Article XXII.—NEW OR LITTLE KNOWN MAMMALS FROM THE MIOCENE OF SOUTH DAKOTA. AMERICAN MUSEUM EXPEDITION OF 1903.

By W. D. MATTHEW and J. W. GIDLEY.

Part I.—Geological Notes, J. W. G.
" II.—Carnivora and Rodentia, W. D. M.
" III —Dicotylidæ, J. W. G.[1]

I. GEOLOGICAL NOTES.

The work of the American Museum Expeditions of 1902 and 1903 under the William C. Whitney fund was confined chiefly to the Miocene exposures along the Little White River, South Dakota, and the Niobrara River in the vicinity of Fort Niobrara, Nebraska. This region is of special interest and importance, as it was visited in early days by parties of the U. S. Geological Survey, and it was at these localities that the government parties under F. V. Hayden, in 1857, obtained most of the typical Loup Fork[2] material afterward described by Leidy.

All the localities visited by the American Museum parties present two distinct terranes of the Miocene series. The lower beds represent probably the lowest stage of the Lower Miocene, while the upper beds, which are true Loup Fork, belong to the uppermost Miocene. There are no traces of the Middle Miocene in this region.

UPPER MIOCENE.

Loup Fork Beds.

Although the typical Loup Fork locality is on the Loup Fork River, thirty or forty miles south of Fort Niobrara, Nebraska, there seems no doubt that the terrane at that

[1] Parts IV and V, Equidæ, J. W. G., and Camelidæ, W. D. M., will be published when the preliminary studies of these groups are completed. The new Rhinoceroses in the collection will be described by Prof. H. F. Osborn, along with other new Miocene Rhinoceroses, in a paper shortly to appear.

[2] Loup Fork is used in the present paper in its limited sense as a terrane and not as a time division.

place is continuous with the beds in the vicinity of Fort Niobrara and the Little White River.

The Loup Fork beds, in the region examined by the American Museum parties, lie unconformably on the much eroded surface of the Lower Miocene. Large areas of the beds are covered by recent formations of sand and prairie loess known as sand hills, with occasional small areas of Pleistocene deposits. These 'sand hills,' although made up mostly of a coarser and purer variety of sands than the underlying formations, have evidently been derived from the broken down and rearranged deposits of the Loup Fork and Pleistocene beds; the Pleistocene, in its turn, being chiefly made up of rearranged Loup Fork deposits.

The evidence for such an explanation of the origin of these vast sand deposits is found in a study of present conditions in the localities where they now occur. Wide expanses of country are entirely bare or only sparsely covered with vegetation, thus there is practically no protection from the action of strong winds which for the greater part of the year are of almost daily occurrence. Under the wind action the loose materials of which these beds are composed, constantly shifting about, are scooped out into deep pits or hollows and piled into great mounds many feet in height, each change in the direction of the wind causing a rearrangement of the materials. It is obvious that in this constant shifting of materials the wind acts as a great separator, the heavier, coarser sands, moving but a short distance, remain in the vicinity, while the finer, lighter materials, especially the finely divided clays, are finally carried entirely away to be deposited elsewhere as prairie loess.

The Loup Fork beds are composed principally of sands more or less intermixed with clay, and in places highly impregnated with lime and interwoven with characteristic rootlike concretions. In the opinion of the writers, the character of the formation of the Loup Fork beds shows that they are not of lake origin, as has been generally supposed, but were deposited by the action of rivers or streams with extensive flood plains and frequently shifting channels, augmented doubtless by large quantities of material carried by the winds from the surrounding plains. The conditions under which these deposits were laid down were very probably similar to those existing to-day in some sections of the Great Plains, especially portions of the Platte River Valley.

The Loup Fork beds extend over a wide area of country, roughly about one hundred and fifty miles long by fifty miles wide. They have a comparatively even thickness of about 100 feet. There is a total lack of uniformity in sedimentation and much variation in thickness of the principal strata composing the beds. There are numerous ancient stream channels, usually containing interstratified and cross-bedded materials of a coarser nature than the surrounding beds, quite often being intermixed with coarse gravel and large lumps of water-rolled clay. These channel formations occur at any level and are widely distributed over the beds. We found indications of them near the head of the Little White River, at Big Spring Cañon, sixty miles west of the Rosebud Indian Agency, at various places along the Little White River, and in the vicinity of Rosebud Agency, at the head of Oak Creek, thirty miles east of Rosebud, and in the vicinity of Fort Niobrara, Nebraska. At Big Spring Cañon we found indications of four successive stream channels, each cutting through the filling of its predecessor. These were: (1) A Miocene channel in the bottom of which we found an articulated skeleton of *Procamelus* surrounded by numerous separate bones of camels, horses, etc. (2) A second Miocene channel cutting off one end of the bone layers in the bottom of the preceding channel and filled with similar but somewhat softer and finer sand partly consolidated. (3) A later channel, probably Pleistocene, filled with loose sand. (4) The modern gully.

The condition, preservation, and distribution of the fossil remains, as well as the predominance of land animals, found in these beds also argue strongly against lake conditions during their deposition. The following observed facts seem to point to stream and plains conditions. The fossils occur most frequently in the channel formations. There are numerous scattered and fragmentary bones in every locality where the Loup Fork beds are exposed, yet but few of the fragments show water-worn edges; most of the bones show unmistakable signs of weather checking, even in articulated skeletons. There are occasional deposits, of small area, in which are thickly imbedded the bones of Proboscidians, Rhinoceroses, Horses, Camels, Carnivores, Rodents, etc., indiscriminately mixed. The bones are for the most part disarticulated and disassociated, many of them being broken and the pieces separated. The conditions for such a deposit of bones are furnished by the numerous temporary springs and ponds found to-day in the Western Plains country. Many animals seeking water become mired in these places during certain seasons and their bones are gradually buried. As these miry places gradually dry up animals can wade further and further toward the center until finally they can walk with safety over places which a few weeks before had been veritable mire holes. Under these conditions carcasses of animals which had been mired earlier, being only partially covered, are pulled apart by carnivorous animals and the bones more or less scattered, many of them being broken by heavy animals stepping on them in wading through the partially stiffened mud as the miry places are gradually dried up. Another season of rainy weather comes, the place again becomes miry, the bones already accumulated sink deeper, other animals are mired and their bones are added to the deposit. This alternation from wet to dry or nearly dry conditions is sometimes carried on for many years until many bones of numerous varieties of animals are accumulated.

Davis, Johnson, Hatcher, Matthew, and others have given extended discussions of the highly interesting subject of the origin of Tertiary deposits of the Western Plains and Rocky Mountain regions, in which they seem to agree that, except for such formations as the Green River shales of the Eocene in Wyoming, these vast deposits were not laid down in extensive lakes, as has been generally believed and taught by leading geologists, but that their origin is much more satisfactorily explained by alluvial fans, river and flood plains, and subaërial conditions.

We are in entire accord with these more modern views. Without at present going into a further discussion of the subject we wish simply to present here the foregoing observations which seemingly suggest a somewhat different phase of continental deposition from those presented by the above mentioned authors.

Faunal List.

