# University of Montana.

MISSOULA, MONTANA.



# THE NEOCENE LAKE BEDS OF WESTERN MONTANA

AND

DESCRIPTIONS OF SOME NEW VERTEBRATES
FROM THE LOUP FORK.

A Thesis by Earl Douglass, B. S., for the Degree of M. S.

Four Plates

JUNE, 1899.

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# DESCRIPTION OF LAKE BEDS.

Since coming to Montana in the spring of 1894, I have spent much of my time in studying the lake bed deposits in the western part of the state, and in collecting and studying the vertebrate fossils found in them.

These deposits occur in nearly every large valley in the mountain regions. I have myself observed them in the valleys of the upper Missouri (above the region of Helena), Gallatin, Madison, Jefferson, Beaverhead, Ruby (Stinkingwater), Big Hole, Hell Gate, and Bitter Root rivers, and their tributaries.

Hayden and Peale, in the Annual Reports of the U. S. Geol. Sur. of the Territories for 1871 and 1872, have given very good general descriptions of these beds.

These fresh water lakes filled the valleys and at some time, east of the main divide, left only the tops of the mountains standing as islets, long islands, and peninsulas in the waste of waters. West of the divide the land masses were larger.

Though over a good share of the area of the ancient lakes there are no good exposures yet it is not a difficult matter to ascertain approximately their former extent by the topography of the country and the occasional outcrops. The sands and clays that compose the deposits are often grassed over, covered with drift, or entirely washed away; yet in some of the valleys there are good and quite extensive exposures. One strip fifteen to twenty miles long near the Madison forms a miniature "Bad Land."

At one time there was a large irregular shaped lake extending from about ten to twenty miles north of Helena, southeastward, and then southward about seventy miles, to the vicinity of Pony, in Madison county, on a line nearly west of Bozeman; and, probably, over the rather low and narrow divide to the south and up the Madison valley about sixty miles farther, making the whole distance between one hundred and thirty and one hundred and forty miles. Its greatest width from the vicinity of Bozeman to that of Whitehall was at least sixty miles. To the southwestward an arm extended up the Beaver Head and its tributaries nearly or quite to the main watershed of the Rocky Mountains south of Dillon. It extended eastward to Virginia City, and probably across the divide to the east connecting with the waters of the Madison valley, so the South Boulder mountain range was an island or peninsula. The Ruby Mountains were either an island, or connected by a narrow isthmus at the lower canon of the Ruby with the Tobacco Root range to the east.

East of this great lake across the Gallatin range was another lake in what is now the upper Yellowstone valley. *

To the west of the continental divide another lake began in the vicinity of Butte, extending westward and then northward, occupying the Deer Lodge valley, and perhaps down the Hell Gate to the vicinity of Drummond. There was another smaller one in the vicinity of Phillipsburg on Flint creek a tributary of the Hell Gate. There was also a large lake occupying the Bitter Root and Missoula valleys.

Near White Sulphur Springs in the valley of Smith or Deep river was a comparatively small lake, belonging, according to Dr. W. B. Scott, to the later John Day ** and early Loup Fork divisions; while the other beds belong to the White River and later Loup Fork horizons. As the Deep River beds have been studied, and their vertebrate remains described by Cope and Scott, I will confine myself, principally, to the more extensive deposits in the other parts of the state.

By far the best exposure is in the lower Madison valley. This valley extends about twenty miles south from the Three Forks, where the Jefferson, Madison, and Gallatin rivers unite to form the Missouri.

On the west side of the river extending eight or ten miles in a north and south direction is a series of nearly perpendicular cliffs composed principally of clay, fine sand, volcanic ash and conglomerate, gray in color, but often stained with iron. They are usually soft, yet there are in places some very hard layers. The river has not cut through the bed so as to expose the rock beneath, but the thickness of the exposure must be at least two hundred feet.

Above these beds, on the east side of the valley, are softer, marly beds, almost white, weathering into conical hills and bluffs with evenly sloping sides which have an angle of twenty-five to thirty-five degrees. I have observed no distinct line of separation between these beds and the ones just described.

