter; the heel smaller, anterior basal cusp absent; and other details join to show that it is a Musteline.

**RODENTIA.**

**ISCHYROMYIDÆ.**

**Ischyromys veterior**, spec. nov.

The anterior part of a skull and some forty jaws or parts of jaws, upper and lower, represent this species. It is considerably smaller than a series of specimens from South Dakota, which agree well with Leidy's types of *I. typus*, and the teeth are narrower throughout with higher cusps. It is much closer to the variety or separate species from Colorado, *I. cristatus* (Cope, 1872), which Cope has referred to *I. typus* and described and figured in 'Tertiary Vertebrata.' From this species I find a constant distinction in the last molar, which in the Montana jaws has always a narrow heel with the last crest imperfect internally, while in all the Colorado specimens the heel is as wide as the rest of the tooth, and the third (last) crest perfectly developed.

In the upper teeth a corresponding difference is to be seen in the last molar, and also the valley between the anterior and posterior inner cusps is well marked on all the teeth, distinct nearly to the base of the enamel, while in the specimens
from Colorado and from South Dakota it is obsolete on p₄ and on the molars does not extend so far down.

? CASTORIDÆ.

**Cylindrodon fontis** Douglas.

We have eight lower jaws and an upper jaw of this species, some of which exhibit the tooth pattern, and enable us to refer this curious little rodent provisionally to the Beavers. The two lower jaws on which the species was based were of comparatively old individuals, and the pattern had disappeared, so that it was not possible for Mr. Douglas to determine its relationship.

The dentition is 1½ c⅔ pⅣ mⅢ — four cheek teeth in each jaw, as in Castoridae, instead of five above and four below as in Sciuridae and Ischyromyidae. The pattern resembles that of *Steneofiber* more than any other related form, consisting in the lower molars of a deep and persistent external enamel inflection, and three fossettes corresponding in position to the internal enamel inflections of *Steneofiber* and *Castor*. Of these fossettes the median is the most persistent; the median and posterior are at first internal enamel inflections, the posterior inflection becoming a closed fossette at a very early stage of wear, while the anterior fossette is closed from the first.

It would appear from the history of those teeth that the enamel inflections did not originate on the sides of the tooth and become gradually deeper and more complicated as the tooth became more hypsodont, the fossettes being a secondary modification; but that the inflections and fossettes
have both originated from the valleys and lateral notches of a brachyodont molar, such as that of Ischyromys. Either of these is easily derivable from a primitive tritubercular molar such as those of the Tillodonta, but not easily from such teeth as are displayed by Paramys and its allies, in which, as in the squirrels, the teeth appear to be specialized and degenerate rather than primitive.

The upper jaw of Cylindrodon (No. 9639) is that of an old individual, with but little indication of the pattern left on the teeth. From what there is present it appears that the pattern exhibited a strong median external inflection and anterior and posterior fossettes, and a trace remains on p₄ of an internal inflection. The pattern was probably like that of Ischyromys, in having the external inflection of greater persistence and depth than the internal. In other Castoridae this condition is reversed. The upper molars decrease in size from before backward and are of rounded peg-like outline, fossettes on all but m₁. The incisor originates just above the roots of p₄ and m₁, and is stout, not grooved, with a moderate diastema between it and the grinding teeth. The antorbital foramen is small and the palate in front of it is narrow.

The depth of the jaw of Cylindrodon in its anterior portion is a very marked character. Ischyromys comes nearest to it in this respect.

**SCIURIDÆ.**

**Sciurus (Prosciurus) vetustus,** subg. et spec. nov.

Represented by an upper jaw, No. 9626, with complete unworn dentition.

The species is smaller than S. relictus of the Oreodon Beds, and at least a third smaller than S. jeffersoni Douglas of the Pipestone Creek Beds, or S. wortmani of the John Day formation.

It is larger than S. ballovianus of the John Day, the first molar (the only upper tooth
preserved in the type of *S. ballovianus*) is considerably wider transversely, its anterior cingulum much less developed, its *mesostyle* or median external cusp (between the anterior and posterior transverse ridges) more prominent. In none of the other species is the upper dentition known, so that an exact comparison is not possible.

Compared with modern Sciuridae this species shows some interesting points of difference. It is nearest to *Sciurus*, but differs in several points of importance:

1. The cross crests on the molars are less complete, and are partly broken up into separate cusps.
2. The third premolar is a much larger tooth and has a small accessory posterior cusp.
3. The heel of *m3* bears a short transverse crest and a strong posterior marginal ridge. In *Sciurus* the posterior part of *m3* is a slightly concave flat basin.
4. The base of the zygoma is anterior to *p3*.