Camels and Three-toed Horses are the most abundant fossil mammals in this formation at all the localities visited. Other mammals, though much less common, present considerable variety. Remains of land-tortoises are more frequently seen than any of the mammals, and silicified wood (rolled logs as far as our observations go) is found in large quantity in some places.

Following is a list of the mammals found in the Loup Fork sands by our party:

Ischyrocyon hyænodus.	*Merychippus* sp.
Ælurodon sævus.	*Hypohippus* sp.
" *haydeni.*	" sp.
" ? *wheelerianus.*	*Peraceras* ? *malacorhinus*
? *Amphicyon* indet.	? *Diceratherium* sp.
Canid, gen. indet.	*Teleoceras* sp.
" " "	? *Trilophodon* sp.
Potamotherium lacota.	*Prosthennops crassigenis.*
Lutra pristina.	*Procamelus robustus.*
Insectivore, gen. indet.	" *occidentalis.*
Mylagaulus monodon.	*Pliauchenia* sp.
Dipoides tortus.	*Ticholeptus* sp.
Neohipparion occidentale.	? *Merycochœrus* sp.
" *whitneyi.*	*Palæomeryx* sp.
" sp.	" sp.
" sp.	*Blastomeryx wellsi.*
Protohippus ? *perditus.*	*Merycodus necatus.*
" sp.	" sp.
" sp.	

LOWER MIOCENE.

Rosebud Beds.

The lower formation above mentioned, for which we propose the local term *Rosebud Beds*, is best exposed along the

Little White River and in the vicinity of the Rosebud Agency. These beds closely resemble portions of the upper Oligocene beds, both in character and general appearance, except that they contain a little more sand. In certain exposures an examination of the fossils contained in the beds is necessary to determine their horizon. The Rosebud Beds are possibly equivalent to the formation of similar appearance (*Gering Beds*, of Darton) so abundantly exposed in the northwest corner of Nebraska. Lithological determinations in these river and plains deposits are, however, so unreliable that palæontological evidence, which at present is not at hand, is absolutely necessary to settle this point.

Fossil remains are very rare in the Rosebud Beds, yet enough characteristic specimens were found by the American Museum parties to show that they are true Miocene but belong near the bottom of the series.

Faunal List.

Canid indet., cf. *Cynodesmus.*
Steneofiber pansus.
Meniscomys sp.
? *Eporeodon.*
Merycochœrus vel *Promerycocharus.*
Merychyus, cf. *elegans.*

II. Carnivora and Rodentia.

Canidæ.

Ischyrocyon, gen. nov.

Char. gen. — Dentition $\frac{\quad}{3.1.4.3.}$ Molars without metaconid or entoconid. Premolars reduced, massive, crowded, without heel-cusps except on p_4, and with no accessory posterior cusps. The dental formula and relative sizes of premolars and molars are as in *Amphicyon*, but the cusp composition of the molars is that of *Cyon*. All the teeth are very massive. The lateral incisor is exceptionally large. First premolar two-rooted.

Ischyrocyon hyænodus, sp. nov.

Char. spec. — The type, No. 10802, is the complete right ramus of the lower jaw of a young individual, with the permanent teeth preformed in the jaw but not yet erupted, and of the milk dentition the third premolar only remaining in its alveolus. The lateral incisor, first premolar, and first molar of the permanent dentition are partly erupted; the third permanent molar is not calcified, although the cavity for its reception is completed.

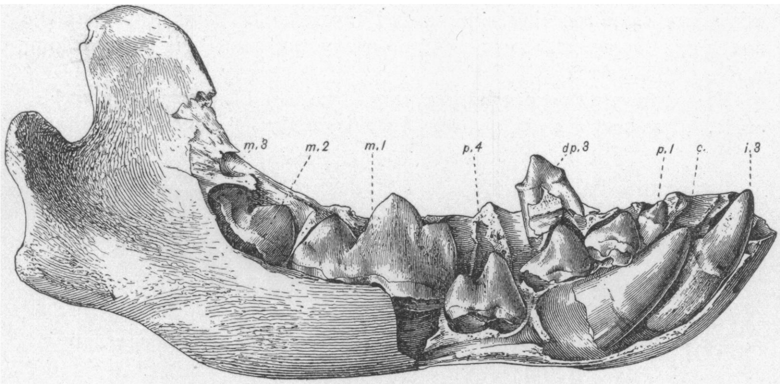

Fig. 1. *Ischyrocyon hyænodus.* Type, No. 10802. External view of immature jaw, with the outer wall removed to show permanent dentition within the jaw. One half natural size.

The size of the species equalled that of the largest Amphicyons, judging from the size of the teeth. The jaw has by no means reached its full size, and is about as large as that of a small grizzly bear.

The alveolus of i_1 is 6 mm. in diameter and close to the anterior border of the symphysis. The second alveolus is 10 mm. in diameter, and is almost directly behind the first. The third incisive alveolus lies external to the second and contains the incisor partly erupted. This tooth is large in proportion to the jaw, high and pointed, with compressed root, strong internal and external ridges, and an obsolete posterior basal cingulum, but no accessory external cusp. It is more like the corresponding tooth in the Machærodonts than in any Canid with which we are acquainted. It suggests a milk canine rather than an incisor, but its position in the jaw precludes that explanation, and the alveolus of the milk canine, a considerably smaller tooth, is perfectly preserved just external to the permanent canine.

The permanent canine is a large, very massive cone, of round-oval section, with comparatively little curve, and with well-defined posterior and internal ridges.

The temporary premolars are lost except dp_3. Their alveoli show that dp_1 was quite small, apparently one-rooted, the others larger, two-rooted. Dp_3 is wider posteriorly than the corresponding tooth in *Canis*, has a small heel-cusp, but no accessory cusp. The milk carnassial (dp_4) appears to have been a rather stout tooth of about 21 mm. length, the posterior root a little larger than the anterior.

The permanent premolars are proportionately small, but remarkably stout and massive, two-rooted, p_4 with well-developed heel-cusp, but no accessory posterior cusp. The others have no heel-cusp, the heel being merely broadened out and a little flattened. The two roots of p_1 are close together, and united towards the crown, so that the tooth has the general form of a one-rooted tooth. P_4 is 24 mm. long and 14 mm. wide.

The permanent carnassial is a very large tooth, 45 mm. long and 21 wide. The heel is as large as in *Amphicyon*, but the entoconid ridge is

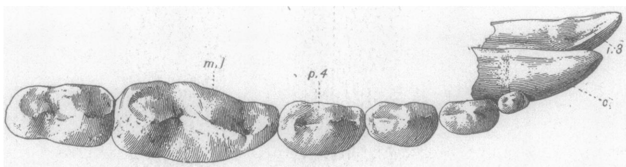

Fig. 2. *Ischyrocyon hyænodus.* Type. Crown view of teeth, one half natural size.

very slight. The protoconid and paraconid are much higher than in *Amphicyon*, considerably higher than in *Canis occidentalis*, and there is no trace of the metaconid. The heel-cusp is much higher than in *Amphicyon*, and more central in position, but its form is otherwise the same.