Between the marly beds and those above, there is a sharp dividing line and the formations can be distinguished as far as they can be seen. Thre is a sudden change from the white slopes of marl to the cream colored clays and darker sands and conglomerates of the upper beds whose sloping sides are broken by cliffs of harder material. There is also unconformity of erosion. The material of the lower beds

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* See Livingston Atlas Sheet (Montana).

**W. B. Scott informs me that Matthew believes the uppermost White River horizon which he has found in Colorado corresponds in age to the lower beds in the Smith River Valley.

was laid down, for the most part, in quiet waters; while a large part of the last described, was deposited by running streams. The latter is overlaid by about two hundred feet of cream colored clays. There is no perceptible break but the upper layers are less sandy and are barren of fossils. As will be seen later the fossils show that the lowest bed is White River while the one above the gray marly beds, and probably the last two are Loup Fork.

On top of the benches in many places are hard, brown, rounded rocks, some of them very symmetrical in shape. In places these form a coarse conglomerate. These rounded stones, which average perhaps three or four inches in diameter, when the softer material is washed away from beneath, slide down the slopes, in some places forming a broad river of them, but flowing only when something disturbs some part of the mass. The pebbles are composed of hard material, mostly quartzyte. They are coated brown and the brown color seems, to a slight extent, to penetrate the rock near the surface. If the sun appears when they are wet by a shower they shine like polished silver. Possibly they were deposited here when the Madison river flowed at this level.

There is a general similarity in the lake beds where I have examined them yet there are many local differences and a considerable lithological variety; so that in nearly every valley one finds something new and interesting. In one place there are large perpendicular seams of Jasper cutting the hard clay and conglomerate, and cavities coated with hyalite; in another, cavities covered with quartz and calcite crystals, the inner ones lined with a thin coat of quartz, and what were apparently logs and stumps turned into calcite or with alternating concentric layers of calcite and quartz crystals. In another place there are what seem to be ancient geyser cones and hot spring deposits, and layers of "petrified moss." On the lower Madison there is much silicified wood some of which is very beautiful. There are also small quantities of fossil wood in other localities.

One almost constant feature of these lake beds is the pure gray volcanic ash occupying one or more layers. On Black Tail Deer creek is a stratum of this material which is seventy or eighty feet in thickness and weathers in a peculiar way. There are pillars standing on the slopes and architectural forms resembling marble temples.

In many of the valleys the overlying material is incoherent sand and gravel, and this so covers the other beds beneath that there are few good exposures. Then, too, grasses and shrubs cover the slopes and benches thus preventing a study of the strata.

As stated in the Three Forks Atlas sheet the beds are, in some places capped with basalt. I have not now data sufficient to settle positively the question as to the age of these lava flows, whether before or after the deposition of the Loup Fork deposits; but, judging from the character of the strata in the middle valley of the Ruby river, I think the basaltic flow that forms the plateau between this river and Black Tail Deer creek overlies the Loup Fork. West of Dillon and south of Argenta are gray cliffs of what is probably Loup Fork, capped with gray lava in layers a few inches thick, showing many successive flows. The plateau divide between the Ruby and Madison rivers is capped by basalt several hundred feet thick (See Three Forks Atlas Sheet U. S. Geol. Sur.). Around Virginia City this lava is seen to overlie the lake beds the tops of which reach an altitude of 6200 feet. Over this the lava cap reaches an altitude of 7000 feet; but farther south near Old Baldy the height is about 8400 feet. It seems likely as will be seen later that at one time the waters of the lake extended over this divide into the upper Madison valley lake thus making one vast irregular lake occupying the valley of the upper Missouri above the region north of Helena, and all the tributaries flowing in above that place.