From *Tamias* and the other modern Sciuridae it also differs in the retention of the mesostyle, in addition to most or all of the above-mentioned points. The ridges are not so high as in *Cynomys* and *Arctomys*, and their patterns differ in various other details. I have little doubt that with more perfect material it will be necessary to place this and all the other Oligocene *Sciuri* in a separate genus, nearest to *Sciurus*, but retaining the above primitive features in the dentition, and others of more importance in the skull. But with our present knowledge the distinction in the last molar is the only one which we can predicate of all the Oligocene species in common, and this is only of subgeneric importance at best. The last lower molar in *S. relictus, ballovianus*, and *wortmanii* exhibits a correspondingly ridged and unreduced heel to the ridged and unreduced heel of the last upper molar in *S. vetustus*.

<table>
<thead>
<tr>
<th>Upper dentition, <em>p3</em>-<em>m3</em></th>
<th>..........................</th>
<th>7.7 mm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>molars <em>m1</em>-<em>m3</em></td>
<td>..........................</td>
<td>5.5</td>
</tr>
<tr>
<td><em>P3</em> transverse</td>
<td>..........................</td>
<td>0.8</td>
</tr>
<tr>
<td>&quot; longitudinal</td>
<td>..........................</td>
<td>0.8</td>
</tr>
<tr>
<td><em>P4</em> transverse</td>
<td>..........................</td>
<td>2.3</td>
</tr>
<tr>
<td>&quot; longitudinal</td>
<td>..........................</td>
<td>2.0</td>
</tr>
<tr>
<td><em>M3</em> transverse</td>
<td>..........................</td>
<td>2.5</td>
</tr>
<tr>
<td>&quot; longitudinal</td>
<td>..........................</td>
<td>1.8</td>
</tr>
</tbody>
</table>
Matthew, Fauna of Titanotherium Beds of Montana. 215

HETEROMYIDÆ.

Gymnoptychus minor (Douglas).


The position of *Gymnoptychus* and *Heliscomys* has been variously given by different authors; they are, in fact, rather remote relatives of any modern type, and combine characters of Sciuridæ, Geomyidæ, and Heteromyidæ with others peculiar to themselves or shared by the Ischyromyidæ. The dental pattern strongly suggests that of *Ischyromys*, but the resemblance may be superficial; by simplification and hypsodonty it might be converted into a Heteromyid pattern.

I place the genus in this family on Scott's authority.

The present species is intermediate in size between *G. minutus* and *G. liolophus*, but nearer to the latter. The type of *G. liolophus* retains the milk dentition; a specimen of *G. minor* of corresponding age shows a smaller and shorter d₄ and somewhat narrower and smaller m₁.

Seven lower jaws are referred to this species.

**Measurements.**

<table>
<thead>
<tr>
<th></th>
<th>Type (Douglas)</th>
<th>No. 9630.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower dentition p₄–m₃</td>
<td>5.5 mm.</td>
<td></td>
</tr>
<tr>
<td>&quot; m₃–m₃</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>P₄ transverse</td>
<td>1.3 mm.</td>
<td>1.3</td>
</tr>
<tr>
<td>&quot; longitudinal</td>
<td>1.5</td>
<td>1.4</td>
</tr>
<tr>
<td>M₃ transverse</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>&quot; longitudinal</td>
<td>1.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Diastema behind incisor</td>
<td>4.3</td>
<td></td>
</tr>
</tbody>
</table>

![Fig. 10. Gymnoptychus minor. Lower jaws, four times natural size. A, external view, No. 9632; B, crown view of teeth, No. 9630.]
Gymnoptychus minimus, spec. nov.

A smaller species than _G. minutus_ Cope. Fourth lower premolar larger in proportion to the rest of the dentition, its anterior and posterior halves of equal width; while in _G. minutus_ the anterior half of _p₄_ is much narrower than the rest of the tooth. The first and second molars are narrower than in _G. minutus_, and the whole molar series is thus much more uniform in width.

Only one specimen of this tiny rodent was found by our party.

*Measurements.*

<table>
<thead>
<tr>
<th>Description</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of dentition, tip of incisor to <em>m₃</em></td>
<td>8.4 mm.</td>
</tr>
<tr>
<td>&quot; molar-premolar series, <em>p₄₋₃</em></td>
<td>3.5</td>
</tr>
<tr>
<td>&quot; true molars, <em>m₁₋₃</em></td>
<td>2.6</td>
</tr>
</tbody>
</table>

LEPORIDÆ.