The second molar is very large, 28 mm. long and 17 wide. The trigonid consists of a single massive cusp, with anterior, posterior, and postero-internal ridges, and the heel is of the same form, but lower and a little smaller.

The third molar is not calcified and was a small tooth, judging by the size of the cavity for its reception.

The form of the jaw is much as in *Amphicyon*, with short, wide coronoid process, little development of the angular process, and the excavation beneath the coronoid for attachment of the masseter, very shallow and ill defined. The inferior outline is less curved than in *Ælurodon*, *Canis*, or *Simocyon*, more as in *Amphicyon*, *Ursus*, or *Hyæna*. The anterior portion of the jaw is very deep and massive, also as in the three last-mentioned genera.

Found by W. D. Matthew in the Upper Miocene, Loup Fork formation, near Rosebud Agency, S. D.

It is difficult to say where this genus should be placed among the Canidæ. The general proportions suggest *Amphicyon* and *Dinocyon*, but the high carnassial and absence of metaconids on both molars forbid any near relationship.

In all other Canidæ the post-carnassial teeth are relatively small. In *Ælurodon* the metaconid is always small on m_1, and sometimes on m_2, but the heels of these teeth have always a strong internal cusp or ridge, and m_2 and the heel of m_1 are as small as among the typical Canidæ. *Cyon* and *Temnocyon* differ in the large trenchant premolars with well developed accessory cusps and the small size of m_2 and of the heel of m_1. *Enhydrocyon* and *Hyænocyon* have likewise the normal small m_2 and small heel to m_1, if one may judge from the cotype specimens. Their premolars, although suggesting those of *Ischyrocyon* in form, have accessory cusps above the heel-cusp. The recently described *Hyænognathus* Merriam has a differently shaped p_4, anterior premolars more reduced, and post-carnassial dentition of the normal small size. For the large and peculiarly shaped lateral incisor of *Ischyrocyon* we can find no parallel among the Canidæ or related families; but it appears in the Machærodonts.

Measurements of Type, No. 10802.

Total length of immature jaw, 212.
Depth of jaw under dp_3, 49; at m_2, 53; at coronoid process, 84.

Temporary Dentition.

Alveolus of canine,	antero-posterior,	15;	transverse,	8.
Third molar (dp_3)	"	14;	"	7.
Alveolus of carnassial (dp_4)	"	22;	"	9.

Permanent Dentition.

Alveolus of I_1,	antero-posterior,	5;	transverse,	4.		
" I_2,	"	10;	"	5.		
I_3,	antero-posterior,	15;	transverse,	11;	height of crown,	24.
C,	"	20.5;	"	16;	" " "	?
P_1,	"	8;	"	6;	" " "	7.
P_2,	"	16;	"	10;	" " "	11.
P_3,	"	19;	"	12;	" " "	13.
P_4,	"	24;	"	14;	" " "	17.
M_1,	"	45;	"	21;	" " "	29.
M_2,	"	28;	"	17;	" " "	17.

Chamber for m_3, antero-posterior diameter, 7.

Ælurodon Leidy.

An upper jaw, two lower jaws, and other more fragmentary specimens were found by our party. They are referred to two species, *Æ. sævus* Leidy and *Æ. haydeni* Leidy.

The species of this genus were clearly differentiated by Professor Scott in 1890. We are now able to add to his characterizations of the species, as follows:

Ælurodon sævus Leidy. Upper and lower premolars (except p^4) reduced, not crowded, without anterior basal cusps. Lateral upper incisor moderately large. Second molar of moderate size.

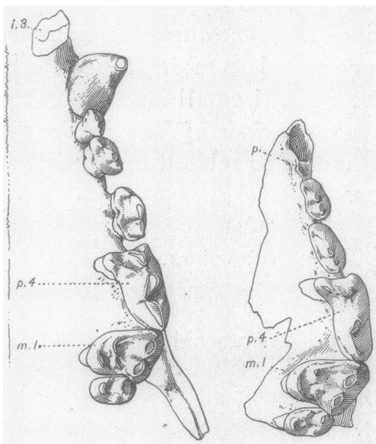

Fig. 3. *Ælurodon wheelerianus* Cope and *Æ. sævus* Leidy. Upper teeth of the right side, crown view, one half natural size. Nos. 8307 (Cope Coll.) and 10804 (Exped. 1903).

Ælurodon haydeni Leidy. Upper jaw unknown. Lower premolars reduced, crowded, p_2 set transversely in the jaw, all without anterior basal cusps. M_2 elongate, larger than in *Æ. sævus.* Alveolus of m_3 set in ascending ramus of jaw, varying considerably in the known specimens. In Leidy's type it is two-rooted; in the Harvard specimen described by Professor Scott and in one of ours (No. 10805, Upper Miocene, S. Dakota) it is one-rooted ; in another specimen in our collection (No. 9744, Upper Miocene, Montana) it is absent the alveolus closed.

Ælurodon wheelerianus Cope Upper and lower premolars larger, not crowded, all with anterior basal cusps. Tubercular teeth reduced in size. I^3 very large.

Ælurodon taxoides Hatcher is hardly distinguishable from *Æ. wheelerianus*, except by the absence, according to the published figures, of the anterior basal cusp on p_2 and p_3: Mr. Hatcher does not compare his species with *Æ. wheelerianus*, Cope's figure of which, in Tertiary Vertebrata, p. 945, is very misleading.

The characters of *Æ. sævus* are derived primarily from the fine skeleton in the Cope Collection, Amer. Mus. No. 8305, which agrees very well with Leidy's type. The teeth are considerably worn. An upper and a lower jaw, Nos. 10804, 10806, from S. Dakota, show the characters of the unworn teeth, and a number of other specimens are referred to this species. The type of *Æ. wheelerianus* is a lower jaw from New Mexico (Nat. Mus. Coll.) with the teeth mostly broken off; a fine palate and jaws in the Cope Collection (No. 8307,

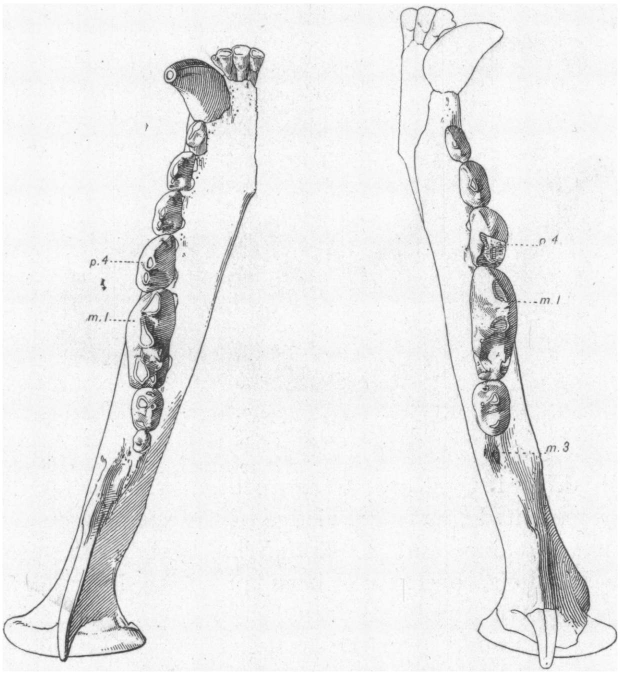

Fig. 4. *Ælurodon wheelerianus* Cope and *Æ. sævus* Leidy. Lower jaws, from above one half natural size. Nos. 8307 (Cope Coll.) and 10806 (Exped. 1903).

