56. 9 (1183: 78.2)

# **Article XXVII.**— A PLIOCENE FAUNA FROM WESTERN NEBRASKA.

By W. D. Matthew and Harold J. Cook.



## I. Introductory.

During the summer of 1908 the writers, in conjunction with Messrs. Albert Thomson, Roy L. Moodie and William Stein, were employed under direction of Professor Henry Fairfield Osborn in collecting fossil mammals in the Tertiary of Sioux Co., Nebraska, for the American Museum of Natural History. The expedition was in charge of Mr. Thomson and was provided for through the generosity of Mrs. Morris K. Jesup. We are indebted for many courtesies and material assistance in various ways, to Mr. James H. Cook of Agate, Neb., to whom our cordial acknowledgments are here made. The results of the season's work consisted of a large series of skulls and skeletons of Lower Miocene fossils, of a smaller collection from a Middle Miocene horizon, and of a large but mostly fragmentary collection representing a Lower Pliocene fauna hitherto unknown in the Plains region. The study and description of this part of the collection was assigned by Professor Osborn to the writers, and its results appear in the following pages.

The Pliocene mammals of North America are very imperfectly known. The various faunæ which have been referred to this epoch by Leidy, Marsh and Cope, are now regarded as chiefly Upper Miocene on the one hand or Lower Pleistocene on the other. The only true Pliocene fauna of the Western Plains, according to Osborn's recent correlation (U. S. G. S. Bull. No. 361), is the Blanco of Texas, referable to the Middle Pliocene and containing some twenty species of mammals.[1] The discovery of a large and varied fauna of Lower Pliocene age, intermediate between the Blanco and the typical Upper Miocene, and equivalent to the Pikermi fauna of Europe, helps materially to fill this gap in our series. The new fauna

[1] Certain beds containing *Elephas imperator* may also be referable to the Pliocene, but the two or three species which they are known to contain, can hardly be called a fauna.

represents over fifty species, mostly closely allied to those of the Upper Miocene, but differs (1) in the presence of more advanced species or mutations of the several phyla, and (2) of certain Pleistocene or modern genera not hitherto recorded from the Tertiary, (3) in the greater abundance and variety of three-toed horses, certain species of which show distinct approach to the Pleistocene *Equus* and *Hippidion*, and (4) in the abundance of gigantic camels of the genus *Pliauchenia*.

## II. Stratigraphic Relations.

About the end of last June we made a prospecting trip to the Tertiary exposures south of the divide between the Platte and Niobrara Rivers, in Sioux Co., Neb.; and after a few days preliminary prospecting, the entire expedition was moved to this point and about three weeks spent in obtaining a collection. The exposures begin along the southern border of the sandhill region which occupies the crest of the divide, and appear to be of independent origin from the deposits of the Niobrara valley. We regard them as laid down by a different river system and provisionally consider them as the northern margin of the Tertiary formations of the Platte River. Further exploration and more extensive collections will show what their time-relations to the Niobrara River deposits may be. The preliminary work indicates a much nearer relationship to the Tertiary beds to the southward. We may provisionally consider the sandhills of central Nebraska, east and west, as marking an old divide which separated the Tertiary deposition area now occupied by the Niobrara, White and Cheyenne rivers from the deposition area to the south, now occupied by the North and South Platte.

The exposures begin between the sandhills of the divide and the headwaters of Snake Creek, Sheep Creek and Spotted Tail Creek flowing into the Platte. Three distinct series of strata were identified at this point. The lowest, making up the main mass of the "breaks," is very barren, and no fossils were found in it except *Dæmonelix*. These beds may be provisionally considered as Lower Miocene, equivalent to the Dæmonelix Beds of the Niobrara valley. These have not been identified south of the Platte River. Overlying these, separated by an unconformity of erosion, are strata not represented in the upper part of the Niobrara valley, and containing a limited fauna of Middle Miocene age, characterized especially by *Merychippus*. These may be called the Sheep Creek beds, and appear to correspond in age to the Pawnee Creek beds of Colorado, the Deep River of Montana and the Mascall of Oregon. They consist of soft fine-grained sandy "clays" of a light buff color, free from pebbles, and containing harder calcareous layers. Their thickness is estimated at 100 feet. Near the top is a layer of dark gray volcanic ash, two feet thick. *Merychippus* is the most abundant fossil, several incomplete skeletons were found by our party, besides numerous teeth and jaws. Two or more species of camels, one referable to *Alticamelus*, another to *Protolabis*, are represented by skulls, jaws and parts of skeletons. A large cervid, provisionally referred to *Palæomeryx*, and fragmentary remains of *Blastomeryx*, *Merycodus*, ?*Cynodesmus* and other carnivora and rodentia, were found; large and small tortoises are common.

Overlying the eroded surface of the Sheep Creek beds are the remains of a formation which we regard as an outlier of the Ogalalla, which covers the plains to the south of the Platte and extends southward and eastward into Kansas. The typical Ogalalla is composed of clean sand, with a considerable amount of gravel and pebbles of hard rock, scattered through its mass or collected in layers, and the whole mass cemented to a varying extent by lime. It is known to the Kansas geologists as the "mortar-beds." The older Miocene formations in the central Plains (Arickaree) are composed of a comparatively muddy sand, and lack the hard pebbles and gravel derived from the mountains. Even the coarse channel deposits in these older formations are usually composed mostly of mud-pebble conglomerates, not of crystalline or metamorphic rock pebbles.

The Snake Creek Beds, as we shall call this supposed local facies of the Ogalalla, lack this calcareous cement at the typical locality, but are otherwise very like the "mortar-beds" of the Republican River valley. They are composed of a clean sand, with gravel scattered through it, especially in certain layers, and mantling the eroded surface of the Sheep Creek beds. Locally the gravel is concentrated in what appear to have been heavy channel beds, and the sand has been in large part removed, probably by æolian erosion, leaving a residual mantle of some thickness wherever these channel deposits occurred. Scattered through the undisturbed sands of the formation are bones, jaws, etc., of a great variety of fossil mammals, and in the old channel beds are vast numbers of jaws, teeth, and water-worn fragments of bone, forming in places a bone-bed several feet thick. Complete skulls and associated skeletons appear to be very rare. The bones are hard and uncrushed, but for the most part more or less waterworn. Their state of preservation is very much as in the sands of the Niobrara River further to the eastward, and in the fossiliferous sand formations of the Pleistocene.

## III. List of Species of Snake Creek Fauna.

### Carnivora.

Canidæ.

*Amphicyon amnicola* sp. nov.

" sp. indet.

*Ælurodon haydeni validus* mut. nov.

" *sævus secundus* mut. nov.

*Tephrocyon hippophagus* sp. nov.

" cf. *temerarius* Leidy.

" cf. *vafer* Leidy.

" sp. maj.

?*Cyon* sp.

Procyonidæ.

*Bassariscus antiquus* sp. nov.

Mustelidæ.

3 sp. gen. indet.

Felidæ.

*Machærodont* gen. indet.

?*Felis* cf. *maxima* S. & O.

### Rodentia.

*Mylagaulidæ.*

*Mylagaulus* cf. *monodon* (Cope).

Castoridæ.

*Dipoides brevis* sp. nov.

*Dipoides tortus* Leidy.

*Hystricops* cf. *venustus* Leidy.

Geomyidæ.

*Geomys* cf. *bisulcatus* Marsh.

### Edentata.

Megalonychidæ.

Gen. indet.

### Perissodactyla.

Rhinocerotidæ.

*Teleoceras* sp.

*Aphelops* sp.

?*Cænopus* sp.

Equidæ.

*Hypohippus* cf. *affinis* Leidy.

*Parahippus* cf. *cognatus* Leidy.

*Merychippus* 2 or more sp.

*Neohipparion* 3 or more sp.
*Protohippus* 2 or more sp.
*Pliohippus* 3 or more sp.

ARTIODACTYLA.

Dicotylidæ.
*Prosthennops* cf. *crassigenis* Gidley.
" sp.

Oreodontidæ.
*Merychyus* (*Metereodon*) *relictus* subg. & sp. nov.
" " *profectus* sp. nov.

Camelidæ sp.
*Pliauchenia* (*Megatylopus*) *gigas* subg. & sp. nov.
*Alticamelus procerus* sp. nov.
" sp.
" sp.
*Procamelus* sp.
" sp.

Cervidæ.
*Palæomeryx* sp.
*Cervus* sp.
*Blastomeryx elegans* sp. nov.
*Blastomeryx* cf. *wellsi* Matthew.

Antilocapridæ.
*Merycodus* cf. *necatus* Leidy.
? " sp. maj.
? " sp. min.

Bovidæ.
*Neotragocerus improvisus* gen. et. sp. nov.
Bovid gen. indet.
*Bison* sp. indesc.

PROBOSCIDEA.

Elephantid, gen. indet.

| | | |
|---|---|---|
| Total, | Carnivora, | 15 sp. |
| | Rodentia, | 5 " |
| | Edentata, | 1 " |
| | Proboscidea, | 1 " |
| | Perissodactyla, | 15 " |
| | Artiodactyla, | 21 " |
| | | 58 species of mammalia. |

## IV. Correlation of the Fauna.

The above fauna is obviously closely allied to the typical "Loup Fork fauna" of Hayden, Leidy and Cope, and especially to the latest phase of that fauna, represented in the Republican River beds. The genera are with few exceptions Miocene, the species are in many cases indistinguishable from those of the Upper Miocene, while in others they show advanced mutations or are specifically distinct. Among the Carnivora, the aberrant dogs *Amphicyon* and *Ælurodon* are represented by more specialized forms than any hitherto known. The more typical dogs which we refer to *Tephrocyon*, include both large and small species nearly approaching the true *Canis* in teeth. The modern Central American genus *Bassariscus* is represented by a species nearly allied to one of the two living ones. The Felidæ are represented by both Machærodonts and true cats. The Rodentia include three, probably four, upper Miocene genera, all too imperfectly known for satisfactory correlation of species.

The Edentata form an important part of the Blanco and Pleistocene faunæ, and are unknown in the Miocene save for a single characteristic claw reported by Sinclair from the Mascall. A single claw, broken, but unmistakable, is the only representative of this order in the Snake Creek fauna. The presence or absence of edentates of distinctively South-American type in our northern faunæ is of the highest importance in correlation, as is the appearance of northern genera in the Pampean and other South American formations. The Mascall and Snake Creek edentate claws, while much larger than any Santa Cruz edentates, are decidedly small for Pampean genera.

The Rhinoceroses belong to the Upper Miocene and Pliocene genera *Teleoceras* and *Aphelops*, the one with very short limbs and long-crowned teeth, the other with longer limbs and shorter-crowned teeth. The material is too fragmentary for specific comparison. As in the Upper Miocene, a few survivors of the more primitive *Cænopus* group still persist.

Horses are by far the most abundant animals in the collection, and indicate a great number and diversity of species. The genera are the same as in the upper Miocene, but the more advanced forms, *Neohipparion* and *Pliohippus*, show a greater diversity of type, and some of the teeth show a marked approximation to the Pleistocene genera — in *Neohipparion* to *Equus*, in *Pliohippus* to *Hippidion*. This is true both in size and in the pattern of the crown, and suggests the direct derivation of the later genera from unknown or imperfectly known species of *Neohipparion* and *Pliohippus*. We do not mean by this to infer the American origin of the genus *Equus*, but to intimate that the structural origin of the *Equus* molar is more probably through the *Neohipparion* molar with flat protocone, long straight crown, and moderate complication of the enamel lake borders than through the typical *Hipparion* molar with round protocone, shorter and more curved crown, and extreme complication of the lake borders. The habitat of the intermediate species may have been Holarctic or Asiatic, although it does not appear in the known Pliocene fauna of China. More complete material and more extended study is necessary to demonstrate the true relations of the Snake Creek horses to those of the Pleistocene. There is no conclusive evidence that any of them were monodactyl, nor is there among the thousands of teeth preserved a single one which we can refer to the genus *Equus*.

The Camelidæ are numerous and widely varied in size and proportions. The Miocene genera *Procamelus* and *Alticamelus* are well represented, and with them are gigantic Pliauchenias equalling those of the Blanco in size and robustness of limbs. The relative abundance of large camels, the general elongation of the molar crowns, and reduction of the premolars, and the extreme elongation of the limbs in the species of *Alticamelus*, indicate a later stage of evolution than among the later Miocene Camelidæ. The peccaries belong to the Upper Miocene genus *Prosthennops*, but some of the teeth approach quite closely to the primitive species of *Platygonus* recorded from the Blanco.

Oreodonts of the Upper Miocene genus *Merychyus* are present, though not common, but in most if not all of them the premolars are more complicated than in the Miocene species, and the caniniform $p_1$, is reduced in size, and functions as a premolar.

Among the Cervidæ and Antilocapridæ we find species identical with or equivalent to those of the Upper Miocene, with others, imperfectly represented, but apparently approximating the Pleistocene and modern genera.

The most unexpected feature in the fauna is the presence of Bovidæ. True antelopes are positively identifiable, and if our correlation of horns and teeth be correct, they belonged to the Tragocerine group, characteristic of the European Pliocene, and combining a primitive type of horns and teeth not found associated in any one section of the modern family. Remains of a species of *Bison* were also found, but there is some reason to doubt their pertinence to this fauna.

The Proboscidean remains are too fragmentary for exact identification. They are comparable to the so-called Mastodons of the Upper Miocene and Pliocene, *Gomphotherium* and *Dibelodon*, rather than to the true *Mastodon* of the Pleistocene. There is no indication of *Elephas*.

The nearest relationships of the above fauna are evidently with the "Upper Loup Fork" or Republican River Beds, regarded as Uppermost

Miocene or Lower Pliocene,[1] but the modernization is more apparent. The Archer (Alachua clays) of Florida and the Rattlesnake of Oregon may represent an equivalent stage, but are too little known for satisfactory correlation. The Blanco fauna, so far as known, is distinctly more modern, in the relative abundance of Edentata, in absence of Oreodonts, *Merycodus*, *Procamelus* and numerous other Miocene genera; but how far the absence of these genera may be due to our limited knowledge of the fauna it is impossible to say. Very little is known of the Blanco horses, which would furnish the most satisfactory comparisons, but Gidley has shown that the reported occurrence of *Equus* in this formation is an error, the species being all of the Protohippine group and not recognizably more advanced than the Miocene horses. The Snake Creek Pliauchenias compare with those of the Blanco in size and in reduction of the dentition, although of different species.

## V. Descriptions of Genera and Species.

### **Amphicyon amnicola** sp. nov.

Type, a lower jaw, No. 13846, with $M_{1-2}$ and alveoli of the premolars and $m_3$. Size about equal to *A. giganteus* of the Middle Miocene of Europe, or *A. sinapius* of the Pawnee Creek beds of Colorado, but the reduction of the premolars is further advanced than in any known species of this group. The heel of $m_2$ is relatively narrow, and $m_3$ is large and two-rooted, as in *Amphicyon*. In *Dinocyon thenardi* and *Borophagus gidleyi*, the heel of $m_2$ is broad and $m_3$ short, one-rooted. This difference is probably generic, as it is correlated with the presence or absence of $m^3$ in the upper jaw, the primary distinction between *Amphicyon* and *Dinocyon* or *Borophagus*. The reduction of the premolars appears to be as in *Ursus*, a two-rooted $p_4$ with a diastema in front; but the jaw is broken off in advance of this diastema, so that we cannot determine the presence or absence of $p_1$. The form and proportions of the back of the jaw agree entirely with *A. giganteus*. The position of the condyle is considerably above the tooth-line, instead of below it as in *Ursus*, and the inferior margin of the jaw is much more convex beneath the molars than in that genus. The form of the coronoid process, so far as it is preserved, is much as in *Ursus*.