*Palæolagus temnodon* Douglas.

This species is nearly related to _P. haydeni_ of the Oreodon Beds. We have for comparison a series of about seventy-five jaws, upper or lower, but nothing more complete. Mr. Douglas distinguished the species by the presence of an antero-external groove on _p²_.¹ On comparison of our series with several hundreds of jaws of _P. haydeni_ in the American Museum collections, we are able to add a number of other changes less obvious on a single individual, owing to the great variation that age brings about in the characters of the teeth.

The size appears to be nearly constant, approximating that of the smaller specimen described by Mr. Douglas, which, as the first measured specimen, is the type of the species. The molars, and especially the premolars, are less hypsodont than

¹ Mr. Douglas says _p³_, but this must be a slip of the pen.
in *P. haydeni*. The internal enamel inflection on the upper teeth is less deeply impressed and less persistent; it has disappeared on all the older individuals, as it does in *P. turgidus*, but at an earlier age; in *P. haydeni* only a few of the very oldest animals have lost this inflection. The last upper molar is larger than in *P. haydeni*. In the lower jaw *p3* has a less persistent external enamel inflection, so that in old individuals it becomes one-lobed, a character seen also in very old individuals of *P. turgidus*, but which I have not seen in any example of *P. haydeni*.

**Measurements.**

Upper molar-premolar series ......................... 12. mm.
Lower " " ........................................ 11.
Post-canine diastema in lower jaw .................. 8.

**Palæolagus brachyodon**, spec. nov.


This species is of the size of *P. turgidus*, and probably the specimens referred by Mr. Douglas to that species and to *P. triplex* really belong here. It is more brachyodont than *turgidus*, and much more so than any other species of *Palæolagus*. *P2* is smaller and more conical, *m3* appears to have been larger, the internal enamel inflection less persistent. In the lower jaw *p3* is shorter, more conical, and the inflection disappears a little earlier than in *P. turgidus*.

Twelve specimens of more or less complete upper or lower jaws represent this species in our collection.

**Measurements.**

Molar-premolar series, upper jaw (*m3* estimated).. 16. mm.
" " lower jaw ............................. 15.
*P2*, longitudinal ........................................ 1.5
" transverse .............................. 2.5
It appears probable that this species and *P. temnodon* stand in direct or almost direct genetic relationship to *P. turgidus* and *P. haydeni* respectively. The occurrence of the species of *Palæolagus* is:

Oligocene

- John Day
- White River

Leptauchenia Beds
- *P. agapetillus*
- *P. intermedius*

Oreodon Beds
- *P. haydeni*
- *P. turgidus*

Titanotherium Beds
- *P. temnodon*
- *P. brachyodon*

The evolution in *Palæolagus* ran in parallel lines in the different species, some being more progressive in one character, some in another, but none exhibiting either wide divergence or retrogression. The characters in which progress is observed, as I have remarked in a previous paper,\(^1\) are:

1. Superposition of the *Lepus* tooth-pattern over the older and simpler one inherited by *Palæolagus*. This pattern, showing at the crown in the older species, bites continually deeper into the tooth until it entirely replaces the older pattern during the whole life of the animal.

2. Increase in length of teeth, molarization of anterior premolars, and some reduction in size of m\(_3\).

3. Bending down of facial portion of skull on cranial portion. This is associated with lengthening of neck and legs.

4. Increase in brain-capacity, in supra-orbital processes, etc.

5. Increase in size.

It will be observed that in the first and second characters, our two species from the Titanotherium Beds are in all respects more primitive than those of the Oreodon Beds. The difference in size is trifling if any, the third and fourth characters cannot be observed in our specimens.

**PERISSODACTYLA.**

**EQUIDÆ.**

**Mesohippus westoni** Cope.

Parts of upper and lower jaws, fore and hind feet, and many fragmentary jaws and teeth represent one or more species certainly distinct from *M. bairdii*, which does not occur

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\(^1\) Bull. A. M. N. H., XVI, 1902, p. 306.
in these beds. It is provisionally referred to Cope's species, known hitherto by an upper and two lower teeth from Swift Current Creek, Canada. These specimens will be described by Professor Osborn in a later paper.