Nebraska), and a single lower jaw from the same locality (No. 8308) show the tooth-characters of the species. Of *Æ. haydeni* we have but two specimens, both lower jaws (No. 9744, Montana; No. 10805, S. Dakota), agreeing fairly well with Leidy's type. We have seen no additional specimens of *Æ. taxoides*.

Five other species have been referred to this genus.

Æ. compressus Cope is much smaller than any of those hitherto mentioned, the teeth are much more compressed, the jaw not so deep nor thick, nor is the symphysis so heavy. It is probably not *Ælurodon*, but one of the more typical Canidæ.

Æ. hyænoides Cope is doubtfully a Canid and certainly not *Ælurodon*. The heavy antero-internal cusp of p[4], widening of inner part of m[1], and stout rounded anterior premolars are unlike any Canidæ in which these parts are known. It seems

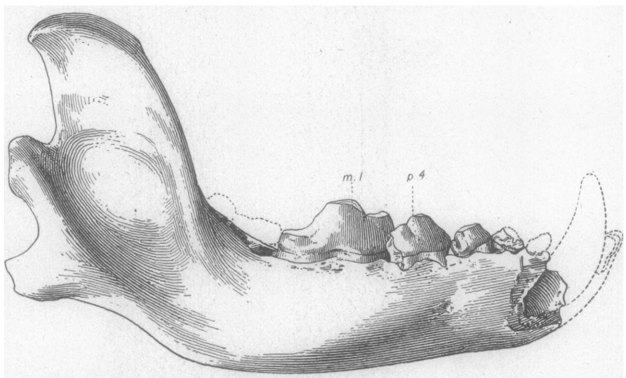

Fig. 5. *Ælurodon haydeni* Leidy. Lower jaw, No. 10805, Loup Fork beds, South Dakota. One half natural size.

equally difficult to refer it to any other Carnivore family with our present inadequate knowledge of the species.

Æ. ursinus Cope and *Æ. mæandrinus* Hatcher are probably not Ælurodons, and have been provisionally referred by Matthew to the Amphicyonines.

Æ.? brachygnathus Douglass is defined by its author on characters common to the genus. The type is a jaw with all the teeth broken off, and we are unable to discover any distinguishing characters in Mr. Douglass's figure.

Canid, sp. indesc.

A lower jaw with teeth broken off represents a species of dog apparently undescribed. The carnassial was a little larger than in the cotype of *C. temerarius*, the jaw about one half deeper. The teeth are compressed as in the coyote, but the jaw is short and stout, and very deep beneath the molars.

Dimensions.

P_3, alveolus, antero-posterior,	8.	
P_4, roots, "	10.	
M_1, broken, "	22,	transverse 7.
M_2, roots, "	10.	
M_3, alveolus, "	8.	

Depth of jaw beneath p_3 17, beneath m_1 25.

Canid, sp. indesc.

Another jaw with broken-off teeth represents a somewhat larger species, also apparently undescribed. The molars are a little larger than those of "*Ælurodon*" *compressus*, but the premolars are larger in proportion and the jaw much deeper and heavier. It may be a small *Ælurodon*.

Dimensions.

P_4, root, antero-posterior,	11.	
M_1, broken, "	22,	transverse, 9.
M_2, broken off, "	10.	
M_3, alveolus, "	6.	

Depth of jaw beneath p_3, 23, beneath m_2, 28.

The above species, with *Ælurodon compressus* and probably other described forms, are distinguished from *Canis* by their short jaw and small close-set premolars. *Canis brachypus* Cope has the slender jaw of the wolves and is a larger species. *C. vafer* is much smaller. *Cynodesmus thoöides* Scott is smaller and comes from a lower horizon. We prefer not to propose new specific names on such imperfect specimens, and describe these merely to indicate the variety of cynoid forms that has been found in the Miocene of this country, few or none of them properly referable to the genus *Canis*.

MUSTELIDÆ.

Potamotherium *E. Geoffroy.*

Distinguished from *Lutra* in the lower jaw by having four premolars, a much narrower carnassial with the protoconidparaconid blade much higher, and the heel small and compressed. The type is *P. valetoni* of the European Oligocene (St. Gerand-le-Puy). In the North American Miocene there are several little known species which have been or may be referred here.

P. ("*Lutrictis*") *lycopotamicum* Cope from the Mascall formation of Oregon was based on a jaw broken just behind the carnassial, so that the character of the following molar or molars is unknown. The type was not figured, and has been lost, and no other specimens referable to the species have been discovered, so that we cannot verify the correctness of the reference. It was a small species, about the size of a mink.

"*Stenogale*" *robusta* Cope probably belongs here rather than with *Stenogale*, in which genus the jaw and teeth are very much compressed, the heel of the carnassial much smaller and narrower, and m_2 much more reduced. It agrees fairly well with *P. valetoni;* the anterior part of the jaw is not so heavy, the premolars are not so wide, and the shear-cusps of the carnassial lower.

Brachypsalis pachycephalus Cope, which has been referred to *Potamotherium*, appears to be a quite different animal; the jaw is extremely short and massive and the masseteric fossa of peculiar form. The teeth are broken off in the type, and no other specimens are known, so that we are unable to state its relationship; but it appears to be a valid genus.

Potamotherium lacota, sp. nov.

A lower jaw (No. 10810) of a much larger species than *P. valetoni* is referred provisionally to this genus. The front of the jaw is considerably more elongate than in the type species, the premolars larger, higher, and more compressed. It resembles *P. robustum* Cope, but is more slender and very much larger; the heels of the premolars, especially p_4, are considerably more broadened out than in either *P. robustum* or *P. valetoni*. The crowns of the fourth premolar and carnassial are broken off, but the carnassial appears to have had the same proportions as in the smaller species. The alveolus of

m_2 is rather larger than in these species, and nearly round, flaring towards its borders and with somewhat raised edges, indicating probably that the tooth had a flattened crushing surface like that of *Lutra*, presenting less of the primitive pattern than *P. valetoni*. The coronoid process is peculiar; it is very wide, rather short, the anterior and posterior borders straight and almost parallel until near the tip, where

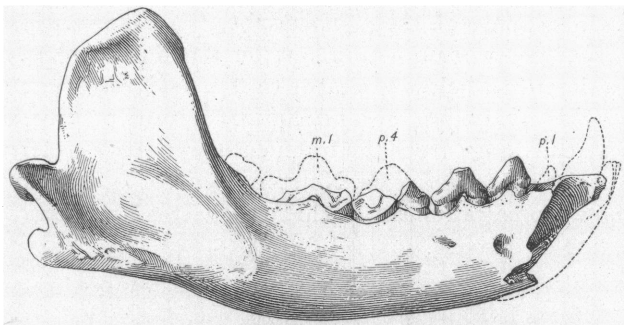

Fig. 6. *Potamotherium lacota.* Type jaw, No. 10810, external view. × ¾.

they bend sharply towards each other to meet in a very blunt tip. The angle of the jaw is developed into a short, stout process, and the condyle is wide and rather heavy.