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[1] Osborn, *l. c.*

Fig. 1. *Amphicyon amnicola*, lower jaw, type specimen, external view × ½, and crown view of teeth natural size.

*Measurements.*

| | mm. |
|---|---|
| $P_4$–$m_3$, length | 105 |
| $M_1$ anteroposterior | 35.6 |
| " transverse width of heel | 18.8 |
| $M_2$ anteroposterior | 26.7 |
| " transverse | 19.5 |
| Depth of jaw below $m_3$ | 67. |
| Height of condyle above angle | 66. |
| Length from condyle to anterior alveolus of $p_3$ | 228.3 |

Several fragments of the skeleton indicate a carnivore of the largest size and are provisionally referable to this genus and species. The most distinctive is a scapholunar bone, measuring 63 mm. transverse by 54 mm. dorsoplantar, and 35 mm. proximo-distal.

### ? **Amphicyon** sp.

A smaller species of the Amphicyonine group is indicated by part of the lower jaw of a young individual, No. 13848, with $p_4$–$m_1$ perfect and unworn, and alveoli of $p_3$ and $m_{2-3}$. It is of the size of *A. ursinus* Cope but the second molar was much larger. The metaconid is comparatively small, the hypoconid high, crested and nearly median in position, the entoconid ridge low, marginal and divided by a furrow across its middle. No accessory cusps on $p_4$; the heel and anterior end are broadened but without cingula. The jaw is shallow, as would be expected in a young individual.

*Measurements.*

| | | | mm. |
|---|---|---|---|
| $P_4$, anteroposterior | 17.3; | transverse | 8.5 |
| $M_1$ " | 30.2; | " | 15. |
| $M_2$ alveolus, anteroposterior | | | 22.5 |
| Depth of jaw beneath $m_2$ | | | 36. |

### **Ælurodon** *Leidy.*

This genus is characteristic of the Upper Miocene. It has been reported by Douglass from the Flint Creek beds of Montana (Middle Miocene), but the specimen figured is too imperfect for positive identification. The genus differs from the remaining Canidæ in the presence of a strong antero-external cusp (parastyle) on the upper carnassial (as in Æluroidea); but in other respects the teeth are typically canid. The premolar region of the jaw is shortened, the premolars more or less reduced in size, massive and crowded. In the specimens from the Snake Creek horizon, this reduction and crowding of the premolars is carried further than in any of the described forms, *Æ. sævus* Leidy being nearest in this respect. The genus *Hyænognathus* Merriam, from the Pleistocene of California, carries this specialization still further, but it is not certain that it can be derived from *Ælurodon*. In the Snake Creek species the lower teeth correspond in all details to *Ælurodon*, and three unassociated upper carnassials have the parastyle well developed.

### **Ælurodon haydeni validus** mut. nov.

This mutation differs from the type of *Æ. haydeni* Leidy, in the shorter and more crowded premolar region, reduction of the tubercular teeth, and slight enlargement of the carnassial. It is based upon a lower jaw, No. 14147, with $p_4$–$m_2$ complete, and roots or alveoli of the other teeth. $P_4$ shows the characteristic form of *Ælurodon*, in its massive proportions, peculiar backward pitch of the protoconid, broad cingulate heel, and high

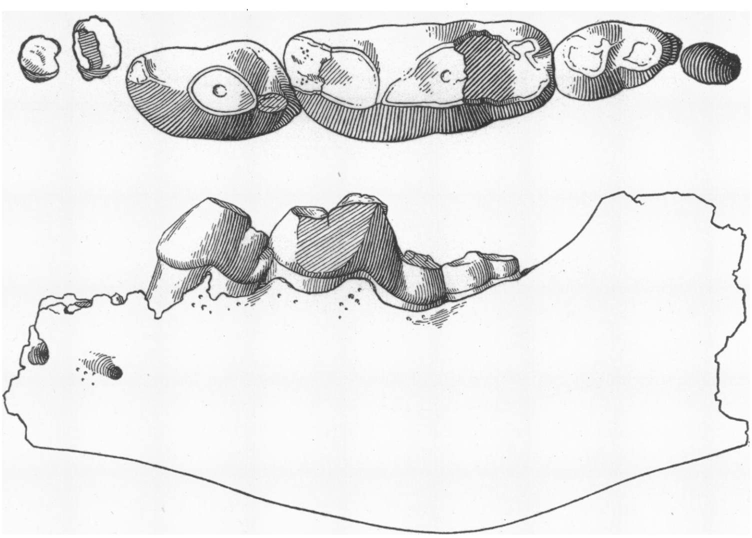

Fig. 2. *Ælurodon haydeni validus*, lower jaw, type specimen, external view $\times \frac{2}{3}$, and crown view of teeth natural size.

strong posterior accessory cusp. $P_3$ is much smaller, and set somewhat transversely in the jaw; in front of it is another transversely set tooth and the presence or absence of $p_1$ cannot be demonstrated. The canine alveolus indicates a large and massive tooth. $M_1$ is like that of the other Ælurodons, with massive paraconid and protoconid, small, low metaconid, and rather small bicuspid heel. It is longer but less robust than in *Hyænognathus* *pachyodon.* $M_2$ is rather small, long-oval as in *Ælurodon,* not quadrate as in *Hyænognathus*; and there is a smaller oval alveolus for a single-rooted $m_3$. The jaw is massive, deep, and with strongly convex inferior border beneath the molars, as in other Ælurodons. In *Hyænognathus* the depth is less, the convexity of the inferior outline more posterior, the symphyseal region more massive, the anterior premolars shorter, not transverse, $p_1$ absent, and there is not metaconid on the carnassial.

### **Ælurodon sævus secundus**, mut. nov.

Type, No. 13831, a lower jaw with $p_3$–$m_2$, and alveoli of the remaining teeth except the incisors. This jaw agrees in size with the type of *Æ. sævus* Leidy, but the premolars are more reduced and crowded, and the jaw shorter, than in the type or any of the referred specimens. The anterior

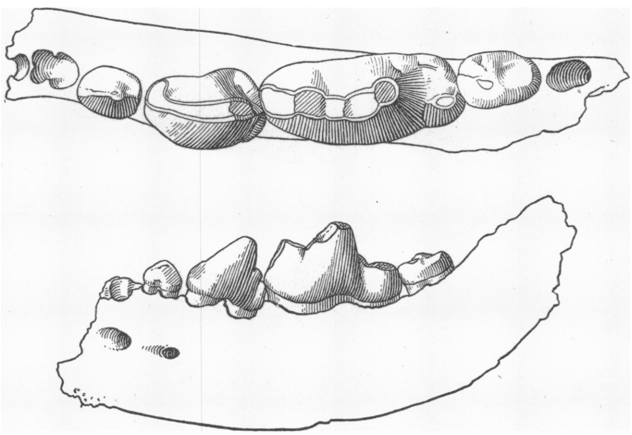

Fig. 3. *Ælurodon sævus secundus,* lower jaw, type specimens, external view $\times \frac{2}{3}$, and crown view of teeth natural size.

premolars are shorter than in *Æ. haydeni validus,* and are not set transversely to the tooth line; the second molar is shorter and relatively smaller. It stands nearer in these respects to *Hyænognathus* than does the preceding form.

### **Ælurodon** sp. div. indet.

A third jaw, No. 13832, a little larger than No. 13831, is doubtfully referable to *Æ. sævus.* The jaw is not so deep, the tubercular molars are more elongate, and $m_3$ is set in the base of the coronoid process, somewhat as in *Æ. haydeni*. Three separate upper carnassials agree in size with *Æ. sævus* or the mutation above described, but are not regarded as determinable specifically.

*Comparative Measurements* (*type specimens*).

| | *Æ. sævus* | *Æ. haydeni* | *Æ. wheelerianus* | *Æ. validus* | *Æ. secundus* | *H. pachyodon* |
|---|---|---|---|---|---|---|
| Lower dentition, $p_3$–$m_3$ | 69.7 | 97. | 77.5 | 97. | 67. | |
| $P_4$, anteroposterior diameter | | 20.1 | 14.3 | 22. | 15.8 | |
| " transverse " | | 10. | | 8. | 10. | |
| $M_1$ anteroposterior " | 27.5 | 36. | 28. | 36. | 27. | |
| " transverse " | 10.2 | 16. | 11. | 15.2 | 11. | |
| $M_2$, anteroposterior " | | 18. | 12. | 15. | 10.4 | |
| " transverse | | | 9. | 10. | 7.8 | |
| Depth of jaw beneath p | | | 25. | | 27. | |
| " " " " $m_1$ | 29.5 | 44.3 | 35. | 48. | 29. | |
| Thickness of jaw beneath $m_1$ | 14.8 | 20. | 17. | | 12.8 | |

## **Tephrocyon hippophagus** sp. nov.

This species is represented by eight lower jaws and part of an upper jaw, and probably by various skeletal parts. The type, No. 13836, is figured. The species is about as large as a coyote, but the jaw is much more robust and deeper anteriorly, and the teeth more massive. It approaches *Ælurodon* in these respects, and agrees with *Canis compressus* (Cope) and other Miocene species. More complete material will very probably show that these later Tertiary dogs are all generically distinct from *Canis*, and that many of them are referable to *Tephrocyon*.

In comparison with *Ælurodon*, the premolars are less reduced, more compressed and trenchant, the accessory cusps more prominent and compressed. $P_4$ does not have the peculiar backward pitch characteristic of *Ælurodon*, and probably correlated with the development of the parastyle on $p^4$. The species is considerably smaller than *Æ. sævus*; it is larger than *Canis* ("*Ælurodon*") *compressus* (Cope), the jaw longer and much deeper, the second and third molars smaller. The jaw is shorter and deeper than in any modern species of *Canis*, the dingo, *C. lupus* and the jackals coming nearest in this respect; the accessory cusps of the premolars are larger and the paraconid of $m_2$ is well developed. We are unable to make comparisons with the Pleistocene South American species which would probably show nearer affinities.

The species agrees quite closely in size and proportions with *Tephrocyon rurestris* Merriam of the Mascall beds of Oregon. The anterior basal cusps of the lower premolars are distinct, while in *T. rurestris* they are absent; the metaconid of the carnassial is smaller, the convexity of the lower border of the ramus is less, and other small differences appear to be indicated by Merriam's figures.

Nos. 13837–41, 13845 and 13850, add nothing to the characters of the type, but show a moderate degree of variability in depth of jaw, and slight differences in size and robustness of the teeth.

No. 13834, a fragment of upper jaw with $m^{1-2}$, is referred to this species,

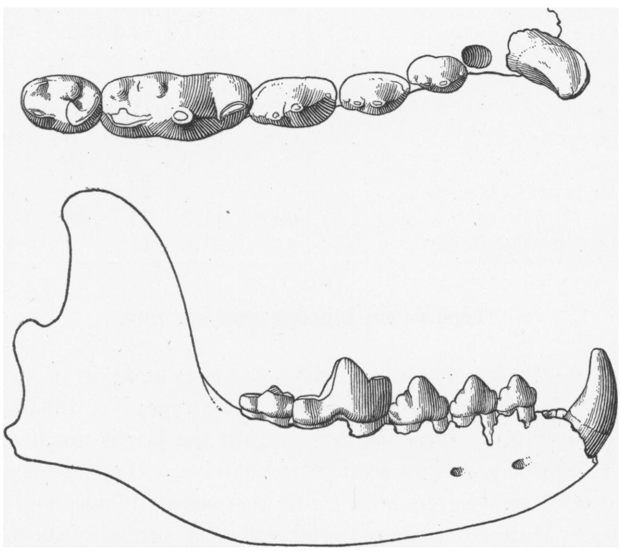

**Fig. 4.** *Tephrocyon hippophagus.* Lower jaw, type specimen, external view × $\frac{2}{3}$, and crown view of teeth natural size.

from its agreement in size, and the resemblance of the teeth to those of *Tephrocyon* and *Ælurodon.* $M^1$ agrees with these genera and differs from *Canis,* in the greater length of the anterointernal border, absence of paraconule and the more external position of the paracone. In the dentition of these genera the line of the external cusps of the upper molars makes more of an angle with the line of the sectorial blade, the molars being more asymmetric from the more external position of the anterior outer cusp (paracone). This in the Canidæ is a primitive feature retained to a varying extent from the ancestral Miacidæ. In the more predaceous Mustelidæ the angle becomes progressively emphasized with the progressive conversion of the tubercular dentition into a transverse blade. Corresponding divergence in adaptation may be seen in the Æluroid group between the Viverrine and Feline extremes, also traceable back (structurally) to the Miacid type of dentition.

*Measurements of T. hippopahgus.*

| Type, No. 13836. | | | mm. |
|---|---|---|---|
| Lower jaw, canine to condyle inclusive | | | 118. |
| Lower dentition c–$m_3$ | | | 79. |
| " premolars, $p_{1-4}$ | | | 33. |
| " true molars, $m_{1-3}$ | | | 35.8 |
| $P_2$, anteroposterior | 8.5; | transverse | 5. |
| $P_3$ " | 9.4 | " | 6. |
| $P_4$ " | 12. | " | 6.8 |
| $M_1$ " | 19.7 | " | 9. |
| $M_2$ " | 10.3 | " | 7.2 |
| Depth of jaw beneath $m_2$ | | | 25.2 |
| " " " " $p_2$ | | | 21.3 |
| Height from angle to tip of coronoid process | | | 56. |
| No. 13834 | | | |
| Upper molars $m^{1-2}$, anteroposterior | | | 21. |
| $M^1$, anteroposterior, along line of outer cusps | | | 14.2 |
| " transverse, across metacone | | | 15.8 |
| " oblique across paracone | | | 18. |
| $M_2$ " " " | 12.; | anteroposterior | 8. |

We are disposed to regard *Tephrocyon* as approximately ancestral to *Canis* on the one hand and *Ælurodon* on the other, and to refer to it a number of the later Tertiary dogs which have been heretofore placed in the modern genus *Canis*. They retain a number of primitive features, most of which are also retained by *Ælurodon*, but they differ from that genus in the absence or rudimentary development of the anteroexternal cusp or parastyle (protostyle of Scott's nomenclature) of the upper carnassial, in the less reduction of the premolars and in other more generalized features. The skull is known only in the type species, which, as Merriam observes, may be approximately ancestral to *Ælurodon*. The species from the Upper Miocene and Pliocene are somewhat nearer to *Canis*, but the direct ancestors of the modern species of wolves, jackals and true foxes will more probably be found in the Pliocene and Pleistocene of Northern Asia and Arctic America. Some of the smaller species of *Tephrocyon* from the later Tertiary of North America may however be direct ancestors of the modern dog-foxes of South and Central America.