**HYRACODONTIDÆ.**

**Hyracodon** sp.

Two lower jaws and an upper molar belong to a species of *Hyracodon*. I do not observe any important distinctions from *H. nebrascensis* in the parts preserved; but in the absence of the diagnostic teeth (upper premolars) make no specific reference.

**ARTIODACTYLA.**

**LEPTOCHÈRIDÆ.**

**Stibarus montanus**, spec. nov.

No. 9668, a lower jaw containing the second, third, and fourth premolars, and the first molar, enables us to place the hitherto problematic genus *Stibarus* in the Leptochèridæ.

*Generic distinctions.* — Molars like those of *Lepto-chèrus*. Premolars much like those of *Leptomeryx*, but with lower and more rounded cusps.

*Specific distinction.* — Third premolar with no posterior cingular cusp. The second premolar is long and laterally compressed, with three rounded cusps in line, the anterior the smallest, the median the highest. The third premolar has a similar form and composition, but the median and posterior cusps are somewhat larger, and there is a cingulum around the posterior end of the tooth. The fourth premolar is wider but not much over half as long as the third, it has a main cusp, protoconid, an anterior cusp connected by a ridge with it, a postero-internal and postero-external cusp, all worn off in the specimen and none marginal, and a
posterior cingulum. The first molar has four chief cusps, the external ones somewhat crescentic, the postero-internal smaller than the others, and a posterior cingulum with small hypoconid. P₂ with diastemata behind and in front of it.

No. 9670 shows the second and third molars of similar composition to the first except that the hypoconulid in m₃ is equal to the other cusps and posterior to them.

This species appears to be closely related to S. obtusilobus Cope, but the posterior cingular cusp (heel-cusp) is lacking, and P₂ has small diastemata before and behind it, while there are none in S. obtusilobus. In size and other characters it is identical as far as the type of Cope’s species permits comparison.

Stibarus has been conjectured to be allied to the camels; its actual position has, I think, never been suspected. It is, in a way, a link between the Leptochœridæ and Leptomeryx, and makes it more certain that the former is truly an artiodactyl family. “Leptochœrus” quadricuspis Hatcher is probably a species of Stibarus.

Measurements.

<table>
<thead>
<tr>
<th>Tooth</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P₂ - m₁</td>
<td>27.3</td>
<td></td>
</tr>
<tr>
<td>P₂</td>
<td>7.6</td>
<td>2.7</td>
</tr>
<tr>
<td>P₃</td>
<td>7.6</td>
<td>2.7</td>
</tr>
<tr>
<td>P₄</td>
<td>4.9</td>
<td>3.7</td>
</tr>
<tr>
<td>m₁</td>
<td>5.0</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Depth of jaw below P₂

<table>
<thead>
<tr>
<th>Tooth</th>
<th>Depth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P₂</td>
<td>7.0</td>
</tr>
<tr>
<td>m₁</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Oreodontidæ.

Bathygenys alpha Douglas.

We have three specimens referable to this genus and species: parts of two upper jaws and one lower jaw. I identify these with Mr. Douglas’s species in spite of wide distinctions in the drawing of the teeth of his cotype specimen. These, if correctly drawn, could hardly be Oreodon teeth; they are fully as narrow and trenchant as those of Leptomeryx. As, however, he compares the teeth to those of Merycochærus, which are short and wide and crowded, I assume that the error is in
the drawing, especially as the other drawings of the type and cotype agree well with the description and with our specimens.

The best upper jaw shows the molars and fourth premolar. The premolar is simpler than that of Oreodon, lacking internal cingulum and antero-external accessory ridge, and consisting of external and internal crescent, the former with slightly concave external surface, the latter with a short postero-internal cingulum. The molars are composed of four crescents, no trace of the paraconule remaining on m² or m³; m³ is a little worn, so that it is uncertain whether or not a minute pl. existed. The anterior halves of m¹ and m² are wider transversely than the posterior, the protoselene projecting further inward on the palate than does the hyposelene. The posterior half of m³ is nearly as wide as the anterior half, as in Agriochærus and the Uinta Oreodonts, instead of reduced in width as in Oreodon and the other Oreodontidæ. The exterior surface of the inner crescents is slightly concave, as in Agriochærus, instead of strongly concave as in the later Oreodonts, or convex as in Protoreodon. The exterior surface of the outer crescents is nearly flat.