The relative sizes of the above species of *Potamotherium* are indicated by the following:

	P. valetoni.	*P. robustum.*	*P. lycopotamicum.*	*P. lacota.*
Length of p_1–m_2,	32	35	22	52

The measurements of the type of *P. lacota* are:

Length of jaw, condyle to anterior border of canine alveolus, 109.
Length of p_1–m_3, 60.; $p_{\overline{1}}$–$_{\overline{4}}$, 36.
Depth of jaw beneath p_3, 21.; beneath m_2, 23.; at coronoid process, 50.

P_2,	antero-posterior,	9.;	transverse,	4.
P_3,	"	10.;	"	5.
P_4,	"	13.;	"	6.5.
M_1,	"	18.5;	"	7.

Alveolus of m_2, 6.5.

From the Upper Miocene (Loup Fork) of Little White River, S. Dakota.

Lutra *Brisson.*

The occurrence of a modern genus in the Loup Fork is a matter of some interest, as very few still existing genera are recorded from the American Miocene, and in most cases the determinations are questionable, based on inadequate types or specimens whose true horizon is not certain. The European Miocene contains a much larger proportion of living genera, although to some of these, no doubt, the same criticism of inadequate types or uncertain horizon would also apply. The species described below is nearer to the modern otter than is *Lutra dubia* of the Middle and Upper Miocene of Europe, so far as we can judge from the fragmentary material referred to that species by deBlainville, Newton, Depéret, and Hoffmann, but shows some peculiarities that throw it a little out of the direct line of descent.

Lutra pristina, sp. nov.

The type is a very perfect lower jaw (No. 10811) from the quarry at the Cañon of the Little White River, S. Dakota. It is considerably larger and more robust than *L. canadensis*, the carnassial has a nar-

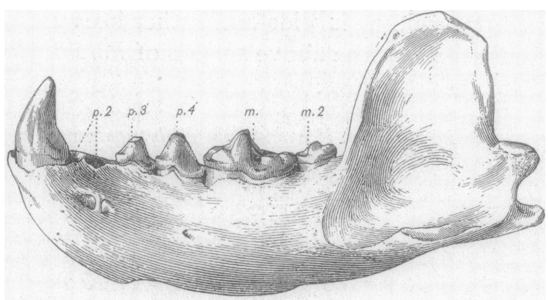

Fig. 7. *Lutra pristina.* Type jaw, No. 10811, external view. × ¾.

rower trigonid with higher pa^d and pr^d, me^d less widely separated and somewhat more posterior in position, the heel broader and more basin-shaped, with stronger internal ridge, lower hy^d, and distinct hl^d. M_2 is of proportionately larger size, the surface flatter, the cusps lower, the outline more regularly circular. The heels of the premolars are narrower than in *L. canadensis*, with a well-defined cingulum, but no heel-cusp. The angle of the jaw is produced into a short stout process, absent in the modern species; the coronoid process is much wider, especially towards the tip, and directed more backward. The muscular attachments are marked by much stronger ridges and rugosities.

The carnassial is larger and wider than in *L. dubia*, with a much broader heel. The metaconid appears to be somewhat more separated, and the paraconid-protoconid shear lower.

Dimensions.

Length of jaw from incisive alveoli to condyle, 103.
Depth of jaw beneath p_3, 22.; beneath m_2, 22.; at coronoid process, 44.

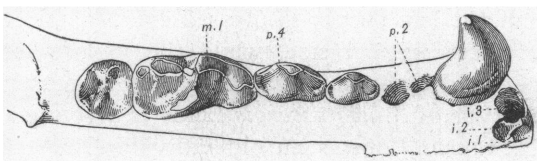

Fig. 8. *Lutra pristina.* Type. Crown view of teeth, natural size.

Length of entire dentition, incisive alveoli to m_2, 63.
" " premolar-molar dentition p_2–m_2, 48.

C_1,	antero-posterior	diameter,	10.;	transverse, 8.
P_3,	"	"	8.;	" 4.
P_4,	"	"	10.;	" 6.
M_1,	"	"	17.;	" 9.
M_2,	"	"	8.;	" 8.

CASTORIDÆ.

Steneofiber pansus *Cope.*

This species was founded on associated upper and lower jaws, et cetera, from the "Loup Fork" (Miocene) of New Mexico. The dentition is as primitive and the size as small as in any of the Oligocene species; it was a matter for surprise, therefore, to find it in a late Miocene formation. No additional specimens had hitherto been discovered, but we are now able to describe a well-preserved skull and jaws from the sandy clay formation (Rosebud Beds), which underlies the true Loup Fork and overlies the White River on the Rosebud Reservation. This formation contains *Merychyus* and *Merycochœrus*, ? *Eporeodon*, *Meniscomys*, and some indeterminate forms, and is provisionally referred to the Lower Miocene. We suspect from certain allusions in Professor Cope's descriptions that the type of *S. pansus* may also have been derived, along with "*Eumys*" *loxodon*, from a similar formation underlying the normal "Loup Fork" (Upper Miocene) of New Mexico.

Cope distinguished *S. pansus* by the form and relative size of the molars and the simplicity of the molar pattern. All these characters change greatly with the wear of the teeth, the patterns of the crowns becoming more simple by disappearance of the less deeply impressed enamel inflections, the premolars increasing in size, while the molars increase in transverse, but decrease more rapidly in antero-posterior diameter. The type of *S. nebrascensis* Leidy is a young adult, the type of *S. pansus* Cope is an old individual. A skull from the White River formation (Protoceras Beds), Am. Mus. No. 1428, described by Matthew in 1902, agrees in skull-characters with Leidy's type, and comes from the same horizon and locality; but its teeth are much more worn, and these show the proportions and pattern ascribed by Cope to his *S. pansus*. The skull we describe here, on the other hand, is that of a young adult, and has the tooth-characters shown in Leidy's figure of *S. nebrascensis;* we refer it to *S. pansus*, however, as it has the large bulla of Cope's type, agrees in size, comes probably from about the same horizon (Lower Miocene), and the difference in the relative size and pattern of the teeth is exactly what we should expect to find in view of the difference in their wear.