### ? **Tephrocyon** sp.

A species closely resembling *T. hippophagus* but one half larger lineally

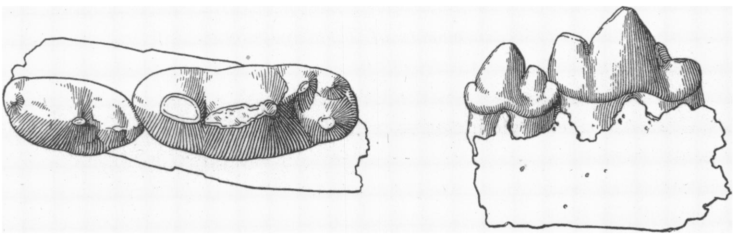

**Fig. 5.** *Tephrocyon* sp. indesc. Part of lower jaw, No. 13843, external view × $\frac{2}{3}$, and crown view of teeth natural size.

is indicated by a jaw fragment with $p_4$–$m_1$ and two isolated lower carnassials. It is intermediate in size between *Ælurodon haydeni* and *Æ. sævus*.

### ? **Tephrocyon** cf. **temerarius** *Leidy*.

No. 13859, a lower jaw with badly damaged teeth, agrees in size with Leidy's species. The jaw is shallower, the heel of the carnassial appears to have about the same construction and proportions; the remaining teeth are broken off in our specimen and absent in Leidy's type.

### ? **Tephrocyon** cf. **vafer** *Leidy*.

Another fragment of lower jaw, No. 13858, may be compared with this species although somewhat larger than the type, and with more elongate and slender premolar region of the jaw. The second molar is preserved entire with the roots of $p_4$–$m_1$. In the long slender premolar region it agrees better with specimens from Fort Niobrara referred by Cope to *Canis vafer*.

The slender jaw, rather large heel to the carnassial, compressed premolars etc., in this and the preceding species suggest relationship to the South and Central American "dog-foxes", in which the construction of the teeth approaches more nearly to that of *Tephrocyon* than it does in any of the northern Canidæ.

### ? **Cyon** sp.

We provisionally refer to this genus an isolated lower carnassial with trenchant heel and vestigial metaconid. It agrees in size with *Lycaon* but in that genus the metaconid is better developed. A jaw fragment which may be provisionally correlated with the carnassial shows a rather long narrow $m_2$ and no third molar, but the crowns of the teeth are broken off and the association is hence uncertain. $M_3$ is retained in *Lycaon*, absent in *Cyon*.

In 1899 Wortman and Matthew painted out the relationship between *Temnocyon* of the upper Oligocene (and Lower Miocene) and the modern group of dogs represented by *Cyon*, with which should be associated *Lycaon* and *Icticyon*. This group differs from the typical dogs in the trenchant heeled carnassial and low trenchant tubercular teeth, and corresponding differences in the upper molars. The tubercular teeth are more or less reduced, the metaconid of $m_1$ small to absent, the premolars large, compressed with strong accessory cusps, skull rather short faced, and muzzle heavy.

Various remains of intermediate forms in the later Tertiary of North America have been found, all very fragmentary, but sufficient to give evidence of the validity of this relationship. Its especial interest lies in the fact that the three modern genera occupy marginal areas in the distribution of the Canidæ in South America, South Africa and India and their structural relationship is only explainable by a dispersal from a northern centre, preceding the dispersal of the typical modern Canidæ.

## PROCYONIDÆ.

### **Bassariscus antiquus** sp. nov.

An incomplete lower jaw, No. 13860, is not generically separable from *Bassariscus*. The specimen retains the molar teeth perfectly preserved, and the roots of $p_4$. It is about the size of *B. astuta*; $m_1$ has about the same proportions, but a higher paraconid; $m_2$ is one-fifth larger, the paraconid much better developed, the heel somewhat larger in proportion.

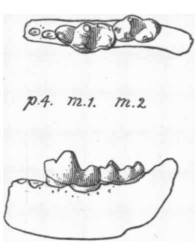


Fig. 6. *Bassariscus antiquus*. Part of lower jaw, type specimen, external and crown views, natural size.

*Comparative Measurement.*

| | *B. antiquus* | *B. astuta* |
|---|---|---|
| Length $p_4$–$m_2$ | 17.4 | 17.2 |
| $M_1$ anteroposterior | 7.9 | 7.9 |
| " transverse | 3.8 | 3.9 |
| $M_2$ anteroposterior | 5.9 | 5.0 |
| " transverse | 3.5 | 3.2 |
| Depth of jaw beneath $m_1$ | 7. | 7. |

The discovery of this species adds one more to the number of Central or

South American types in the late Tertiary faunæ of our Western States. The genus has not hitherto been found fossil.

### Mustelidæ.

Three lower jaws are referable to this family but are hardly determinable as to genus. The two larger, Nos. 13861 and 13863 are apparently allied to *Potamotherium lacota* Matthew, although the second is considerably smaller. The generic reference of *P. lacota* is, however, wholly provisional, as the upper teeth and skull are unknown. The third jaw, No. 13862, is of much smaller size, probably mustelid, but has lost all the teeth. It differs from *Potamotherium* in the two-rooted $m_2$.

An upper carnassial, No. 13865, is possibly referable to "*Ælurodon*" *hyænoides*, which may prove to be a Mustelid, in spite of its large $m^2$ and the presence of a parastyle on $p^4$.

### Felidæ.

Part of an upper carnassial, part of a large laniary canine, and a claw, are the only indications of Machærodonts. A complete humerus compares

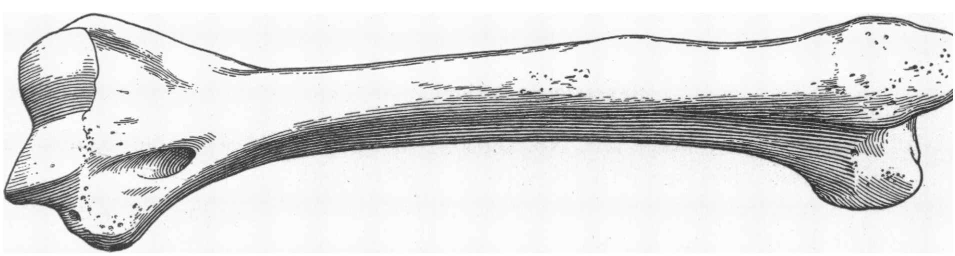

Fig. 7. *Felis* cf. *maximus*. Right humerus, anterior view, one third natural size.

much more closely with the true cats, and indicates a species one eighth larger than *F. leo*. Several astragali are referable to this family, and other skeleton bones, all indeterminate generically.

| *Humerus.* | No. 13852 | *F. leo* |
|---|---|---|
| Length | 379. | 339. |
| Width of head anteropost | 108. | 94. |
| Width of distal end, transverse | 96. | 83.5 |

## MYLAGAULIDÆ.

Three lower jaws and a separate premolar represent this family. These differ widely in size of premolar, pattern of its grinding surface and reduction of the posterior teeth. Nor do they agree closely in these respects with any of the described species. It is evident however from what we know of the Mylagaulidæ that there was either a very wide individual or age variation or an extraordinary number of species in proportion to the specimens known. The difference in wear of the four specimens under consideration is such that they might be regarded as representing four successive stages in the wear of the teeth of a single species, and referred to *Mylagaulus monodon* Cope. This view cannot be proven, except by sectioning the teeth and comparing their wear at different points, but is provisionally accepted in preference to making four distinct new species in addition to those already on record, which are almost as numerous as the specimens known.

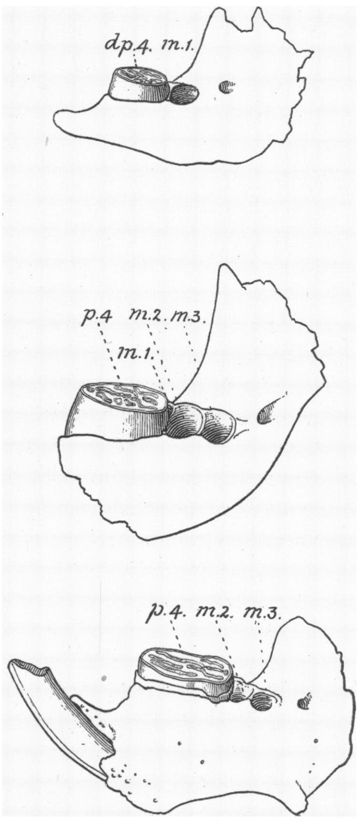


Fig. 8. *Mylagaulus* cf. *monodon* Cope. Lower jaws, natural size, internal views, illustrating three supposed stages in ontogeny of the teeth. Nos. 13867, 13868, 13866.

### **Mylagaulus monodon** (*Cope*).

The type of this species is a lower jaw from the Republican River beds. Its generic relations to *M. sesquipedalis*, the type of the genus, are at present uncertain, and it may prove advisable to transfer it to *Epigaulus* Gidley.

Of the specimens referred here, the smallest, No. 13867, is considered as representing the milk dentition. The $dp_4$ is similar in form to its permanent successor but only three fifths as large, and with a simpler pattern, three as against four rows of enamel lakes in $p^4$ at a similar stage of wear. Behind the $dp_4$ is a single rather shallow alveolus for a small round $m_1$.

The second specimen, No. 13868, shows the permanent dentition at a similar stage of wear. The large $p^4$ has an oval wearing surface, which in the course of further wear will become considerably elongated, and finally much narrowed transversely. The pattern consists of four rather irregular enamel rows, somewhat oblique to the long axis of the tooth. Behind the premolar are two rather deep rounded alveoli for $m_2$ and $m_3$.

The type of the species shows a slightly more advanced wear of $p_4$, the rows of enamel lakes becoming more regular and less oblique and their number in course of being reduced from four to three.

In No. 13866 the wear of the teeth is considerably further advanced, the enamel lakes are more longitudinal and continuous, reduced to three rows, and the elongation of the tooth has encroached upon the alveolus of $m_2$ to a marked extent, both alveoli being quite shallow at this stage.

The remaining specimen, No. 13869, is a separate $p_4$, at nearly the same stage of wear as $p_4$ of the type of *M. monodon*, but is more elongate and narrow.

If the foregoing interpretation be correct, $m_1$ appears with the milk dentition, and is lost before the permanent dentition replaces it. This would accord with the conditions shown in the specimens of young Mylagaulid jaws figured by Douglass, although not with his interpretation of the specimens. It is very probable if this theory be correct, that *M. paniensis* Matthew represents the milk dentition of one of the larger species. The same may be true of *Mesogaulus ballensis* Riggs. The relations of the horned and hornless genera are not yet clear.

## CASTORIDÆ.

This family is represented by two Upper Miocene genera *Eucastor* (= *Dipoides*) and *Hystricops*, both being specialized descendants of *Steneofiber* of the Oligocene and Lower Miocene. *Dipoides* is distinguished by more hypsodont teeth of simpler pattern than in *Steneofiber* or *Castor*, *Hystricops* by the same characters in addition to larger size, greater relative enlargement and peculiarly inflated form of $p\frac{4}{4}$. Matthew in 1902 pointed out that *Hystricops* was more probably Castorid than Hystricid; if our reference of No. 13870, an upper jaw with $p^4$–$m^1$, to Leidy's species be correct, it is unquestionably quite nearly related in dentition to *Steneofiber* and *Dipoides*. These genera may represent the American derivatives of *Steneofiber*, but do not lead up into *Castor*,[1] which is more probably derived

[1] *Dipoides*, on the contrary, shows a marked approach, both in tooth pattern and in the characters of the infraorbital region, to the Pleistocene genus *Castoroides*.

from the Palæarctic Steneofibers through *Chalicomys* or unknown related forms of the Old World. *Dipoides* however, occurs in the Pliocene of China, and intermediates between it and *Steneofiber* are not known from our Miocene, so that it is perhaps also Palæarctic in origin. Intermediates between *Hystricops* and *Steneofiber* do occur in the Middle Miocene of Colorado, so that on present evidence this phylum appears to be of American origin; but they are very imperfectly known and this conclusion is provisional until the discovery of better specimens.

### **Dipoides tortus** *Leidy.*

No. 13872, upper jaw with $p^4$–$m^2$, and 13873, five isolated molars and a humerus, may be referred to this species, but do not add to our knowledge of its characters.

### **Dipoides curtus** sp. nov.

No. 13871, a lower jaw with incisor and $p_4$–$m_2$ perfect, represents a decidedly smaller species with relatively shorter diastema. The molars are less hypsodont and retain more of the *Steneofiber* pattern than in *D. tortus*, but otherwise it agrees with *Dipoides*.

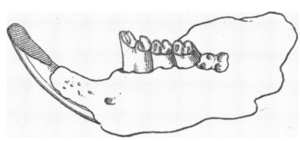

Fig. 9. *Dipoides curtus*, lower jaw, type, internal view, natural size.

*Measurements.*

| | mm. |
|---|---|
| Length of lower dentition $I_1$–$m_3$ | 28.7 |
| " diastema behind incisor | 7.2 |
| Diameters of $I_1$, anteroposterior 3.8; transverse | 3.2 |
| Diameters of $P_4$, anteroposterior 4.6; transverse | 3.8 |
| " $M_1$ " 2.8; " | 3.1 |
| " $m_2$ " 2.8; " | 3.2 |
| Depth of jaw beneath $m_2$ | |

### **Hystricops venustus** *Leidy.*

The type of this species consisted of an associated lower premolar and molar. No. 13870, upper jaw with $p^4$–$m^1$ is referred on the ground of its correspondence in size, pattern, and the peculiar enlargement and inflated form of $p\frac{4}{4}$ in contrast with the more primitive type shown in *Steneofiber*. The size compares with the beaver and porcupine, but the tooth pattern departs widely from either. $P^{\underline{4}}$ is a large robust tooth, rudely quadrant-shaped in cross-section, the anterior and internal surface strongly convex, vertically as well as horizontally, the posterior and external surfaces flattened. The pattern of the grinding surface is like that of *Steneofiber* save that there are three small oval enamel lakes instead of one at the postero-external corner; antero-internal to these lies a deep enamel inflection from the external side, and antero-internal to this a deep inflection from the internal side; both inflections are converted into long narrow lakes in the course of wear.

The pattern of $m^1$ is the same except that there are only two small postero-external enamel lakes.

The teeth are rooted, although long-crowned, and the convexity and much greater length of the internal side of the crown indicates that it is pushed up from this side as it wears, and that the inner side therefore wears much more rapidly than the outer. The lower teeth are convex on the outer side and their wear comes principally on that side. The premolar is much longer crowned, and is also convex anteriorly, with corresponding results in the wear of its grinding surface. These conditions are seen in *Steneofiber* in a much more rudimentary stage; they are somewhat more advanced in *Dipoides*, and in *Hystricops* the specialization is carried still further.

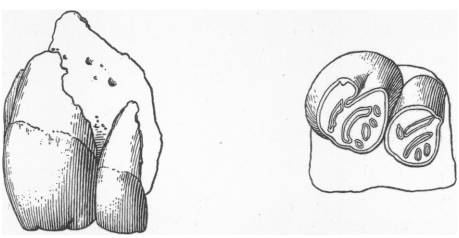

Fig. 10. *Hystricops* cf. *venustus*, upper teeth, natural size, internal and crown views, No. 13870.