The fourth lower premolar is oreodont in type, but differs from Oreodon and resembles Promerycochærus, Merycochærus, and Merychýus, in that the entoconid is a ridge extending down and back from the deutoconid, instead of a separate cusp or distinct ridge. In Protoreodon the entoconid is rudimentary. This tooth is a little narrower anteriorly than p₄ in Oreodon, wider than in Protoreodon, Merychýus, or Promerycochærus. The molars are proportioned nearly like those of Oreodon, but are more brachyodont. They are shorter, higher, and with more crescentic cusps than those of Protoreodon.

Bathygenys is in most respects between Oreodon and Protoreodon, but considerably nearer to the former. Some characters point toward a nearer relationship with the Merycochærid group of Oreodonts than with Oreodon itself.
More complete material is needed before its place can be definitely determined.

Measurements.

<table>
<thead>
<tr>
<th>齿</th>
<th>测量值</th>
</tr>
</thead>
<tbody>
<tr>
<td>上颌第二磨齿, m$_1$-m$_3$</td>
<td>1.7 mm</td>
</tr>
<tr>
<td>&quot; &quot; premolar p$_1$, longitudinal</td>
<td>4</td>
</tr>
<tr>
<td>下颌齿, p$_1$-m$_2$</td>
<td>16</td>
</tr>
<tr>
<td>上颌第二磨齿纵向</td>
<td>5.3</td>
</tr>
<tr>
<td>&quot; &quot; m$_2$</td>
<td>5.8</td>
</tr>
<tr>
<td>&quot; &quot; m$_3$</td>
<td>6.2</td>
</tr>
</tbody>
</table>

*Limnenetes* sp.

A number of lower jaws and parts of jaws may be provisionally referred to this genus, although the characters of the teeth are nearer to those of *Bathygenys* than to *Oreodon*; while Mr. Douglas describes the teeth of *Limnenetes* as so like those of *Oreodon* as not to need a separate description. The premolars are narrower than those of *Oreodon*, the entoconid ridge not separated from the deuteroconid on p$_4$, and the structure of p$_3$ is intermediate between that of *O. culbertsoni* and *Merychys elegans*, but more brachyodont than either. The lower molars are intermediate between those of *Proto-reodon*, with conical internal cusps, and those of *Oreodon* with fully crescentic internal cusps. Heel of m$_3$ narrow, as in *Proto-reodon*.

There is more than one species, and may be more than one genus, among these specimens, and it is inadvisable to attempt to place them very definitely at present.

**HYPERTRAGULIDÆ.**

*Leptomeryx* ? *esulcatus* Cope.

The type of Cope's species is an upper molar, probably m$_1^1$, from the Titanotherium Beds of Swift Current Creek, Canada.

We have a large number of parts of lower jaws and separate upper teeth, which belong to one or more species of *Leptomeryx* a little larger than *L. evansi*, but variable in size. These are referred provisionally to *L. esulcatus*, because it is within the limits of size, comes from the same geological hori-
zon, and agrees well enough with other first molars in our series. The character by which Cope separated it from *L. evansi*, the absence of defining furrows to the rib of the external crescents, is exhibited only on first molars, and not on all of these; but two other characters of more importance are seen in our material, viz.:

1. The median internal cusp, a strong cusp in \( m_3 \) of *L. evansi*, and a smaller one on \( m_2 \) and \( m_1 \), is quite small on \( m_3 \), and absent, or nearly so, on \( m_2 \) and \( m_1 \).

2. In the third lower premolar the protoconid has two posterior ridges, of which the internal one connects with the heel, and the external one does not; while in *L. evansi* and other species from the Oreodon and Leptauchenia Beds, the external ridge connects with the heel, and the internal one does not.

In the lower jaw I have observed no entirely constant distinctions, except in \( p_3 \). The first premolar is small, and is separated from \( p_3 \) by a diastema of about the same length as that of *L. evansi*; the size of the jaws averages larger than those of *L. evansi* from South Dakota, and all are larger than *L. evansi* of Colorado. The height of crowns and proportion of the teeth are about the same, and the premolar pattern, allowing for individual variation, is identical, except as above noted.

I have no doubt that better material will furnish more satisfactory distinctions, but, except for the characters noted above, I am unable to find any in the teeth.

**Measurements.**

- Lower premolars \( p_2-4 \) ........................................ 19 mm.
- Lower molars \( m_1-3 \) ........................................ 24
- Upper molar, \( m_3 \), antero-posterior .................. 8.
- " " " transverse ..................... 8.5
Leptomeryx mammifer Cope.