The skull is well distinguished from any of the described species by its extreme width and shortness. The width across the arches nearly equals the entire length of the skull. The zygomatic arch is very deep, except at the posterior end, and the occiput is very wide and low. The muzzle is short and small, the nasals much reduced in length, the basicranial region short, the bullæ set more transversely than longitudinally, the basioccipital moderately excavated, without median ridge. The palate is roofed over as far back as the anterior border of the third true molar. The postorbital constriction is moderate; the temporal crests approximate a little behind it and finally unite to form a very low sagittal crest. The paroccipital processes are either broken off or were altogether absent, and the exoccipital bones appear much reduced in width lateral to the condyles. The mastoid portion of the squamosal has a very wide exposure, forming most of the lateral border of the occiput, as in *Castor*, but its inner border is not so much covered up by the occipital bones. The mastoid process is short and small. In *S. nebrascensis* and in the type of *S. peninsulatus* the paroccipital processes are less reduced and the mastoid exposure smaller and less prominent. In the short bulbous nasals this species approaches *Castor* rather than *Steneofiber;* the deep zygoma is seen in *Castor* and likewise in *S. peninsulatus*, but in neither is it developed to so great an extent. In most other characters *S. pansus* shows a divergent specialization if we take *S. nebrascensis* as the most primitive member of the genus. The extreme width and flatness of the skull suggest analogy with the sewellel (*Haplodontia*), but there is

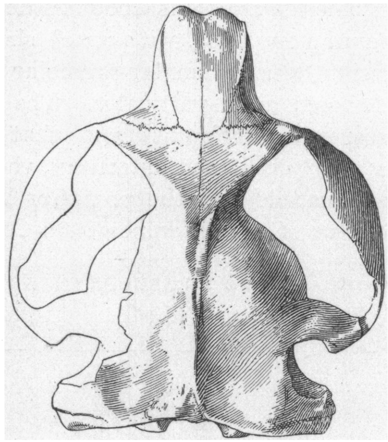

Fig. 9. *Steneofiber pansus*, No. 10818. Top view of skull, natural size. Rosebud beds (Lower Miocene), South Dakota.

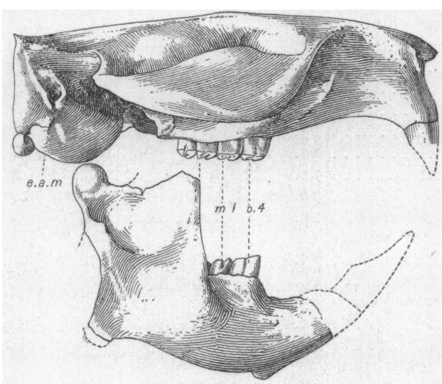

Fig. 10. *Steneofiber pansus*, No. 10818. Skull and jaw, natural size, right side view.

really little resemblance between the skulls except in general proportions.

The lower jaw is about as deep as that of *S. peninsulatus*, figured by Cope, with much shorter diastema behind the incisors, smaller molar-premolar series, and coronoid process directed more vertically. The conformation of the angle is somewhat different from that of *Castor*, the border more strongly inflected anteriorly, the pterygoid fossa more deeply excavated; but the posterior border is incomplete, and the extent of the difference from *Castor* cannot be stated.

COMPARATIVE MEASUREMENTS OF SPECIES OF *Steneofiber* and *Castor*.

	Steneofiber pansus. Am. Mus. No. 10818.	*Steneofiber peninsulatus* Type.	*Steneofiber nebrascensis.* Am. Mus. No. 1428.	*Steneofiber gradatus.* Am. Mus. No. 7008.	*Steneofiber æseri* (from Filhol's figures.)	*Castor canadensis.* Am. Mus. No. 2029.
SKULL.						
Total length of incisors to condyles....	57.5	70.2	62.	53.	80.	141
Width across zygomatic arches........	52.	49.			52.	99.
" of occiput....................	36.5	31.	24.3		36.	66.
Height of occiput....................	16.2	22.	17.		20.3	41.
Length of nasals....................	18.8	25 +			31.	48.
Width of muzzle....................	13.5	17.	12.5	12.7	15.	32.
Depth " "	12.4	12.			17.	37.
Width at postorbital constriction......	11.	7.		7.5	12.	26.
Depth " " "	20.	23.5		21.7	27.6	60.
Length of diastema behind incisors....	19.	23.	22.	16.	29.	47.
Length from posterior border of palate to condyles....................	25.	32.	25 ±	24.5	34.	52.
Width of palate including molars......	16.	18.	16.2	15.	21.	37.
Length of grinding series (at base of exposed crowns)..................	12.1	14.1	13.	12.	18.	33.
Transverse diameter of incisor........	4.	4.		3.2		8.2
Length of muzzle inferiorly from posterior border of premaxillæ.......	15.1	19.5	15.5		19.	44.
LOWER JAW.						
Length from condyles to base of incisors........................	42.4				55.	105.
Length of diastema behind incisors....	7.	11.			14.	24.
" " lower grinding series at base of exposed crowns...............	14.1	15.			20.	37.

Dipoides *Jäger.*

Syn. *Eucastor* Leidy, ? *Sigmogomphius* Merriam.

Dr. Schlosser's excellent figures and descriptions of *Dipoides* make it clear that the pattern of the molar teeth is the same as in *Eucastor* and *Sigmogomphius*, namely, one external and one internal inflection of the enamel. In *Sigmogomphius* there are but three upper teeth, according to Dr. Merriam's description, but his words imply some uncertainty as to the normal absence of m^3.[1] He distinguishes *Sigmogomphius* from *Eucastor* by the pattern consisting of inflections instead of isolated enamel lakes, but this is an age character, as Leidy's specimen "belonged to a quite aged animal, as indicated by the condition of the molar teeth, which are nearly worn away to the fangs,"[2] and in consequence all the enamel inflections were converted into isolated lakes before their disappearance, as in other Castoridæ. *Eucastor* certainly had four teeth in each jaw, as indicated by Leidy [3] and shown by all our specimens. It appears, therefore, that there are no generic characters to separate it from *Dipoides*, to which Schlosser has already remarked its resemblance in pattern.[4]

Dipoides tortus (*Leidy*).

Three lower jaws agree in size with this species. One is almost complete, and affords some interesting comparisons with *Steneofiber* and *Castor*.

The jaw is longer anteriorly than in these genera, the incisor more horizontal in direction, considerably less robust, with convex anterior face (nearly flat in *Steneofiber* and *Castor*) and the tip drawn to a much more slender chisel-edge than in the true beavers. The descending process at the posterior end of the symphysis is quite small, and the jaw is not so

[1] "As the number of molars is one of the important characters of the genus, it should perhaps be stated that, although the head bones extend backward beyond the molars, no sign of a fourth tooth could be found on either side." — Bull. Dept. Geol. Univ. Cal., Vol. I, p. 365, March, 1896.
[2] Ext. Mam. Faun. D. and N., p. 341.
[3] *Ibid.*, p. 342, measurements.
[4] Fossilen Säugethiere China's, p. 42 and figures; also Beitr. z. Kennt. Säugethierreste aus den Suddeutschen Bohnerzen, p. 22 and figures.

deep at this point nor the symphysial angle so abrupt. The internal inflection of the angular border of the jaw is very marked, especially at its anterior end just behind the grinding series, and the pterygoid fossa is very deeply excavated; but the angle is not produced backwards like that of *Castor*, so that the outline of this part is decidedly peculiar. Unfortunately the posterior border of the angle is incomplete, so that we cannot decide whether it was produced as in *Haplo-*