The upper jaw shows a little of the root of the zygoma, which agrees in form and position with that of *Steneofiber*, and is unlike that of the Hystricomorpha. While there is not enough preserved to be of much weight as evidence of relationship, it accords with the tooth-pattern in referring the genus to the Castoridæ.

*Measurements.*

| | | | | mm. |
|---|---|---|---|---|
| Diameters of $P^4$ at grinding surface, anteropost. | 9.5 | ; transv. | . . . . | 8.8 |
| " base of crown " | 12. | ; " | . . . . | 14. |
| Diameters of $M^1$ at grinding surface " | 7. | ; " | . . . . | 8.7 |
| " base of crown " | 6. | ; " | . . . . | 11. |
| Height of crown of $P^4$ internal 8.; external | | | . . . . . . . | 14. |
| " $M^1$ " 4.; " | | | . . . . . . . | 8. |

## **Geomys** cf. **bisulcatus** *Marsh.*

A lower jaw without molar teeth but otherwise nearly perfect is undoubtedly referable to *Geomys* and provisionally referred to Marsh's species, from the "Lower Pliocene" of Nebraska.

It is worthy of note that most if not all of our known Miocene and Pliocene rodents are fossorial. The skeleton of *Eucastor* is not known, but *Steneofiber, Entoptychus,* the Mylagaulidæ, *Thomomys, Geomys,* are all fossorial rodents, and *Hystricops,* as a descendant of *Steneofiber,* is presumably the same. It is of course to be expected that fossorial types would be relatively abundant in any fossil fauna, the conditions for their preservation being relatively favorable, but the entire absence of non-fossorial rodents, with the exception of the cursorial *Lepus,* is in contrast with the Eocene faunæ, where fossorial forms are few and arboreal forms abundant, and less sharply so with Oligocene faunæ where arboreal and terrestrial rodents are still numerous and the fossorial genera are not so highly specialized. The explanation is probably to be found in the climatic conditions. In a forested country with moist climate, the arboreal adaptations predominate, the terrestrial types are not specialized for running, and fossorial types are scarce. With progressively arid climate the forests are replaced by open plains, arboreal types disappear, most of the terrestrial types become specialized for swift running in open country and fossorial types become abundant.

## EDENTATA.

A single imperfect claw, No. 14051, is all the evidence we have of the presence of this order in the Snake Creek fauna. It is definitely recognizable as of Gravigrade relationships, and compares with some of the smaller Megalonychidæ. In size it is intermediate between the Pampean and Santa Cruz genera. True Gravigrada have been supposed to make their first appearance in North America in the Middle Pliocene Blanco formation. But the discovery by Mr. Sinclair of an undoubted Gravigrade claw in the Mascall formation, Middle Miocene, shows that they were present in this continent at an earlier epoch. Except for this fact we would regard the presence of a gravigrade edentate as strong evidence for the Pliocene age of the Snake Creek beds.

## PROBOSCIDEA.

Fragmentary Proboscidean remains are not rare in the Snake Creek, but we did not succeed in obtaining anv very distinctive specimens. Part of a lower jaw, several incomplete teeth, two carpal bones, an astragalus, a patella, a cervical and a dorsal vertebra, indicate one or more large species of the Mastodon group, apparently rather advanced in dentition as compared with most of the Miocene Mastodons which have been variously called *Gomphotherium, Trilophodon, Tetrabelodon, Tetralophodon* and *Dibelodon* (the first three names are based upon the same species and are undoubtedly synonymous, *Gomphotherium* having priority; the relations of the other two are not clear).

## RHINOCEROTIDÆ.

Various jaws, teeth, foot-bones, and other parts of the skeleton, indicate the presence of several genera of Rhinoceroses but most of the material is more or less indeterminate.

### Teleoceras.

A complete ramus mandibuli, a nasal horn-core, and numerous characteristic foot-bones etc., are referable to this genus. The lower jaw appears to be specifically distinct from *T. fossiger*; the premolars are less reduced and the tusk exceptionally small. Some of the metapodials are even broader and shorter than in *T. fossiger*. Detailed comparisons with the Florida *Teleoceras* appear to be unprofitable.

### Aphelops.

Various teeth and foot-bones are referable to the long-limbed rhinoceroses of the type of *A. malacorhinus* and *ceratorhinus*, in which the molars are more brachyodont, and premolars less reduced than in *Teleoceras*. This form also occurs in the Florida Pliocene, as well as in the Upper Miocene formations.

### ? Cænopus.

Teeth and foot-bones indicate also a much smaller and more primitive rhinoceros, which in the proportions and construction of the feet is widely different from *Aphelops* or *Teleoceras* and agrees with the rhinoceroses of the Lower Miocene, so far as comparison can be made.

## EQUIDÆ.

Remains of horses are very abundant and varied, but almost all fragmentary and waterworn. The best specimens obtained were two complete lower jaws. There are some hundreds of incomplete jaws, and about ten thousand separate teeth, besides great numbers of limb and foot-bones, but none of them associated.

All but one of the genera of Miocene horses are here represented, viz: *Parahippus, Hypohippus, Merychippus, Protohippus, Neohipparion* and *Pliohippus*. The two first are comparatively rare; the four last (Protohippinæ) show a wider range of specific variation than in the Miocene. The abundant material for comparison indicates a very close relationship between the Protohippine genera, and it appears doubtful to us whether they should not all be regarded as at most subgenera of *Hipparion*. The distinction made by Gidley between *Merychippus* and the following genera lay in the short-crowned uncemented milk molars of this genus. A large series of young jaws of species very closely related to *M. insignis* throws some doubt upon the complete validity of this character, at least in the type species. The milk teeth, when preformed and first protruded above the bone, are cementless, but cement is deposited after their protrusion from the bone, so that by the time they come fully into wear they are quite heavily cemented. This appears to be also true, to a varying extent, of the milk teeth of the other genera. We do not exclude by this statement some differences in degree of cementation; but on present evidence they are not very great.

It is true that the Middle Miocene species referred by Mr. Gidley to *Merychippus* are more or less clearly distinguishable from most of those of the Upper Miocene by the comparatively short crowns of the permanent teeth, and absence of the higher specializations of one kind or another shown in those of the Upper Miocene and Pliocene; but we doubt whether the name *Merychippus* is properly applicable to them, as present evidence indicates that *M. insignis*, the type of the genus, known only from unworn milk teeth from an Upper Miocene or Pliocene horizon, is probably a more specialized form. It may prove advisable to revive Cope's name *Stylonus*, the only generic name applied to a Middle Miocene species, to cover this more primitive group of Protohippinæ, from the Middle Miocene beds. It is also to be observed that an adequate knowledge of the skulls and skeletons of the Lower Pliocene horses, would very probably show adequate generic distinctions among them. Our observations, confined mainly to the dentition, do not give clear and definite distinctions which we can regard as of full generic value. In view of these facts we do not think it advisable to attempt revision of the group until more complete material is at hand. Nor does it seem wise to attempt to define and name the various undescribed species indicated among our specimens of fossil horses.

### **Parahippus** cf. **cognatus** *Leidy.*

This genus is rather rare in the Snake Creek fauna. It is readily distinguishable from the Protohippinæ by the brachyodont uncemented permanent dentition, from *Anchitherium* and *Hypohippus* by the crotchet of the upper cheek teeth and separation of metacone and metastyle in the lower series. Both milk and permanent teeth have a superficial resemblance to the unworn milk teeth of *Merychippus* and its allies. But a more careful examination shows the *Parahippus* pattern to be decidedly nearer to the lophodont type of the Anchitheriinæ while the pattern in the temporary dentition of *Merychippus* is more advanced toward the fully crescentic type of the Protohippinæ.

There does not appear to be more than one well defined species in the Snake Creek collection; it is close to or identical with *P. cognatus* Leidy.

### **Hypohippus** sp.

*Hypohippus* is the least common of the fossil horses in our material. It is represented by an associated $p^{2-3}$ a jaw fragment with two molars and several isolated teeth, and foot-bones. There is no evidence of more than one species, which agrees well enough in size with *H. affinis* Leidy. The metapodials are readily distinguishable by their more massive proportions, and certain differences in the proximal facets. The distal keels differ from those of *H. osborni* in the extension of the median keel on the dorsal side of the facet, a progressive character more marked in this species than most of the Protohippinæ, and fully as much as in *Equus*.

### **Merychippus.**

To this genus we refer over half of the specimens in the collection. Typically they present in the permanent dentition rather short crowns, the protocone round-oval in section, partially separate from the anterior inner crescent, but not usually to the base, and to a varying extent in different teeth of the same individual, even if we make allowance for difference of wear. The borders of the lakes are moderately complicated. A large series of parts of jaws represents various stages of the milk and permanent dentition apparently of one species. The unworn milk teeth (Fig. 11) agree fairly well with the type of *M. insignis*; at a later stage of wear they are comparable with *M. mirabilis* (= *Protohippus mirabilis* auct. Gidley). A third stage (Fig. 11) shows the permanent premolars preformed beneath the milk molars, and other specimens (Fig. 11) show the permanent dentition in various stages of wear.

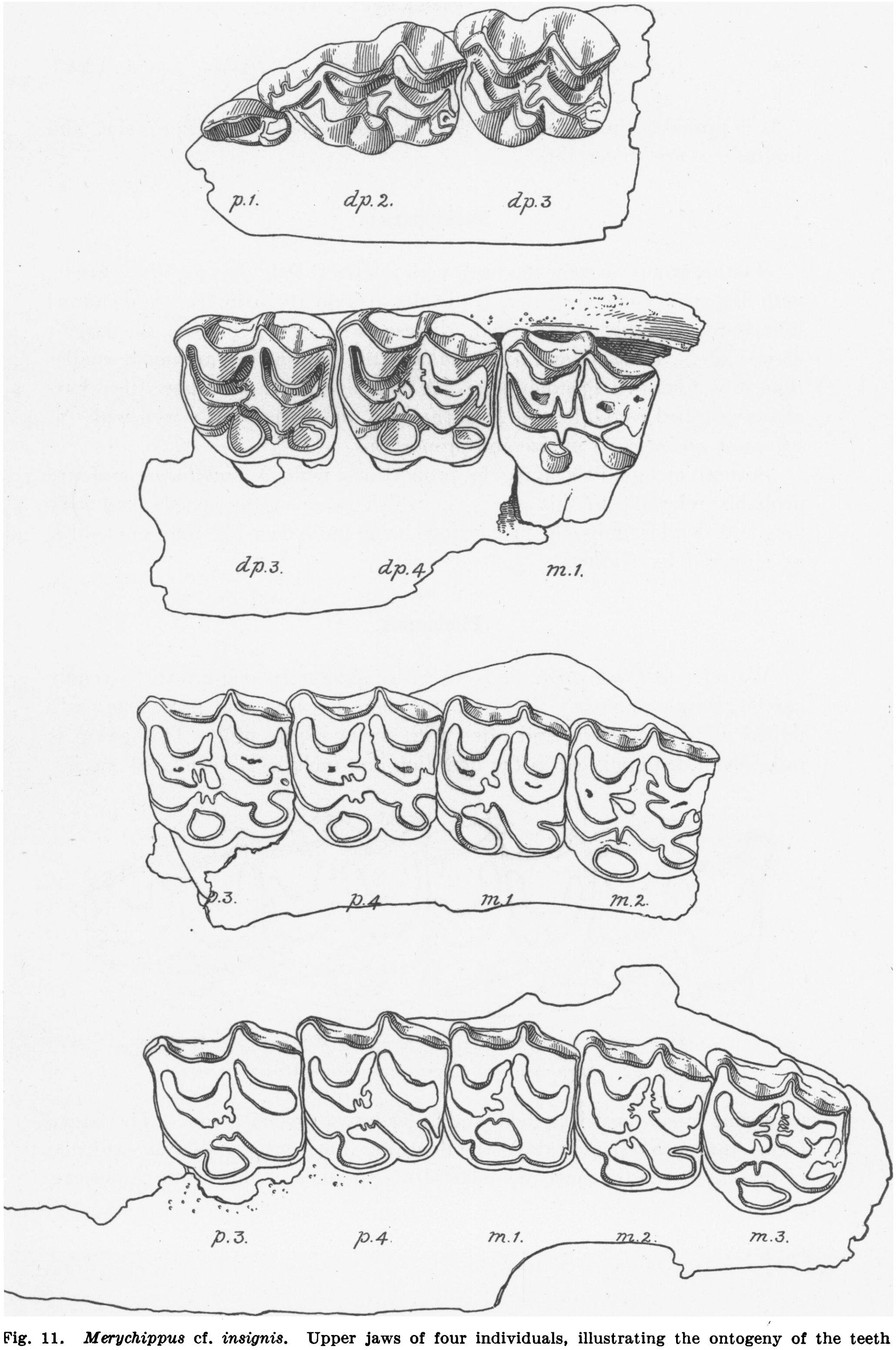


Fig. 11. *Merychippus* cf. *insignis*. Upper jaws of four individuals, illustrating the ontogeny of the teeth 14010, 14014, 14003, 14001; all natural size.

It is probable that several species are represented but their number and limitations are uncertain.

### Neohipparion.

To this group we refer the teeth with relatively long crowns, little curved, with flattened protocone generally distinct to or nearly to the base, and enamel lake borders highly complicated. These vary greatly in size, the largest exceeding *N. whitneyi* and *occidentalis,* while the smallest are much smaller than any described Protohippinæ. A complete lower jaw shows the characters ascribed by Gidley to *Neohipparion* and agrees fairly well with *N. affinis* or *niobrarensis* in size and proportions.

Several metapodials agree in proportions with *N. whitneyi,* and are probably referable to this genus, in which some of the species had very long and slender limbs, the proportions being more deer-like than horse-like, as observed by Gidley.

### Pliohippus.

We refer to *Pliohippus* the teeth with moderately long crowns, strongly curved, simple or nearly simple enamel lake borders, and protocone early united with protoselene and often with metacone as well. This group is rather well distinguished in the dentition and includes a very large species,

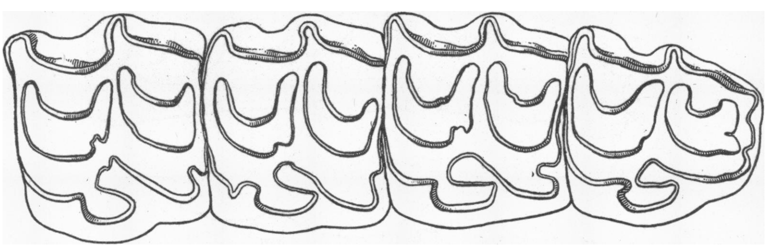


Fig. 12. *Pliohippus* sp. Upper teeth, natural size, No. 14004.

exceeding in size any described, and at least two smaller forms. The larger forms approach *Hippidium* in the dentition, but we have seen no evidence of the characteristic short monodactyl metapodials of this South American genus.

### Protohippus.

Comparatively few of the teeth and jaw fragments agree very nearly with the typical *Protohippus* or with the smaller form represented by *P. placidus*. There are, however, a great many that might be included within the genus or subgenus more readily than with the three preceding.