A much larger species than the preceding, size about that of Poebrotherium eximium. Distinguished from L. evansi by the pattern of p₃, which is like that of L. esulcatus, but with the external ridge of the protoconid more clearly separate from the heel, and the postero-internal more clearly joined to it. The first lower incisor is large, second and third small, canine nearly as large as first incisor (larger than in L. evansi).

First premolar equally spaced between c and p₄; remaining premolars close set. Molars an enlarged copy of those of L. evansi. Parts of the feet of Leptomeryces of appropriate size were found at the locality; they show no important distinctions either in fore or hind foot, from L. evansi. The upper molars have a smaller median internal cusp than those of L. evansi. The size is nearly a third larger, lineally.

Lower premolars, p₂₋₄ .............................. 24 mm.  
" first premolar, p₁ ............................. 2 
Space between c and p ........................... 17 
Lower molars, m₁₋₃ ............................... 32 
Complete lower dentition, estimated .......... 78 
Upper molar, longitudinal ....................... 9  
" transverse .................................. 11

CAMELIDÆ.

Leptotragulus profectus, spec. nov.

Parts of several lower jaws represent a species of Camelid nearly as large as Poebrotherium wilsoni, but with brachy-
dont molars like *Leptotragulus*. No. 9681 (type) shows $p_4$-$m_1$; No. 9682 (cotype) $p_4$-$m_3$ and the root of $m_3$; No. 9683 a number of lower molars and milk molars. Nearly all these teeth are unworn or very little worn.

The species is of about the same size as *Leptomeryx mammifer*, but is distinguished by the camelid pattern of the pre-

![Diagram of *Leptotragulus projectus*]

Fig. 28. *Leptotragulus projectus*. Type specimen, external view, natural size; second and third molars supplied from another individual.

molars. The molars are very difficult to separate from those of *L. mammifer*; they are a little wider and shorter-crowned, with the crescents placed less obliquely, and $m_3$ has but a vestigial postero-internal cusp. The fourth premolar has no deuterocone, but two strong posterior crescents from protocone to heel sub-parallel, enclosing a narrow lenticular fossa. The third premolar is similar, but more compressed; the second has but one complete posterior ridge. Their pattern differs from that of *Poebrotherium* chiefly in the completeness of the inner posterior ridge, which in *Poebrotherium* does not reach the heel on $p_3$ and $p_4$, and is entirely absent in $p_1$.

The cotype shows a moderate diastema, considerably shorter than that of *L. proavus*, separating $p_2$ from the alveolus of a strong caniniform tooth.

The heel of the last molar in referred specimens is like that of *Leptomeryx* or *Leptotragulus*, with postero-external crescent and small antero-internal cusp. In *Poebrotherium* is a posterior crest, not crescentic, and a small antero-internal cusp.

The species is about a fifth larger than *L. proavus*, with which its premolar pattern corresponds quite closely, according to Scott's description. The molars are a little wider and
Unfortunately no upper teeth can with entire certainty be referred to our species. Those which are doubtfully referred have the *Leptomeryx-Poebrotlzerium* pattern, with strong mesostyle and a rib on the external face of the anterior external crescent, but none on the posterior; they are less extended transversely than those of *Leptonzeryx*, much more than those of *Poebrotherium*. The upper molars of *Hypertragulus* are very easily distinguished by the entire absence of mesostyle and equal development of the external ribs on anterior and posterior crescents. No upper teeth of this pattern were found in the Pipestone beds. The upper molars of *Leptotragulus proavus* are not known.

From the above facts I am inclined to believe that *Leptotragulus*—this species at least—is more nearly related to *Poebrotherium* than Professor Scott has supposed, and that it has not much to do with *Hypertragulus*. It is probable in either case that the caniniform tooth is the first premolar. The species is really far nearer to *Poebrotherium* than is *Protylopus petersoni*; how much of the resemblance is due to parallelism remains to be determined.

Mr. Gidley discovered last summer in the Oreodon Beds of South Dakota, a brachyodont camel, which may be a direct descendant of this species.

**Measurements.**

<table>
<thead>
<tr>
<th>Description</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower premolars, p₂-p₄</td>
<td>25 mm.</td>
</tr>
<tr>
<td>Diastema in front of p₂</td>
<td>10 mm.</td>
</tr>
<tr>
<td>Last lower molar</td>
<td>15 mm.</td>
</tr>
<tr>
<td>Lower molars, m₁-₃ (from three specimens)</td>
<td>30 mm.</td>
</tr>
</tbody>
</table>