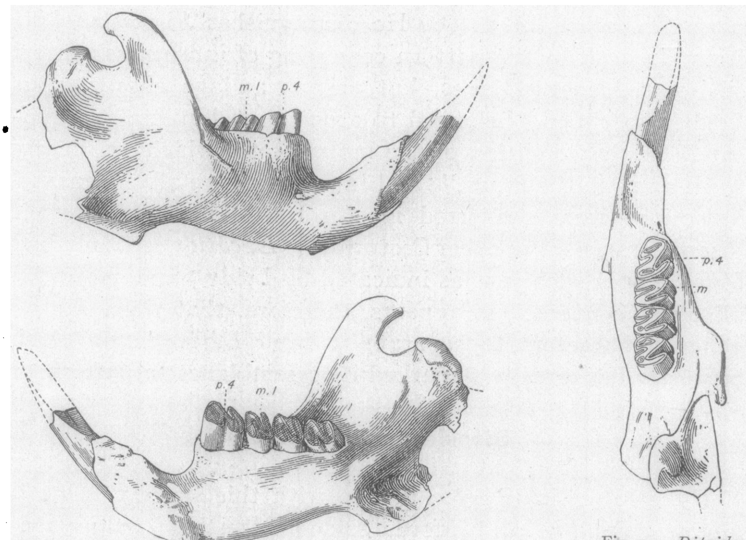

Fig. 11. *Dipoides tortus* (Leidy). Lower jaw, natural size, outer and inner aspect. No. 10821, Loup Fork beds, South Dakota.

Fig. 12. *Dipoides tortus* (Leidy). Lower jaw, from above, natural size. No. 10821.

dontia into a stout process projecting externally; but the parts preserved correspond more nearly with that genus than with any other living rodents. *Steneofiber pansus* exhibits the same peculiar form much less developed, as does also *S. viciacensis* to some extent, according to Filhol's figures; but in both, unfortunately, the posterior border of the angle is defective. [This may be associated with widening and flattening of the back of the skull, necessitating a different development of the pterygoid muscles from that which prevails in the longer-skulled *Castor;* if so it would involve notable difference in the form of the skull between *Dipoides* and *Castor*.]

HAPLODONTIIDÆ.

Meniscomys, sp. indet.

A lower jaw (No. 10824), with the three true molars and part of the alveolus of the fourth premolar, represents this John Day genus in the Rosebud Beds, associated with *Steneofiber pansus*, *Merychyus*, *Merycochœrus*, etc. The three teeth preserved agree well in size and pattern with *M. hippodus* Cope. The small part of the premolar alveole preserved indicates a large tooth, but not enough to show its actual size or form, so that we do not venture to refer it to that species. The occurrence of the genus is of interest, as it has hitherto been limited to the John Day Basin, occurring in the middle and upper levels of the John Day formation, according to Merriam.

Lower Miocene (Rosebud formation), Little White River, S. Dakota.

The dentition of *Meniscomys* has a strong resemblance to that of *Haplodontia*, as was remarked by Professor Cope,[1] and may be observed in the accompanying diagram. The most marked feature is the high straight external wall (ectoloph) of the upper molars, with sharp prominent median-external buttress (mesostyle), and the corresponding internal wall and buttress of the lower molars. In *Meniscomys* the molars are less hypsodont and the intermediate cuspules (paraconule and metaconule) are distinct; in *Haplodontia* the paraconule and metaconule are converted into crests uniting protocone and ectoloph, the posterior and anterior cingula elevated, and the intermediate valleys converted into isolated lakes, which disappear on further wear of the tooth. The relations of the two genera may be about the same as those of *Steneofiber* and *Castor*. It seems advisable, therefore, to

[1] Tertiary Vertebrata, p. 827.

place *Meniscomys* with the Haplodontiidæ rather than with the Sciuridæ, for its teeth differ very considerably from those of any genus of Sciurids. The genus *Mylagaulodon* Sinclair appears to be related to *Meniscomys* and *Haplodontia*, but we are unable to trace any relationship to *Mylagaulus*, whose teeth in our opinion are derived from a Castorid or Hystricomorph pattern, with quadrate p^4 and no p^3. *Meniscomys*, *Mylagaulodon*, and *Haplodontia* have, like the Sciurdiæ, a tri-

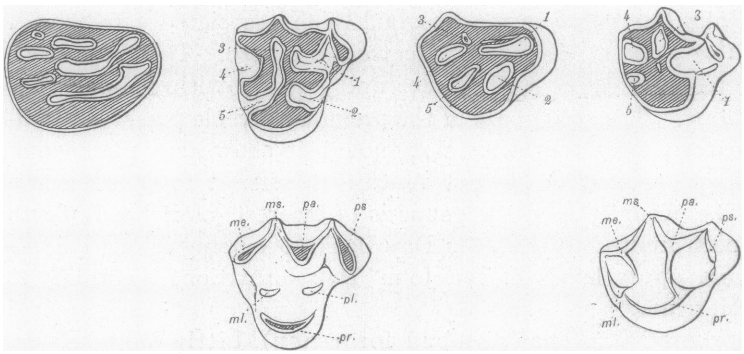

Fig. 13. Fourth Upper Premolar in Mylagaulidæ and Haplodontiidæ.

Mylagaulus	*Meniscomys*	*Mylagaulodon*	*Haplodontia*
Middle Miocene	Upper Oligocene	Lower Miocene	Recent
(Amer. Mus. Coll.)	(Amer. Mus. Coll.)	(After Sinclair)	(Amer. Mus. Coll.)

The numbers refer to corresponding enamel lakes in teeth moderately worn; the letters to corresponding cusps in the unworn teeth. Osborn's molar cusp nomenclature is used as a matter of convenience, not necessarily implying homology with the cusps of the true molars.

angular p^4, and p^3 very persistent although small. The molar pattern in Haplodontiidæ and Sciuridæ is clearly derived from the primitive tritubercular one; in the latter family it is but little altered, and in the former the process of change parallels in some respects the evolution of the teeth in the Equidæ. In Castoridæ and most of the Hystricomorphs the tritubercular derivation of the molar pattern is hardly recognizable; the teeth are quadrate with oblique enamel inflections, normally three external and one internal in the upper, three internal and one external in the lower molars. In Mylagaulidæ these oblique inflections are converted into mostly longitudinal lakes, and in the fourth premolar the number of lakes is increased apparently by successive additional crests arising from the cingulum; while the true molars tend to reduction and disappearance.

MYLAGAULIDÆ.

Mylagaulus monodon *Cope.*

Four specimens referred to this species were obtained in the Loup Fork sands at Big Spring Cañon on the Little White River. Two were unfortunately lost in the field or in unpacking the collection, and the others do not add much to the morphology of the species.

III. DICOTYLIDÆ.

Prosthennops, gen. nov.

Generic Characters. — Incisors vestigial; canines elliptical in cross-section, more recurved than in *Tagassu;* premolars less completely molariform than in *Mylohyus* (or *Tagassu ?*); muzzle anterior to premolars more elongate than in *Tagassu*, but less so than in *Mylohyus;* malar bones expanded transversely into massive tuberosities; orbits placed well back, being directly over the glenoid fossæ.