### Hipparion.

A considerable number of the teeth, etc., approach the American species which Gidley has referred to *Hipparion*, but do not seem to come especially near to the typical European species. In the absence of more satisfactory distinctions we do not feel warranted in predicating the presence of the true *Hipparion* in this fauna, unless we broaden the limits of the genus so as to include *Merychippus, Protohippus, Pliohippus* and *Neohipparion* as subgenera. As already intimated this inclusion does not appear to be justified without much more extended study than we have been able to give to the problem, especially in view of the careful and thorough consideration that Mr. Gidley has given to the relationships of these genera.

## Foot-bones of Equidæ.

A large series of metacarpal and metatarsal bones show wide variations in size and proportions but for the most part have the relatively slender proportions of the known Protohippinæ. They separate into nine or ten quite well defined types of metacarpals and as many of metatarsals, indicating the presence of at least that number of species. But with the exception of *Hypohippus* and *Neohipparion,* it is impossible to positively correlate them at present with the teeth and jaws, and the provisional correlations that might be made would appear rather unprofitable labor. We have made no attempt at correlating the hundreds of astragali and other tarsal and carpal bones, phalanges, limb-bones and vertebræ.

## Dicotylidæ.

### Prosthennops cf. crassigenis *Gidley.*

A lower jaw, No. 14052, with $p_3$–$m_3$, indicates a species of *Prosthennops* about the size of *P. crassigenis*. Exact comparison is impossible, as the lower dentition of Mr. Gidley's species is not known, and the upper dentition too much worn for accurate correlation. The species is distinguished from *P. serus* Cope, by smaller size, broader heeled $m_3$, and less molariform

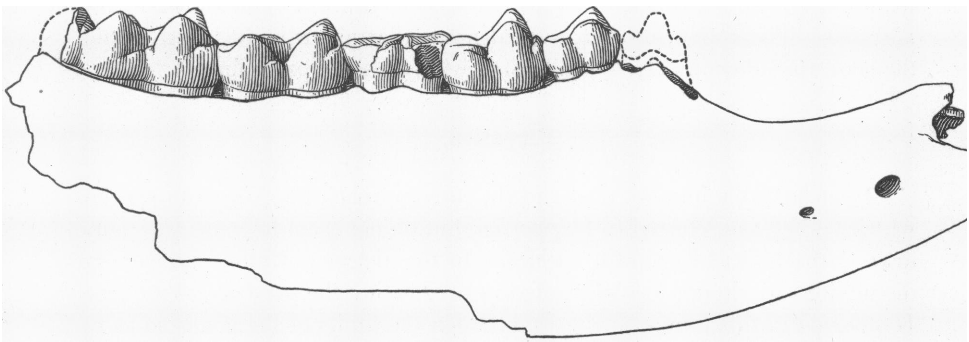

Fig. 13. *Prosthennops* cf. *crassigenis*. Lower jaw, natural size, external view, No. 14052.

premolars. The deuteroconid is distinct on $p_3$, but the heels are lower and less clearly bicuspid, the species thus approaching *Platygonus*.

**Prosthennops** sp. div.

A number of isolated teeth indicate at least two species of this genus, one as large as *P. serus*, the other smaller, agreeing in size with the lower jaw above described. They vary so much that they cannot be satisfactorily correlated.

The anterior molars and premolars of this genus of peccaries show a startling resemblance to the teeth of Anthropoidea, and might well be mistaken for them by anyone not familiar with the dentition of Miocene peccaries. We have not found among the dozen or so of teeth of this description, any which could not be placed in the dentition of *Prosthennops*. It should nevertheless be pointed out that the improbability of finding Anthropoid teeth in a Lower Pliocene formation in this country is substantially decreased by the discovery of true antelopes at this horizon. The Bovidæ have hitherto been supposed to first appear in North America in the Mid-Pleistocene, and man probably about the same time. The antelopes of the Snake Creek beds belong to the Tragocerine group which are found associated with extinct Anthropoidea in the Upper Miocene and Pliocene of Europe. Their occurrence at a corresponding horizon in this country was quite as little to be expected as the occurrence of anthropoidea would be, although of course not of equal scientific interest.

A metatarsal of a Dicotylid, presumably *Prosthennops*, is of some interest, as hitherto nothing whatever has been known of the foot structure in any Tertiary Dicotylidæ. The foot referred by Osborn and Scott to "*Hyotherium americanum*" (= *Perchœrus*) is apparently that of an Oreodont, and no reasons are given for its reference to the Suoidea. The metatarsal from the Snake Creek bed indicates a completely didactyl pes, the lateral digit reduced to a short flat thin splint, but without coössification of the median pair, such as occurs in *Platygonus* and *Mylohyus*. In *Dicotyles* the lateral digits are less reduced.

*Measurements.*

| | | | | mm. |
|---|---|---|---|---|
| No. 14052. | Lower cheek teeth $p_2$–$m_3$ ($m_3$ estimates) | | | 85. |
| | Lower true molars | | " | 53. |
| | $P_3$, anteroposterior | 10; | transverse | 8. |
| | $P_4$ " | 12.5: | " | 11.5 |
| | $M_1$ " | 14. ; | " | 11. |
| | $M_2$ " | 17. ; | " | 14. |
| | $M_3$, transverse diameter | | | 15. |
| No. 14053. | Metatarsal, length 102; diam. distal end | | | 15. |

## OREODONTIDÆ.

Oreodonts are not common in the Snake Creek fauna, but include a variety of species related to *Merychyus*, but all of them more advanced in dentition than the type of that genus, *M. elegans* of the Upper Miocene Nebraska beds. We refer them to *Merychyus*, but as a separate section or subgenus.

### **Merychyus**, sub. gen. **Metoreodon** sub. gen. nov.

Premolars more complicated than in the typical group. Lower canine premolariform, not enlarged.

The complication of the premolars consists in a series of minutiæ, the most obvious of which is perhaps the deep grooving of the outer side of the lower premolars, which is confined to $p_4$ in *Merychyus elegans*, but in *Metoreodon* has extended to $p_3$ and is more faintly indicated upon $p_2$ and even upon $p_1$. With this is associated a greater development of the inner crests of the premolars, the conversion of $p_1$ into a premolariform tooth no larger than the tooth behind it and similar in construction. The upper premolars show a correspondingly greater complication and the heel of $m_3$ is more clearly split into two crescents, with a corresponding development of a bifid heel upon $m_3$.

All these changes are the culmination of a slow evolution in the premolars which is carried further in *Merychyus elegans* and other Upper Miocene species than in any of the Middle or Lower Miocene Oreodonts, and in *Metoreodon* is still further advanced. It appears probable that the changes proceeded independently in more than one subphylum of the family. But we have as yet no knowledge of the skull of any Upper Miocene or Pliocene Oreodont save the aberrant *Pronomotherium,* and cannot satisfactorily unravel the tangle of relationships and nomenclature until these later specializations of the family are more completely known. The reduction of the caniniform premolars appears sporadically as early as the Lower Miocene, in certain *Merychyi* from the upper Rosebud and Upper Harrison formations.

**Merychyus (Metoreodon) relictus** sp. nov.

Type a lower jaw, No. 14056, with almost unworn teeth, the canine, incisors and second molar missing. This species is about the size of *Merychyus elegans.* The alveoli of $i_{1-3}$ and $c_1$ indicate teeth of about the same

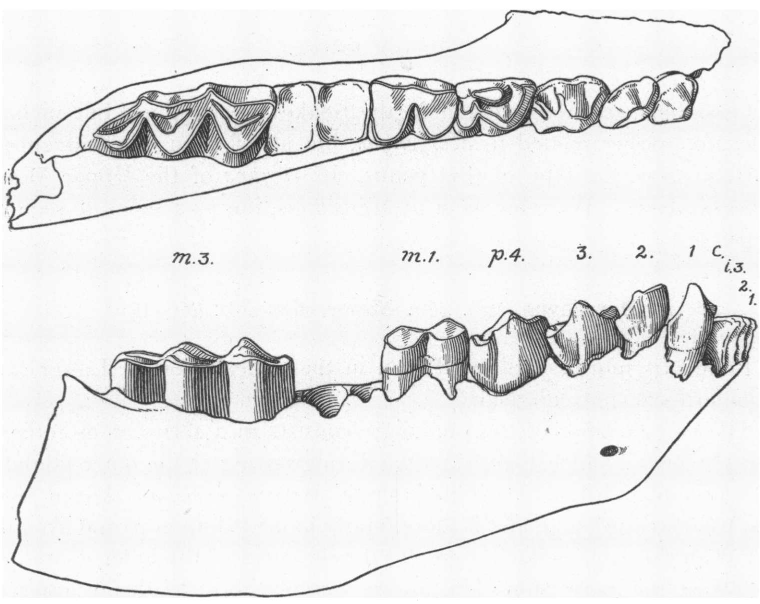


Fig. 14. *Merychyus relictus,* lower jaw, type specimen, external and crown views, natural size.

size. $P_1$ is much smaller and its crown premolariform with compressed pointed crest recurved inward at the anterior end, smaller than $p_2$, set obliquely in the jaw. $P_2$ is much larger than in *M. elegans,* with rudimentary inner crests, outer border as in $p_1$ but less pointed. $P_3$ is very similar to $p_4$ of *M. elegans,* except that the posterior inner crest is replaced by three small transverse crests projecting inward from the outer crest. These are rudimentary in *M. elegans.* The outer face of the outer crest is deeply grooved behind the apex, about as in $p_4$ of *M. elegans.* $P_4$ has the outer groove more accentuated than in *M. elegans,* and the posterointernal crest is more distinct from the outer crest. The molars are about as hypsodont as in *M. elegans*; the heel of $m_3$ is composed of two distinct crescents, which are not united by wear until after the union of the crescents in front of them.

*Measurements of M. relictus, type.*

| | | | mm. |
|---|---|---|---|
| Lower dentition, length | | | 86. |
| " true molars, length | | | 47. |
| $P_1$, (oblique) length | 8. ; | width | 5. |
| $P_2$ " " | 9.2; | " | 5.8 |
| $P_3$ " " | 10.8; | " | 7.5 |
| $P_4$ " " | 12.8; | " | 8. |
| $M_1$ (anteroposterior) length | 11.3; | (transverse) width | 9. |
| $M_3$ " " | 24. ; | " " | 11. |
| Depth of jaw beneath $p_3$ | | | 23. |
| " $m_3$ | | | 28. |

*Measurements of larger forms (infra).*

| | | | | |
|---|---|---|---|---|
| No. 14058; | length of $m_{1-3}$ | | | 55. |
| " | $P_4$, length | 15; | width | 9. |
| " | Depth of jaw beneath $p_3$ (internal side) | | | 30. |
| " | " $m_3$ (external) | | | 33. |
| No. 14065; | length $p^1$–$m^3$ | | | 90. |
| " | " $m_{1-3}$ | | | 49.5 |
| " | diameters of $m^3$, anteroposterior 24; transverse | | | 18. |
| No. 14057; | length of $m_{1-3}$ | 55. ; | of $p_3$–$m_3$ | 82. |
| " | $P_4$, length | 15.4; | width | 10. |
| " | Depth of jaw beneath $p_3$, 34; | | beneath $m_3$ | 39.5 |

## **Merychyus** cf. **relictus.**

A large variety or distinct species is indicated by several lower jaws or parts of jaws, Nos. 14060, 14058 and 14064. Two upper jaws, Nos. 14065, 14067, may be correlated with these. There is no gap between $c^1$ and $p^1$, and the two anterior premolars are relatively larger than in *M. elegans,* but all the premolars are worn or broken. The molars are very similar to those of Leidy's species. This form is a little larger throughout than his type, intermediate in size between *M. elegans* and *M. medius.*

**Merychyus** sp.

A lower jaw, No. 14057, about the size of the preceding but the premolars more compressed and less complicated, $p_1$ enlarged as in *M. elegans*, but heel of $m_3$ more bifid. The jaw is deeper and shorter than in the preceding forms or *M. elegans*.

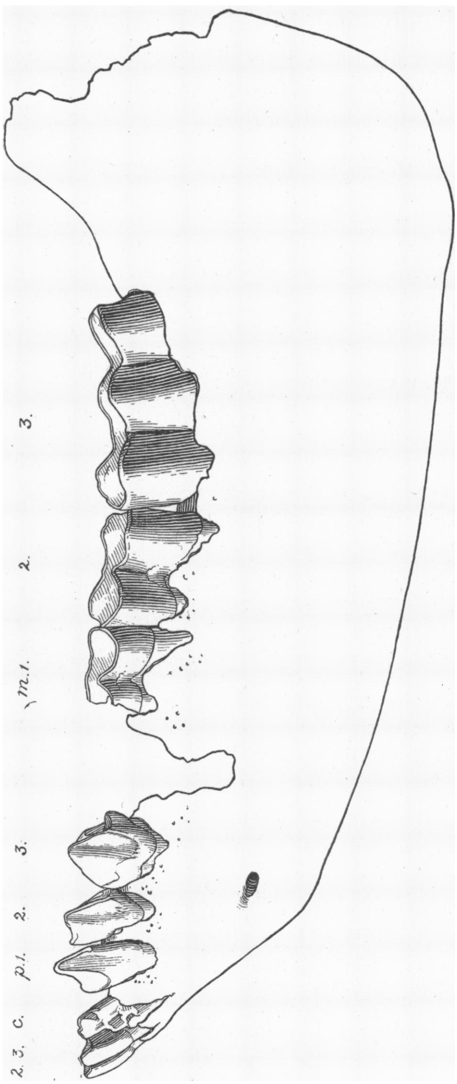


Fig. 15. *Merychyus profectus*, lower jaw, type specimen, external view, two thirds natural size.

**Merychyus (Metoreodon) profectus** sp. nov.

Type No. 14055, left ramus of the lower jaw with dentition complete except $i_1$ and $p_4$. This species is about the size of *M. medius* Leidy, but $m_{1-2}$ are considerably larger and the heel of $m_3$ is not bent outwards as in that species, but aligned with the inner border of the tooth-row. The anterior teeth increase uniformly in size from $i_2$ to $p_3$, and form a progressive series in their structure, which is almost identical with that of *M. relictus*, allowing for some difference in wear. The inner and outer crescents are still partially separate on the heel of $m_3$, united on all the anterior crescent pairs.

Various fragments of jaws and teeth are referable to this species. An upper jaw, No. 14066, which appears to be of appropriate size and a separate $m^3$, No. 14068, show a type of $m^3$ much like that of *Merychyus elegans* but with the bifid posterior outer end much more developed. A tooth of this type was figured by Leidy in 1869[1] and referred doubtfully to *Merycochœrus*, but it is wholly different from the $m^3$ of that genus, and is evidently much nearer to *Merychyus*, and especially to the present species. It was recorded as from the same locality as *Merycochœrus proprius* but may be from a later horizon.