Usually the Loup Fork beds are nearly horizontal but the White River beds are often inclined at a considerable angle sometimes as high as thirty-five degrees. It is evident that during the White River period the valleys occupied nearly the same position as at present, that in these valleys sediment was deposited to a considerable thickness; the lakes were then drained and a large part of the sediment removed, leaving benches and bluffs in more protected places as at the present time. The drainage again being intercepted in Loup Fork times, lakes were formed once more and new deposits formed over the old; then the lakes were again drained and erosion removed a great part of these deposits. It must not be forgotten, however, that some of the larger valleys were probably not evenly filled and the centers were left as depressions, the bulk of the deposits being deposited nearer shore.

While the White River deposits were being eroded the lake in the Smith river valley was formed. This was probably dry land again before the later Loup Fork lake was established. Scott has ascertained by a study of the vertebrate fossils from the Smith river region that there are here two distinct horizons; and my collection seems at present to indicate that there were at least two in the other valleys, both distinct from those on Smith river.

Though these Miocene deposits are geologically modern, yet they must represent, humanly speaking, a vast lapse of time. Peale estimates the thickness in the Gallatin and Madison valleys to be about 2000 feet or more. The area of drainage was small, probably not larger than the whole area of deposition. The streams were short, and it evidently took a vast amount of time for the small deltas to push themselves out into the large and deep lakes until a good portion was dry land or marsh. Then came a period of drainage and erosion which was perhaps as great. As this was repeated, the length of time was certainly long enough to make several almost complete changes in the species of higher animals.

The geological age of the beds outside of the Smith river valley has been a matter of doubt; and so far as I have been able to ascertain, few fossils had been collected from them. Hayden and Peale called all Pliocene without distinction. In the Jefferson valley Hayden discovered what Leidy called Anchitherium and a species of Helix. *

Leidy described the former under the name Anchitherium agreste.** This I believe to be a Protohippus as I have the lower jaw, with teeth that cannot be distinguished from that described by Leidy, associated with part of the upper jaw and teeth of a Protohippus from near Townsend.

Peale in the Three Forks atlas sheet says: "In the summit of the Madison bluffs, in a layer of gray conglomerate sandstone numerous fragments of fossil bones were found, which were identified as the same as were found in other localities in the Pliohippus beds of Marsh."

In no place have I found fossils abundant, yet there has been enough to arouse and sustain the most lively interest. No great quantity of any one species was found and the collection presents a large number of species in proportion to the amount of material.

Besides the bones mentioned by Peale, teeth and jaws of two or three mastodons and a skull of Procamelus were found by ranchmen, but so far as I know they have been preserved only as curiosities. The Procamelus skull was purchased, and it is now in my collection.

I give on the next page a table showing succession of strata as exposed on the lower Madison, with list of the fossils, so far as have been determined, that have been obtained at this place, and from the same horizon in other localities in the state.

There is a considerable difference in species between the Loup Fork of this region and that of other localities, but the difference is probably one of locality rather than age. There was, I judge, as great a difference in the animal life between this mountain region and the region east of it as there is to-day. Probably the Montana species more resembled those found near Cottonwood creek in Oregon. Although the material has not been fully worked up, there are some species that are especially interesting as they show the close relationship between the fauna of this country and that of the corresponding

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* Sixth Ann. Rep. U. S. Geol. Sur. Terr., p. 65.

**Monograph I, U. S. Geol. Sur. Terr., p. 251, Plate XVII.

**Table Showing Divisions of the Miocene.**

| Age | | Estimated Thickness | Character of Strata. | Fossils. Newly named species italicised. |
|---|---|---|---|---|
| ? | No. 5 | | Smooth rounded pebbles | No fossils. |
| Loup Fork | No. 4 | 250 ft. | Rather soft cream colored clays and fine sand. | No fossils. |
| | No. 3 | 250 ft. | Clay, sand and gravel. Sometimes quite hard. Layers of volcanic ash. | Sciurus, Castor, Mus? Felis, Canis, Aelurodon saevus, Mustela, Chalicotherium? Aphelops, *Anchitherium minimus.* Protohippus fossulatus, P. speciosum, P. sejunctus, Hippotherium isonesum, H. relictum, *Merycochoerus altiramus, M. madisonius, M. compressidens,* Dicotyles, *Gomphotherium serus, Protolabis montanus, Procamelus madisonius,* P. occidentalis? *P. lacustris,* Blastomeryx gemmifer, Cosoryx necatus, C. furcatus, *C. agilis, Palaeomeryx americanus, P. madisonius,* Mastodon, Testudo nebrascensis, —Birds, Clams, Fossil wood. |