A complete and finely preserved peccary skull (No. 10882 Amer. Mus. Coll.), found by J. W. Gidley in the Loup Fork sands, indicates that the so-called *Dicotyles* of the Upper Miocene is quite distinct from the modern genus, as well as from the Pleistocene peccaries, *Platygonus* and *Mylohyus*. This distinction appears to have been suspected by Cope, for the type specimen of his *Dicotyles serus* (a lower jaw from the Upper Miocene of Kansas) bears the label "*Prosthennops serus*." We adopt Cope's manuscript name for the genus.

Prosthennops crassigenis, sp. nov.

Specific Characters. — Premolars much smaller than the molars; p^2 triangular, three-rooted; p^3 and p^4 four-rooted, but not completely molariform as indicated by the close approximation of the two inner fangs; the palatines extend well backward, throwing the posterior nares somewhat behind the glenoid fossæ; the bullæ are large and occupy a more posterior position than in any species of *Tagassu;* the ridge on the outer surface of the maxilla is not produced forward as in the modern peccaries, but is short and bifurcated anteriorly by a deep pit. Anterior to this pit is another larger pit in which the infraorbital foramen opens; still another shallower pit of smaller size occupies a position anterior to and somewhat above the large pit. There are also two long, narrow pits or grooves on the upper face of the skull, extending the entire length of the nasals. The sagittal crest is broad

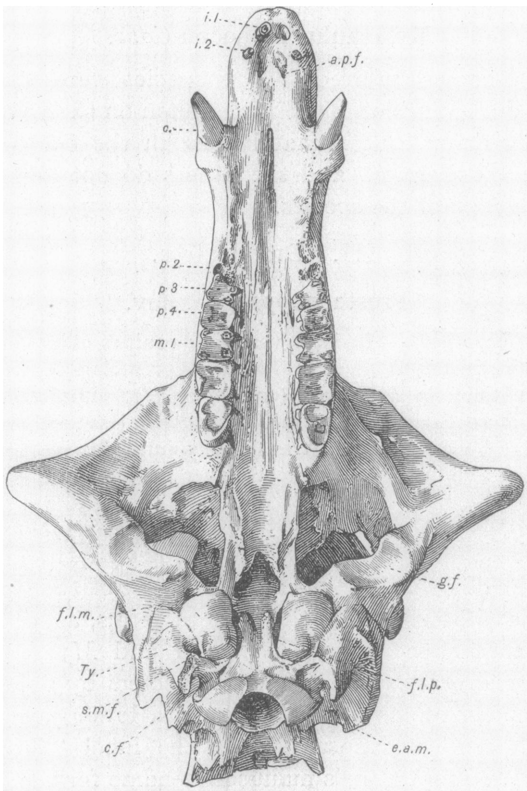

Fig. 14. *Prosthennops crassigenis.* Skull, palatal view, one third natural size. Type, No. 10882, Loup Fork beds, South Dakota.

and flat on top. Some of the above specific characters may prove to be of generic value.

Measurements.

Length of dental series m^3 to i1 inclusive	175	mm.
" " molar-premolar series	80	"
" " molar series	50	"
" " diastema between p^2 and canine	50	"
Total length of skull	295	"
" width " " across malar bones	215	"

The primitive Suidæ, common to both hemispheres in the Oligocene, gave rise in the New World to the Dicotylinæ [1] and in the Old World to the true pigs (Suinæ). These two subfamilies became separated as early as the beginning of the Miocene. Since that time the Suinæ have been confined entirely to the Old World, while the Dicotylinæ branch continued on in the New World, and is to-day represented by a single living genus *Dicotyles*. No representative of the subfamily Dicotylinæ has ever been found in the Old World.

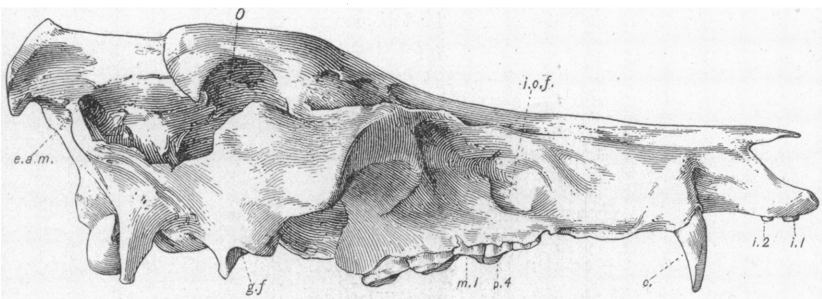

Fig. 15. *Prosthennops crassigenis*. Skull, side view, one third natural size. Type specimen.

Many extinct American species have formerly been referred to the genus *Dicotyles* by various authors, but it now appears that most of these species belong to other genera.

The recognizable genera of the Dicotylinæ are briefly distinguished according to their upper teeth and skull characters as follows. Their known distribution is also given below.

Tagassu *Frisch.*

Dicotyles CUVIER.

Distribution. — Tropical America, ranging as far north as Texas. *Horizon.* — Pleistocene to present time.

Characters. — Three upper premolars; p^4 molariform; p^2 and p^3 more or less molariform; molars low crowned with distinct cusps, but tending to become multicuspid; canines nearly straight and somewhat triangular in cross-section; incisors two in number, inner pair much the stronger; diastema between p^2 and c about equalling the premolar series of teeth in length.

[1] Properly, *Tagassuidæ* Palmer, 1904.

Mylohyus *Cope.*

Known Distribution. — Eastern and middle-western United States. *Horizon.* — Pleistocene.

Characters. — Three upper premolars; p^3 and p^4 completely molariform; p^2 usually four-rooted; form of canines not known; molars quadricuspid; incisors vestigial or wanting; muzzle anterior to premolars very long, diastema between p^2 and c twice the length of premolar series.

Platigonus *Le Conte.*

Distribution. — Greater portion of the United States. *Horizon.* — (?) Upper Miocene, Pliocene, and Pleistocene.

Characters. — Three upper premolars which are all simple, two or one principal cusp; molar crowns higher than in *Tagassu* and composed of two more or less well-defined transverse crests; basal cingulum in both molars and premolars strongly developed; length of diastema between p^2 and c but little greater than length of premolar series.

Prosthennops *Matthew and Gidley.*

Distribution. — South Dakota, Nebraska, and probably western United States in general. *Horizon.* — Upper Miocene.

Characters. — Three upper premolars all smaller than molars, less progressive than in *Mylohyus;* canines small and more curved than in *Tagassu;* incisors vestigial; muzzle in front of premolars somewhat longer than in *Tagassu*, but much shorter than in *Mylohyus;* diastema between p^2 and c about one and three sevenths the length of the premolar series; molars tending to become multicuspid; malar bones developed into widely expanded massive tuberosities.

The foregoing genera are readily distinguishable from *Perchœrus* and other Oligocene genera, in which the teeth are all more primitive. In *Perchœrus* p^1 is usually present, and all three incisors are strongly developed. The muzzle is short, there being little or no spacing between the forward teeth. Molars are always simple quadricuspid, premolars bicuspid and never molariform. In the later Dicotylines the premolars became successively molariform (*cf.* Perissodactyls), showing in the different genera various stages of molarization as was observed by Cope.