*Measurements of M. profectus, type.*

| | | | mm. |
|---|---|---|---|
| Lower dentition, length, $i_2$–$m_3$ | | | 155. |
| " true molars $m_{\overline{1-3}}$ | | | 82. |
| $P_1$, oblique length | | 12. ; width | 8. |
| $P_2$ " | | 15.5; " | 8.5 |
| $P_3$ " | | 17.4; " | 12. |
| $M_1$ anteroposterior | est | 18. ; transverse | 15. |
| $M_2$ " | | 23. ; " | 17. |
| $M_3$ " | | 41. ; " | 18.5 |
| Depth of jaw beneath $p_3$ | | | 38. |
| $m_3$ | | | 46. |

## Camelidæ.

The Camels of the Snake Creek beds are next in abundance to the horses and much more varied in size. They include three diverse types comparable to *Pliauchenia*, *Alticamelus* and *Procamelus*, as these genera are generally understood, with a variety of apparently intermediate forms. The intergradation may however be due to the lack of associated material. Our material includes a fragmentary but uncrushed skull of *Pliauchenia*, a badly crushed skull and jaws of *Alticamelus*, associated with considerable parts of the skeleton, and a great number and variety of parts of jaws, teeth, and isolated limb and foot bones, vertebræ, etc., representing apparently some eight or ten species of camels.

The Miocene Camelidæ are sadly in need of revision, and the senior author of this paper has undertaken this task. It is not advisable in this paper to discuss the nomenclature or generic references of the species described, nor to give names to the several undescribed forms indicated by fragmentary material.

### **Pliauchenia** *Cope.*

The type of this genus is *P. humphreysiana*, founded upon a fragment of lower jaw from the Miocene of New Mexico, in which $p_2$ is stated by Cope to be absent. There is however a distinct alveolus, in the type specimen, indicating the presence of $p_2$, although the tooth may have been vestigial or

[1] Extinct Mam. Dak. and Neb. Pl. X, fig. 5.

abnormal. There are nevertheless various jaws of medium-sized or small camels from the Upper Miocene in which $p_2$ is normally absent. It is not at all certain that they pertain to one genus, nor that they are congeneric with the type of *Pliauchenia.* But in the absence of additional material from the type locality of *P. humphreysiana* we cannot satisfactorily revise the identifications.

In 1892 Cope referred to the genus a gigantic species from the Blanco Pliocene, *P. spatula,* based upon a complete lower jaw, in which $p_2$ is certainly absent. An incomplete skull in the American Museum collection from the Blanco, agrees fairly well with this species in size and proportions, and indicates the absence of the second premolar in the upper as well as in the lower jaw.

Various remains of large camels in the Snake Creek beds agree generically with *P. spatula.* It is doubtful whether they are congeneric with the little Pliauchenias of the Miocene with $p_2$ present (vestigial) or absent, but at present we have no satisfactory generic distinctions except the wide difference in size, the more advanced reduction of the premolars, and somewhat longer crowned molars. It is convenient to regard these as subgeneric.

### **Megatylopus** subgen. nov.

Gigantic camels with dentition $I\frac{1}{3}$ $C\frac{1}{1}$ $P\frac{3-2}{3-2}$ $M\frac{3}{3}$, the second premolar absent in both jaws, the first retarded or absent, the reduction of the posterior premolars intermediate between *Procamelus* and *Camelus.* Upper molars with prominent external ribs and styles, as in *Auchenia* Limbs and feet moderately elongate and very massive, large in proportion to size of skull. Type *M. gigas* infra.

### **Pliauchenia** (**Megatylopus**) **gigas** sp. nov.

Type a skull, No. 14071, from the Snake Creek beds of Nebraska, found by Albert Thomson. We refer to the species various jaw-fragments, teeth, limb- and foot-bones from the same locality, on account of their appropriate size and their generic agreement with *P.* (*M.*) *spatula* from the Blanco beds of Texas.

The skull lacks the premaxillæ, and the posterior part was weathered into fragments, but it is practically uncrushed, and by diligent piecing, it was possible to restore the entire cranial part from the fragments preserved.

The skull is about the same size as in the Bactrian Camel, although the limb bones indicate a much larger animal. The form differs materially from *Camelus*; the muzzle is very much fuller in advance of the orbits and considerably deeper. The orbits are less prominent, the cranium deeper

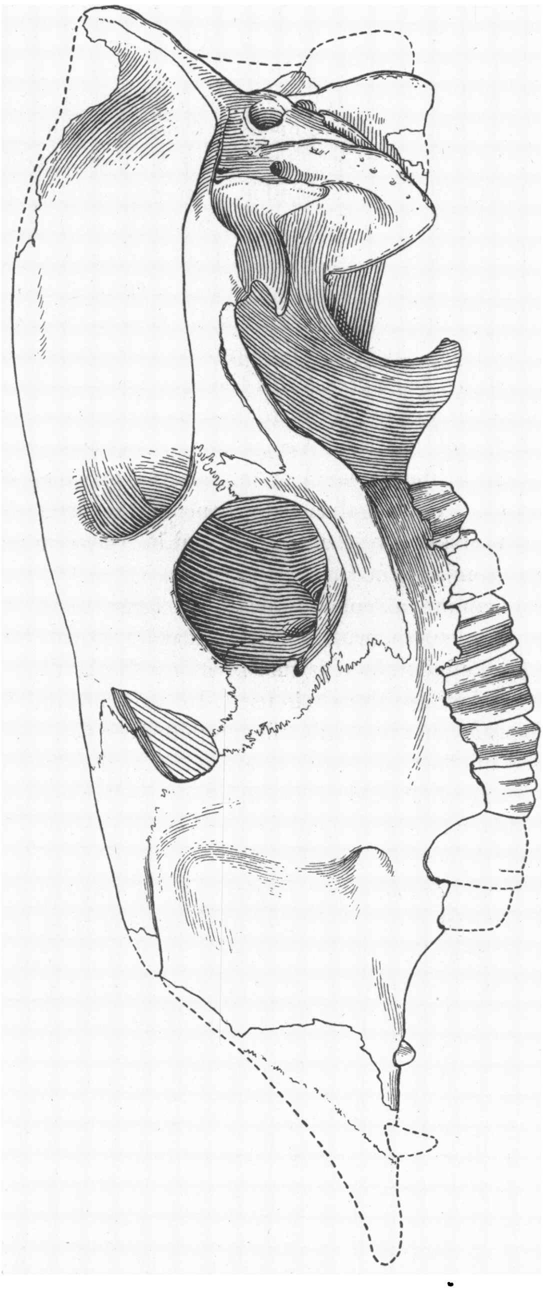

Fig. 16. *Pliauchenia gigas*, skull, type specimen, one third natural size.

and more capacious, the angle between basifacial and basicranial axes is considerable, while in *Camelus* they are nearly parallel. In all these respects the skull shows much closer relationships with the llama, The lachrymal vacuity is very large and sub-round, the orbit is large, rather low down on the side of the face, and situated above $m^2$ as in *Camelus,* while in *Auchenia* as in *Procamelus* it is further back. There is a shallow maxillary fossa situated above the infraorbital foramen and in front of the lachrymal vacuity. The cranial portion of the skull is relatively long in comparison with *Camelus, Auchenia* or even *Procamelus.* The glenoid articulations are set wide apart, the process external to the fossa is absent, and in the entire conformation of this part of the skull *P. gigas* agrees with *Auchenia* and *Procamelus* more nearly than with *Camelus.* The pcstglenoid process is better developed than *Auchenia* and *Procamelus,* but agrees with them in form. The zygomatic process of the squamosal extends forward to a point almost beneath the posterior margin of the orb't, as in *Procamelus* and *Auchenia,* but is much heavier anteriorly than in these genera or in *Camelus,* in which it does not extend so far forward. The jugal is deep beneath the orbit, its inferior margin is a strong compressed crest, entirely absent in *Auchenia* or *Camelus,* incomplete and less prominent in *Procamelus.*

*Dentition.*— The canine alveolus indicates a large tooth. The first premolar is a good sized tooth, with pointed-spatulate crown, but appears to be retarded in development, as it is just breaking through the jaw while the permanent $p^{3-4}$ and $m^3$ are already in use. In *Auchenia* the two caniniform teeth are at this stage in eruption while the milk dentition is still present and $m^3$ is preformed but has not begun to erupt. The diastema behind $p^1$ is rather short, and a much shorter diastema intervenes between $p^1$ and the canine alveolus. This, with the general proportions of the face, indicates a much shorter muzzle than in *P. spatula.*

The cheek teeth are considerably larger than in *Camelus bactrianus.* The premolars are less reduced, their internal crescents more incomplete. The molars are less hypsodont than in *Camelus,* and, as in *Auchenia,* the parastyle, mesostyle and external ribs are very prominent. In *Procamelus* and *Camelus* they are much less prominent. A rudimentary internal pillar between the internal crescents is present, as in *Auchenia,* but there is no trace of the small protostyle of that genus (internal to the protocone).

*Lower dentition.*— Three fragments of lower jaws of appropriate size for this species show the absence of $p_2$, but $p_{3-4}$ less reduced than in the Blanco species.

*Skeleton.*— We are unable to positively associate any skeleton material with this skull, but an ulno-radius of very large size found on the opposite side of the little draw from which the skull was taken, may belong to the

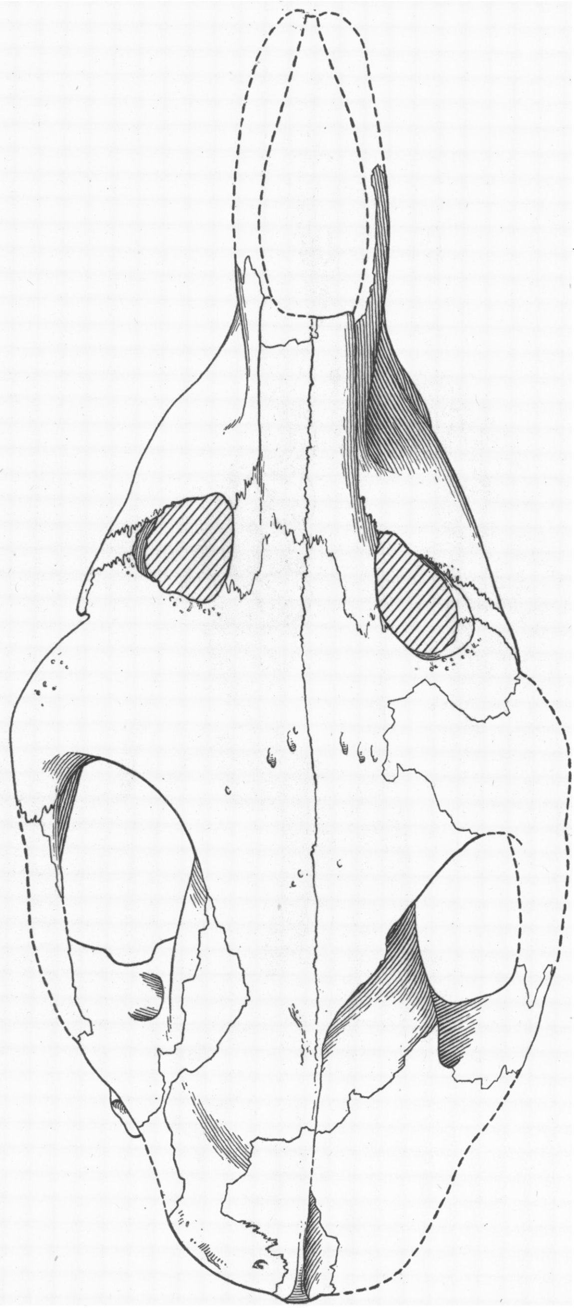

Fig. 17. *Pliauchenia gigas*, type skull, one third natural size.

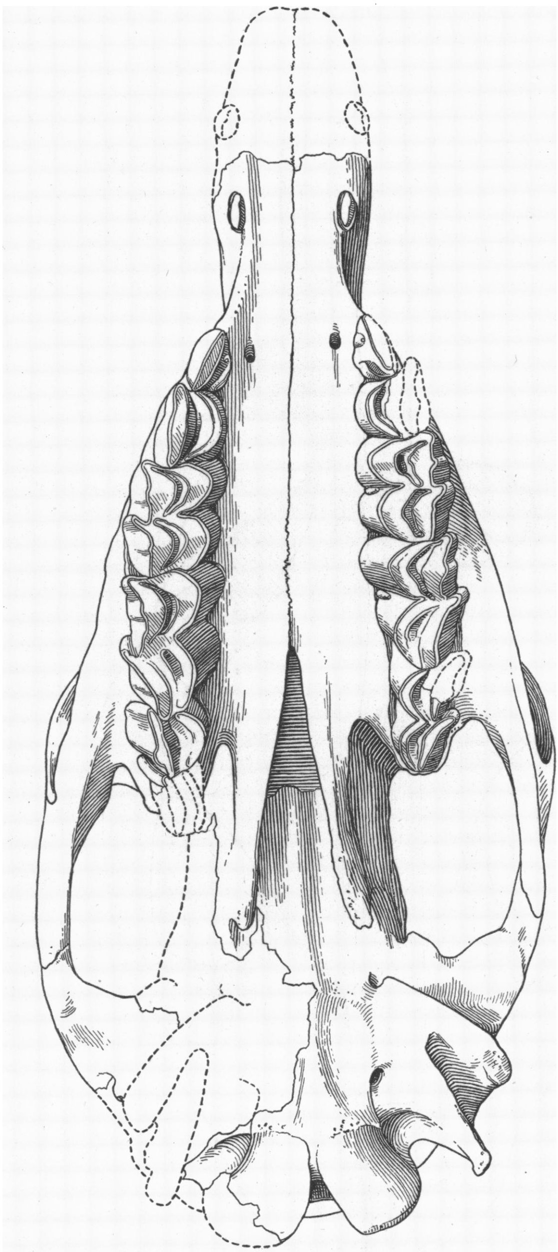

Fig. 18. *Pliauchenia gigas*, type skull, one third natural size.

individual. It is about one-fourth larger than the ulno-radius of the Bactrian camel, straighter and proportionately heavier in the shaft, the articular extremities less expanded, the olecranon projecting less backward and more upward. A second ulno-radius agrees closely with the first, There are numerous astragali, calcanea and other carpal and tarsal bones. incomplete metacarpals and metatarsals, agreeing in proportions with these ulno radii and indicating a camel one-fourth larger lineally than *Camelus bactrianus,* with straighter limb-bones, relatively longer metapodials considerably less expanded at the distal ends, phalanges much less flattened and expanded. The more compressed phalanges are suggestive of *Auchenia,* but the expansion of the distal ends of the metapodials is much less than in that genus.

*Relationships.*— The characters of skull and teeth show much nearer approach to *Auchenia* than to *Camelus* and in various respects stand nearer to *Procamelus* than to either genus. The large size, position of the orbits, short heavy muzzle etc. may be regarded as specializations of an independent sub-phylum, possibly terminating in one of the species of *Camelops* or *Eschatius* — but we have not considered these as generic characters.