(Smith or Deep River Beds)

| | | | | |
|---|---|---|---|---|
| White River on the Madison and in various other localities. | No. 2 | 400 ft. | Marl volcanic dust; soft limestone & fine sand. | Snails. |
| | No. 1 | 200 ft. | Gray and yellow clay. sandstone and conglomerate Hot spring deposits. | Castor, Hyaenodon, Hyracodon, Aceratherium, Colodon dakotensis, C. procuspidatus, Titanotherium, Mesohippus, Oreodon culbertsoni, O. gracilis, Agriochoerus, Poebrotherium, Turtles. |

age in Europe. The discovery of Palaeomeryx has been predicted by Cope and suspected by Scott, but it has now become nearly a certainty as I have found the inferior dentition—exclusive of incisors and canines,—of one species, and the molars of another, both having the characteristic Palaeomeryx fold.* I have also discovered a second American species of Anchitherium (using the term in the restricted sense in which it is used by Scott); but it is much smaller than the

* See note under Palaeomeryx.

European or Smith river (Deep river) species. There is also a tooth like that of Chalicotherium.

I give below a table complete as I can at present make it, showing the faunas of the four different horizons of the Neocene of Montana. The lists under Deep River beds are taken from Scott's Mammalia of the Deep River Beds.*

| White River in various parts of Montana | Deep River, Montana | | Loup Fork of Madison Valley Montana |
|---|---|---|---|
| | Lower | Upper | |
| Castor nebrascensis, | Stenofiber Montanus, | | Sciurus. Mus? |
| | | | Castor, |
| Hyaenodon, | | | Felis, |
| | Cynodesmus thooides, | | Aelurodon saevus, |
| Hyracodon, | | | Canis, |
| | Caenopus, | Canis? anceps, | Mustela, |
| | | Chalicotherium? | Chalicotherium? |
| | | Aphelops, | Aphelops, |
| | | | *Anchitherium minimus.* |
| Metamynodon? | Miohippus anceps | Anchitherium, equinum | Protohippus speciosum, |
| Aceratherium, | M. annectens ? | Miohippus, | P. fossulatus, |
| Colodon dakotensis, | M. equiceps? | Desmatippus crenidens, | P. sejunctus, |
| Colodon procuspidatus, | Mesoreodon chelonyx, | Protohippus sejunctus, | Hippotherium isonesum, |
| Titanotherium, | M. intermedius, | P. insignis, | H. relictum, |
| Mesohippus, | | Merychyus zygomaticus. | |
| Oredon culbertsoni, | | M. pariogonus, | *Merycochoerus altiramus,* |
| O. gracilis, | | Merycochoerus montanus, | *M. madisonius.* |
| Agriochoerus, | | Cyclopidius simus, | *M. compressidens,* |
| | | C. emydinus, | Dicolytes, |
| | | C. incisivus, | *Gomphotherium serus,* |
| | | Pithecistes decedens, | *Protolabis montanus,* |
| | | P. brevifacies, | *Procamelus madisonius,* |
| | | P. heterodon, | P. occidentalis? |
| | | Protolabis, | *P. lacustris,* |
| | | | Blastomeryx gemmifer, |
| Poebrotherium, | Poebrotherium, | | Cosonyx necatus |
| | Hypertragulus calcaratus, | | C. furcatus, |
| | | | *C. agilis,* |
| | | Mastodon proavus, | *Palaeomeryx americanus,* |
| | | | *P. madisonius,* |
| Turtles, | | | Mastodon, |
| Fishes, | | | Testudo nebrascensis, |
| Snails, | | | Birds, |
| | | | Clams. |
| | | | Fossil wood. |

*Am. Phil. Soc. Oct., 1893.