*Measurements.*

| | mm. |
|---|---|
| Skull, total length, premaxillæ estimated | 523. |
| width at orbits | 212. |
| depth at molars | 170. |
| width of palate including molars | 135. |
| height of occiput including condyles | 134. |
| width " " at root of paroccipital processes | 116. |
| length of zygoma, post. border of orbit to posterior margin of glenoid articulation | 121. |
| width of orbit | 63. |
| length of postcanine diastema | est21. |
| " diastema behind $c^1$ | 50. |
| Dentition, $p^3$–$m^3$, length | 179. |
| length of true molars | 133. |
| (measurements taken at base of crown) | |
| $P^3$, anteroposterior 23; transverse | 17. |
| $P^4$, " 30; " | 25. |
| $M^1$ " 33; " | 39.4 |
| $M_2$ " est 45; " | 41. |
| Ulnoradius, length including olec anon | 759. |
| " diameter of distal end | 108. |
| " least transverse diameter of shaft | 73. |
| Astragalus, length 112; transverse diameter | 77. |
| Calcaneum " 176; | |
| Metacarpus, transverse diameter, proximal end | 87. |
| Metatarsus, " " | 79. |
| Largest complete phalanx, length 128 mm.; diameter of head 52 mm. | |

## Alticamelus.

The type of this genus is *Procamelus altus* Marsh. An examination of the type specimen of this species shows that it is much less complete than would be inferred from Marsh's description, and consists solely of a calcaneum. The calcaneum is probably distinct specifically from the Colorado specimen referred to it by Matthew in 1898, but is indeterminate generically. The Colorado specimen which consists of part of skull, lower jaws, neck and hind limbs and feet may under these circumstances be regarded as a neotype of the genus although not of its type species. It has been renamed by Matthew (1909) *A. giraffinus.*

### Alticamelus procerus sp. nov.

Type, No. 14070, a crushed skull and jaws with parts of the skeleton associated, found by W. D. Matthew in the Snake Creek beds.

This species is of medium size among the later Tertiary camels, considerably smaller than *A. giraffinus.* The skull is about one fifth longer than that of *Procamelus occidentalis,* the limb bones nearly twice as long.

*Skull* and *jaws.*— The skull is rather long and slender, but owing to the crushing, its proportions cannot be very exactly stated. The lachrymal vacuity is small; the fossa in front of it deep and sharply outlined, in marked contrast to *Procamelus, Pliauchenia, Auchenia* or *Camelus,* but in agreement with the *A. giraffinus* and with *Oxydactylus.* The lower jaw is moderately deep, the angular hook prominent. The skull is about as long as that of *Camelus arabicus* but very much slenderer throughout. The entire length of the dental series is greater than in *C. arabicus* but the individual teeth are much smaller.

*Dentition.*— The teeth are very well preserved, and are but little worn. Incisors 1 and 2 are absent; the next three teeth ($I^3$, $C^1$, $P^1$) are caniniform with moderately long diastemata behind each. The premolars are much less reduced than in *Procamelus,* especially $p\frac{2}{2}$ The inner crescent of $p^2$ is incomplete, that of $p^3$ complete, but low. The molars are less hypsodont than in *Procamelus,* the parastyle, mesostyle and anterior external rib more prominent, although hardly as much so as in *Pliauchenia gigas.* The detailed characters of the premolars and molars show a marked resemblance to those of *Oxydactylus,* except for the considerably longer crowns.

*Limbs.*— The fore limb is represented only by parts of the humerus, ulno-radius, metacarpus and the proximal phalanges. These indicate a long slender limb, but stouter throughout than the hind limb. The tibia and

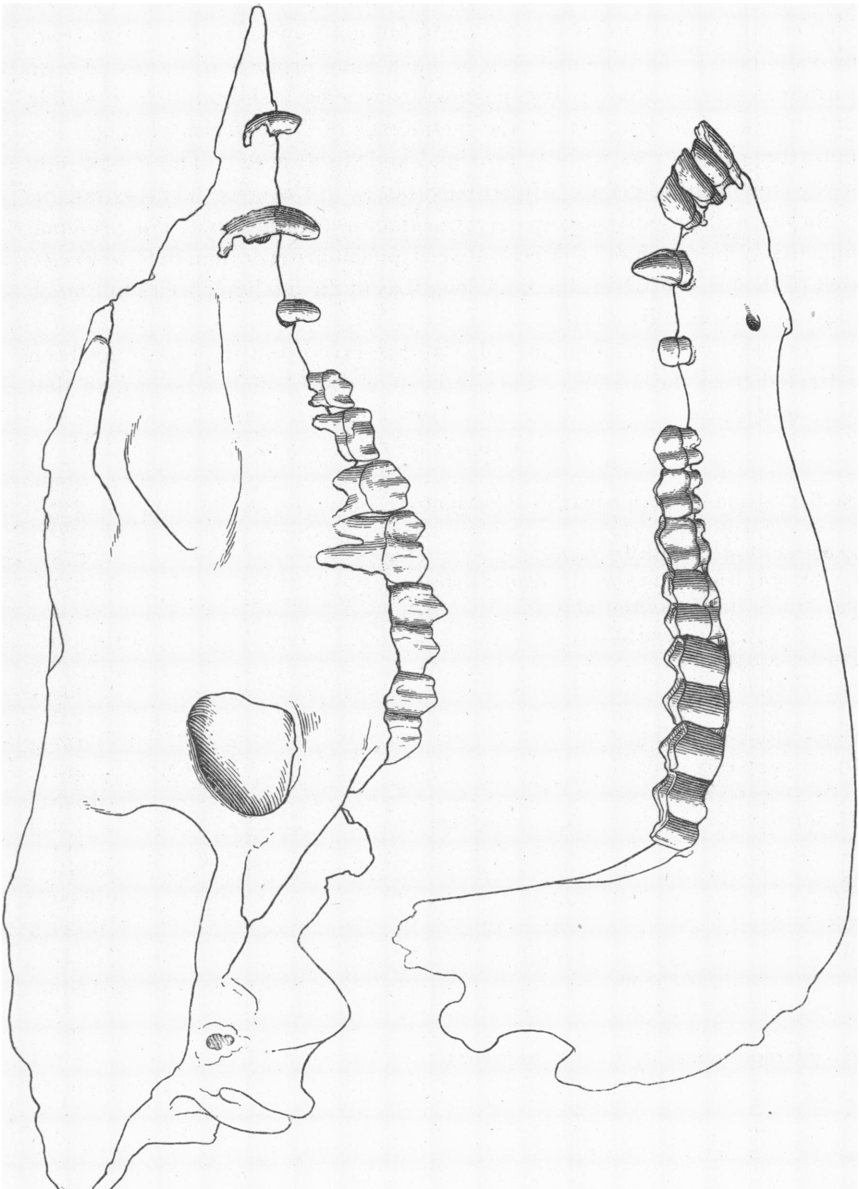

Fig. 19. *Alticamelus procerus*, skull and jaw of type, one third natural size.

metatarsus are preserved entire, with the astragalus, proximal phalanges and parts of the femur. The tibia is about a third longer than that of *Camelus arabicus* about the same size in the shaft, but not nearly as heavy at proximal or distal ends. The cnemial crest is much more prominent, but extends no further down the shaft. The metatarsus is a little shorter than the tibia but nearly a half longer than the metatarsus of *C. arabicus,* although less than three fourths as wide at proximal and distal ends. The cuboid and lesser cuneiform facets are not flattened out as in *Camelus.* The astragalus is shorter and proportionately narrower than in *C. arabicus.* The proximal phalanx of the fore foot is longer but very much narrower than in *C. arabicus*; that of the pes is of about the same length as in the modern species but much narrower, especially distally.

Several dorsal vertebræ and ribs are preserved, but they have not been extracted from the matrix. They indicate a much smaller body than that of *C. arabicus.*

*Measurements of Type*

| | | | mm. |
|---|---|---|---|
| Skull, extreme length, premaxilla to occiput | | | 480. |
| Length of dentition, $i^3$–$m^3$ | | | 260. |
| Length of lower dentition $i^3$–$m^3$ | | | 278. |
| Lower jaw, length, incisors to angular process | | | 377. |
| " depth in front of $p_2$ | | | 34. |
| " " beneath $m_2$ | | | 45. |
| Diastema behind $i^1$ | | | 28. |
| " $c^1$ | | | 25. |
| " $p^1$ | | | 23. |
| Upper cheek teeth $p^2$–$m^3$ | | | 157. |
| Upper premolars $p^2$–$p^4$ | | | 63. |
| " true molars | | | 98. |
| $P^2$, anteropost rior | 18; | transverse | 9.5 |
| $P^3$ " | 20; | " | 12. |
| $P_4$ " | 20; | " | 19. |
| *$M^i$ " | 23; | " | 22. |
| *$M^1$ " | ·33; | " | 28.5 |
| *$M^3$ " | 34; | " | 27. |
| Lower cheek teeth, $p_2$–$m_3$ | | | 164. |
| " premolars $p_{1-4}$ | | | 94. |
| " true molars, $m_{1-3}$ | | | 108. |
| $P_2$, anteroposterior | 16; | transverse | 7.4 |
| $P_3$ " | 19; | " | 8.8 |
| $P_4$ " | 23; | " | 12.3 |
| *$M_1$ " | 26; | " | 16.5 |
| *$M_2$ " | 31; | " | 20. |
| *$M_3$ " | 47; | " | 22. |

*Measurements taken at base of crown.

| | mm. |
|---|---|
| Metacarpus width proximal end | 61. |
| " " distal end | 74. |
| Phalanx of manus, length | 108. |
| " width proximal end | 36. |
| Tibia, length | 618. |
| " width of proximal end | 96. |
| " " distal " | 75. |
| Metatarsus, length | 552. |
| " width proximal end | 53. |
| " " distal " | 73. |
| Phalanx of pes, length | 98. |
| width proximal end | 33. |
| Astragalus, length | 71. |
| " transverse diameter | 47. |

From the parts preserved it would appear that *A. procerus*, with a much smaller body and slenderer limbs than the dromedary, must have stood at least two feet higher in the back. The neck was probably correspondingly longer than in the camel, and the head very slender and long. The proportionate length of fore and hind limbs is not yet known in *Alticamelus*, but as shown by Matthew in 1901 they were probably of equal length, as in the camels generally, instead of the fore limbs being longer as in the giraffe.

### **Alticamelus** sp. div.

At least two smaller species of this genus are indicated by limb and foot-bones, and various fragments of jaws and teeth. There are three long slender metacarpal cannon bones successively decreasing in size from *A. procerus*; various incomplete metatarsal bones may be correlated with these, but doubtfully. A lower jaw with $p_2$–$m_3$ may be correlated with the largest of the three metacarpals; also a humerus and a very long and slender radius and several less complete limb bones. The third and smallest metacarpal has somewhat more the proportions of *Procamelus* and may be referable to that genus. None of these agree with any described species of camel with which comparison can be made.

*Measurements.*

**Alticamelus** sp. No. 1, indesc.

| | mm |
|---|---|
| Lower jaw, No. 14072, length $p_2$–$m_3$ | 143. |
| " " " $p_{1-4}$ | 98. |
| " " " $m_{1-3}$ | 95. |
| Metacarpus No. 14081, length | 484. |
| " " width at proximal end | 58.5 |
| " " " distal " | 72. |

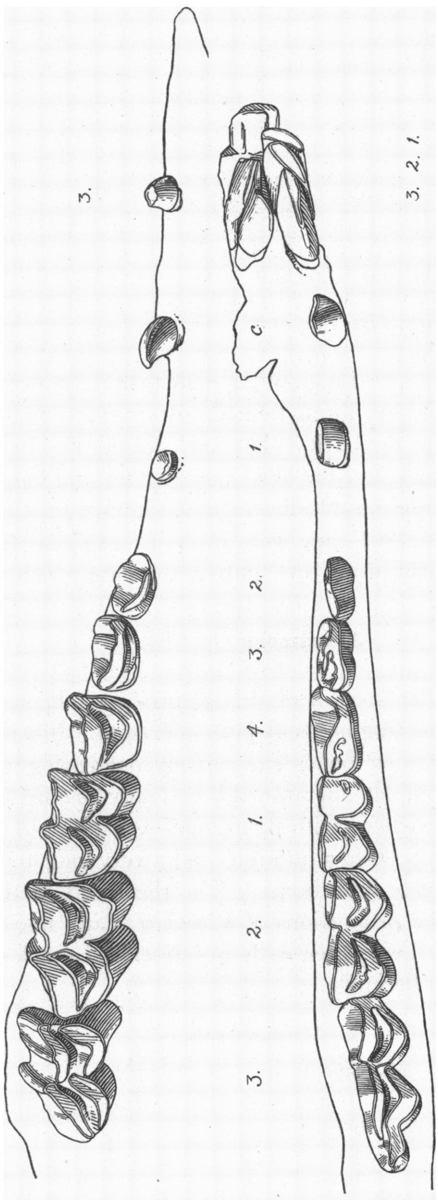


**Fig. 20.** ***Alticamelus procerus,*** **upper and lower dentition of type, crown views, one half natural size.**

| | mm. |
|---|---|
| Ulnoradius No. 14093, length exclusive of olecranon | 494. |
| " " width of distal end | 61.5 |
| Humerus No. 14099, length | 333. |
| " " width proximal (anteropost.) | 101. |
| " " " distal end (transverse) | 61. |

**Alticamelus** sp. No. 2 indesc.

| | |
|---|---|
| Metacarpus No. 14082, length | 399. |
| " " width at proximal end | 52. |
| " " " distal " | 65. |

**Alticamelus** vel. **Procamelus** sp. indet.

| | |
|---|---|
| Metacarpus No. 14083, length | 372. |
| " " width of proximal end | 58. |
| " " " distal " | 72. |
| Metatarsus No. 14084, length | 357. |
| " " width of proximal end | 49. |
| ' " " distal " | 63. |

This species has more the proportions of *Procamelus* in the shorter shaft and more expanded proximal and distal ends. We are unable to satisfactorily correlate any of the varied jaw fragments of appropriate size, in all of which the tooth formula is that of *Procamelus* and *Alticamelus*, but the reduction of the premolars agrees better with the former genus.

### ? **Procamelus** sp. div.

Numerous limb bones, metapodials, jaw fragments etc. indicate at the least two smaller species which are comparable in size to some of the smaller *Procameli*. It appears to be hopeless in the present state of our knowledge to make any satisfactory correlation of these small forms. There is some reason to believe from the manner in which these bones fall into groups, that the proportions of fore and hind limbs are reversed in these small types as compared with the larger forms. In the immature cannon bones of the smallest type, the metapodials are separate.

## Cervidæ.

Parts of jaws, teeth, and various bones of the skeleton indicate several different species of Cervidæ.

**Palæomeryx** sp.

The largest form, represented by fragments of three lower jaws and several separate upper and lower teeth. Nos. 14123, 14124, (14125). This species agrees rather nearly with the figures and descriptions of *P. bojani* and *Kaupi* as given by Meyer (1834). It measures slightly larger than *P. bojani*, the heel of $m_3$ is broader and the inner cusp more distinct and prominent, the "Palæomeryx fold" is prominent on $m_1$, variable on $m_2$,

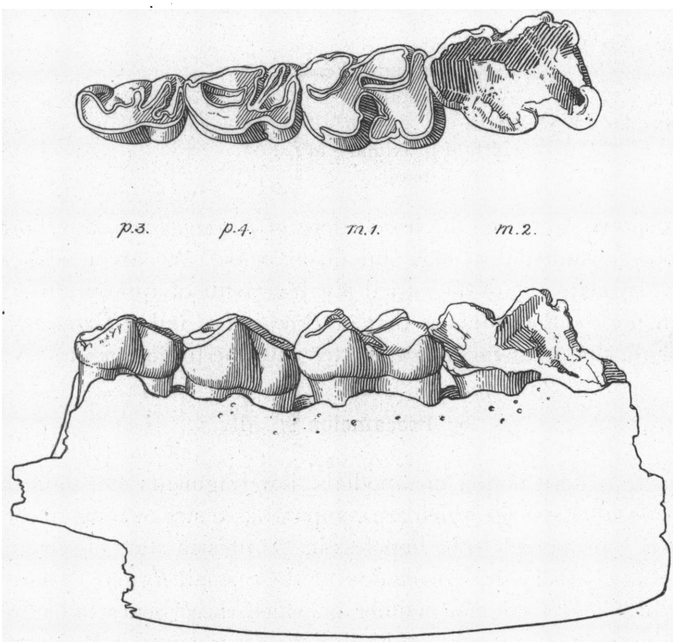


Fig. 21. *Palæomeryx* sp. indesc. Part of lower jaw, No. 14123, natural size, external and crown views of teeth.

vestigial on $m_3$. This species is probably most nearly related to the American Miocene "*Blastomeryx*" *borealis* and *antilopinus*, *Palæomeryx americanus* and *madisonius*. The characteristic broad heeled $m_3$ is found in jaws from the Middle Miocene of Colorado. None of these is as large as the Snake Creek form. Mr. J. W. Gidley has called our attention to the suggestive resemblance to *Alces* shown in the construction of the molars in this group of deer.

*Measurements.*

| | | | | mm. |
|---|---|---|---|---|
| No. 14123. | Length $p_3$–$m_2$ | | | 67. |
| " | $P_3$, anteroposterior | 14.5; | transverse | 9. |
| " | $P_4$ " | 15. ; | " | 10. |
| " | $M_1$ " | 17. ; | " | 14. |
| " | Depth of jaw beneath $m_2$ | | | 33. |
| No. 11425. | $M_1$ anteroposterior | 17.5; | transverse | 13.3 |
| " | $M_2$ " | 20.5; | " | 14.6 |
| No. 11424. | $M_2$ " | 20. ; | " | 14.2 |
| " | $M_3$ " | 30.8; | " | 15. |
| " | " width of heel | | | 11. |

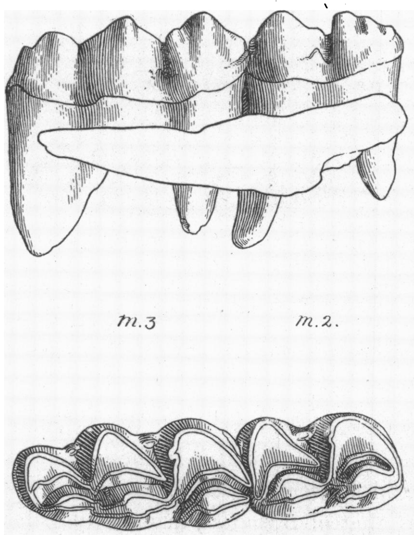


Fig. 22. *Palæomeryx* sp. indesc. Lower molars, No. 14124, natural size, internal and crown views.

## **Cervus** sp.

A second form, somewhat smaller than the preceding, is represented by jaw fragments and teeth, Nos. 14126, 14127. These lack the "Palæomeryx fold" in the lower molars, the heel of $m_3$ is narrow and its internal cusp less prominent, the teeth are slightly less brachydont, and the surface of their enamel less rugose. The reference to *Cervus* is only in a broad sense; they might with equal propriety be referred to *Odocoileus, Mazama, Cervus* s. s., *Dama,* or to Schlosser's genus *Cervavus.*

A very similar but smaller species occurs in the Upper Miocene of South Dakota; it has not received a name.

## **Blastomeryx elegans** sp. nov.

A lower jaw, No. 14101, represents a species of this genus about the size of *B. gemmifer* but with a more advanced type of dentition. The last molar is higher and more compressed than in the type of *B. gemmifer*, or in the referred specimen No. 9449; the dentition is one fifth larger than in the latter, the $p_2$–$_3$ relatively smaller. The molars are about a sixth smaller than

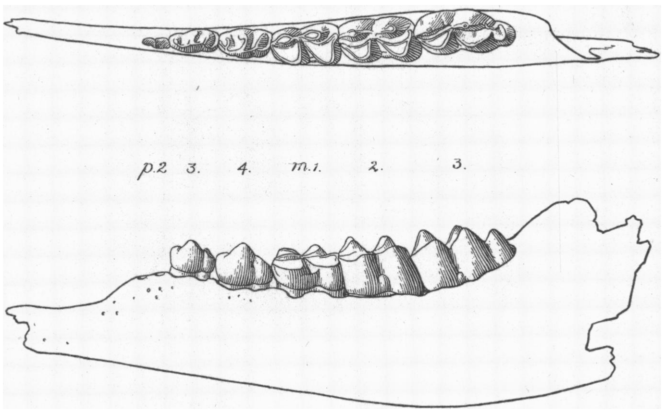


Fig. 23. *Blastomeryx elegans*, lower jaw, type specimen, natural size, external and crown views of teeth.

in *B. wellsi*, the premolars less reduced, the cingular crest of the anterior margin of the molars less prominent. In these respects it agrees more nearly with the Middle and Lower Miocene species, but the pattern of the premolars is more like that of *B. wellsi*; in particular the deuteroconid of $p_4$ is distinct and prominent.

*Measurements.*

| | | | mm. |
|---|---|---|---|
| Lower cheek teeth, $p_2$–$m_3$ | | | 49.5 |
| true molars $m_{1-3}$ | | | 32. |
| $P_3$, anteroposterior | 6.2; | transverse | 3. |
| $P_4$ " | 7.3; | " | 4. |
| $M_1$ " | 9. ; | " | 5.2 |
| $M_2$ " | 10.3; | " | 5.9 |
| $M_3$ " | 13.9; | " | 5.6 |

Depth of jaw at diastema, 6.2; beneath $p_3$, 12.2; beneath $m_3$, 15.8.

### **Blastomeryx** cf. **wellsi.**

Three lower molars, No. 14118, agree with this species in size and otherwise so far as comparison is possible, except that the anterior cingular crest is even more prominent.

## ANTILOCAPRIDÆ.

### **Merycodus.**

This genus is rather common, being represented by sixteen lower jaws, numerous teeth, limb-bones, cannon-bones, etc., with a couple of fragments of antlers. Most of the material belongs to a single species which for the present we regard as a variety of *M. necatus.* A much larger and a much smaller species are also represented — both of doubtful generic reference.

### **Merycodus necatus sabulonis** var. nov.

The type of *Merycodus necatus* Leidy, 1854, is from Bijon Hills, and consists of a fragment of the lower jaw with $p_4$–$m_1$. Leidy subsequently (1869) figured a lower jaw with $p_3$–$m_3$ which he referred to this species. The series of lower jaws in our collection, Nos. 14102–17, run uniformly smaller and slenderer than Leidy's specimens, and better material might show them to be distinct specifically. They show some degree of variation

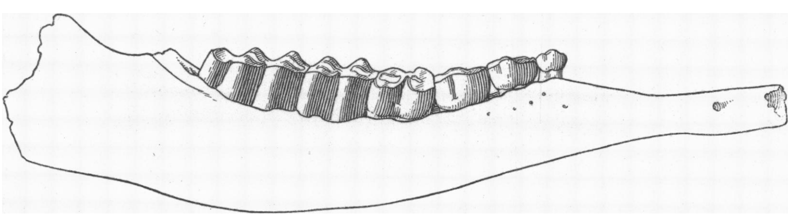

Fig. 24. *Merycodus necatus sabulonis*, lower jaw, type specimen, natural size, external view.

in robustness and size, aside from the variations in proportion of the teeth which are due to age, but are from ten to twenty per cent. smaller, and the two posterior inner crests of $p_4$ are less distinct than in Leidy's figure. In the absence of a satisfactory topotypic series of *M. necatus*, it appears inadvisable to regard these differences as more than varietal. A large series of limb and foot-bones, Nos. 14125, 14132, agrees pretty nearly in size with the better known species *M. osborni*, except that the fore-limb bones are somewhat smaller, as is the jaw. The fragments of antlers agree so far as they can be compared, with *M. osborni*, better than with *M. furcatus*, or the antlers referred to *M. necatus*.

*Measurements of eight adult Jaws.*

| Catalogue Nos. of specimens: | 14103 | 14104 | 14105 | 14108 | 14109 | 14110 | 14111 | 14112 |
|---|---|---|---|---|---|---|---|---|
| Lower jaw, total length . | 111. | | 108. | | | 119. | | |
| Lower cheek-teeth, $p_2$–$m_3$ . | 44. | 47. | 46. | 47. | 48. | 46. | 47. | 46. |
| " premolars $p_{2-4}$ . . | 17. | | 17. | | 18. | 16.5 | | 18. |
| " molars $m_{1-3}$ . . . | 27. | 30.5 | 29. | 28.8 | 30. | 30. | 29.5 | 28. |
| Depth of jaw at diastema . | 6. | 6. | 6. | 7. | 6. | 7. | 6. | 6. |
| Length of $m_3$ . . . . . | 13. | 14. | 13. | 12.5 | 13. | 14.5 | 12. | 13. |

The variation in the above series appears to be partly due to age and partly to individual difference.

### ? **Merycodus** sp.

A third upper and a third lower molar, Nos. 14121, 14119, indicate a species about one half larger than the preceding. The upper molar is very doubtfully referable to *Merycodus*, as it approaches *Antilocapra* in the large size of the posterior lobe and narrowness of the tooth.

### ? **Merycodus** sp.

A metatarsal cannon bone, No. 14131, is much smaller than any described species of *Merycodus* or *Blastomeryx*, scarcely larger than *Leptomeryx* evansi or *Tragulus*. It is adult, and agrees in characters with *Merycodus* and *Blastomeryx*, representing probably some very tiny species of Pecoran.

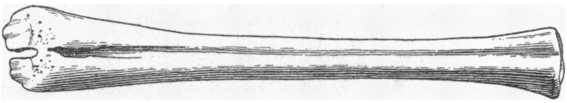

Fig. 25. ?*Merycodus*, sp. indesc., metatarsus, No. 14131, natural size.

| | mm. |
|---|---|
| Length of metatarsal cannon bone . . . . . . . . . . . | 73. |
| Diameter of proximal end . . . . . . . . . . . . | 9.2 |
| " distal end . . . . . . . . . . . . | 11.9 |

## BOVIDÆ.

### **Neotragocerus** gen. nov.

This genus includes antelopes with short straight horns and brachydont teeth, a combination of characters not found in any living groups, but characteristic of the Tragocerine group of the late Miocene and Pliocene reported hitherto only from Europe, Asia and Africa.

The horns are shorter and straighter than in *Tragocerus* or in any of the modern goats (? *Nemorhœdus* excepted). The upper molars resemble those of *Tragocerus* and various other extinct genera which have been recorded by different European authors.

### **Neotragocerus improvisus** sp. nov.

Type a complete horn-core, No. 14141. Paratypes, two upper jaws displaying the molar teeth, Nos. 14136 and 1413.

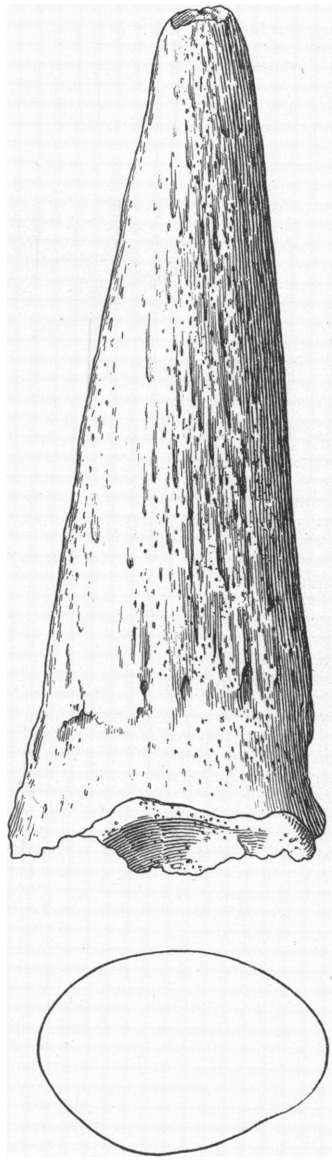

Fig. 26. *Neotragocerus improvisus*, horn-core, type specimen, natural size

The discovery of an unmistakeable bovid horn was a most unexpected feature of this fauna. The horn is about 4⅓ inches long, 1½ inches in diameter at the base, round-oval in cross section and perfectly straight. Its surface is that of the horn cores of Bovidæ, easily distinguished from the horn core of the Pronghorn Antelope by the coarser and less compact structure of the surface, and quite unlike any Cervid antlers in surface. It approaches *Oreamnus* in form and surface about as nearly as any modern genus with which we have made comparison, but lacks the curvature of that genus. In the entire collection there are no hypsodont bovid teeth of appropriate size, but there are two upper jaws and a number of upper and lower teeth which do not agree with either Cervidæ or Camelidæ, and do agree quite nearly with some of the brachyodont antelopes. The correlation of these with the horn-core is of necessity provisional, but, if correct, indicates a type of antelope nearly related to the Pliocene

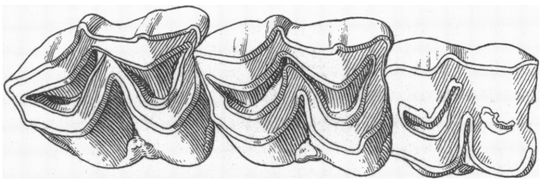

Fig. 27. *Neotragocerus* cf. *improvisus*, upper molars, paratype, No. 14136.

antelopes of the Old World, and retaining a primitive type of teeth and of horns which are not found together in any modern Bovidæ. The short straight untwisted horns are retained in the Cephalophinæ, Caprinæ, etc., but always associated with long-crowned teeth; the short-crowned teeth are retained in the Hippotraginæ but associated with long, spirally twisted horns.

### ? **Bovid**, gen. indet.

A few bones of the feet indicate a species considerably larger than *Neotragocerus improvisus,* and nearly equalling the musk-ox in size. They may belong to *Palæomeryx,* but appear to be too large for the teeth referred to that genus, and agree better in proportions with the larger antelopes.

### **Bison** sp. indesc.

Part of a lower jaw, No. 14135, is unquestionably referable to this genus and differs from the modern American species and from *B. occidentalis,* in the somewhat simpler structure of the crescents, and larger, more compressed heel of $m_3$. The petrifaction of this specimen is less complete than in practically all the specimens of the collection, although there are a few which, while certainly referable to Miocene or early Pliocene species, are in about the same stage of petrifaction as the bison jaw. There is no doubt as to its being taken from the same quarry and in the same level as a large number of characteristic specimens of the fauna described in these pages. But in view of the residual nature of the deposit, the possibility of accidental intermixture of specimens of later age must be kept in mind, and in absence of any confirmatory evidence we do not regard the presence of this Pleistocene genus in the Snake Creek fauna as satisfactorily proven.