The greater part of my collection was obtained along the bluffs bordering the lower Madison valley on the east. These extend north and south for a distance of fifteen miles, being in some places seven hundred feet or more in height. Though there are no permanent streams cutting through them, occasional heavy rains and melting snows have carved many ravines into the soft material, and exposed much of the rock. On the northern slopes grass and trees sometimes grow in abundance, while the hot dry southern slopes only support dwarf cedars, scattered, hardy shrubs, cacti, and occasional bunches of grass. The conditions are favorable for the finding of fossils if they occurred in any great number.

All the Madison valley fossils with the exception of a few teeth and bones, and the skull and jaw of a rodent taken from the White River beds were found in the Loup Fork strata.

I have found a limited number of fossils from both horizons in widely separated localities from near Lima on the Red Rock to the vicinity of Townsend on the Missouri.

Southeast of Dillon is an exposure of a few rods in extent where fragments of teeth and bones were quite numerous. Prof. E. A. Steere, then principal at Dillon, discovered this locality in 1894, and obtained from it parts of upper and lower jaws and teeth, with other bones, of a species of Protohippus.

West of the main divide * only a few fragments have been found, among which are a small piece of mastodon tooth, the distal end of the ulno-radius of a camel, an incisor of a rodent—probably Sciurus, and a few pieces of fossil wood, found in the Bitter Root valley. Some who have dug wells have found fossil wood and fragments of bone; but, so far as I have examined them, these beds are very poor in fossils.

There were lakes west of the mountains that existed in later times than the others that have been described. In the latter region there are few, if any, places where the ancient shore line can be plainly traced. In the Missoula and Bitter Root valleys on the mountain sides and along the foot hills are level lines or small terraces, evidently shore lines, formed by the dashing of waves against the mountain sides. These can be nicely studied around Missoula. The University buildings stand at the foot of a steep mountain slope, and on this slope about sixty of these lines can be counted, beginning near the foot and extending upward, perhaps a thousand feet. The same is seen on Mt. Jumbo, and on the hills north of Missoula. They

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* Since this was written a small Loup Fork exposure near Drummond has yielded some excellent specimens. Several White River fossils were found near the same place.

are also found along the Bitter Root. Prof. Elrod says they are still plainer in the region of Flathead Lake. These lines are always level and keep at the same altitude along mountains of hard quartzyte and hills of loose gravel. It is difficult to see how these lines can be preserved so long where the material is soft and incoherent; and one is led to believe that the water cut with comparative rapidity through its barrier in geologically recent times. When the water reached its highest point it remained for a long time at or near the same level. Prof. Bailey Willis of the U. S. Geological Survey who has visited this region suggests the idea that this was a Pleistocene lake dammed by a glacier. In the Missoula valley are soft laminated clays quite different in appearance from these from which fossil bones were found.

The lake beds lie in contact with all the older formations that occur in the western part of the state—the Archaeon, Algonkian, Cambrian, Devonian, Triassic, Jurassic, and Cretaceous.* The newer beds lie unconformably on the older—at least in many places—and in the interval between the deposition of the two the White River beds were tilted and carved into hills and benches and valleys, and the waters covered them again, after nearly all vertebrate life had changed, and a new deposit was made with remains of a later fauna entombed in it.

The most of the remains found are mammals and turtles, though there are a few fragments of bird bones, representing two or three species. Many snails and a few clams have been collected but have not been determined.

I have had time to study and describe only a small portion of my collection, and then under circumstances not the most favorable; though the young and growing University of Montana has done all it could to help me. It has been my effort to make as few mistakes as possible, yet, as circumstances have compelled me to work alone, isolated from other collections and libraries complete with the literature needed, it is impossible that no mistakes should be made. So I ask the kind indulgence of those older in the work and more favorably situated. I think it better to do the best I can than to leave other workers in perfect ignorance of what is found here.

It could hardly be expected that in the formation with fossils so much resembling the Loup Fork of Nebraska there should be so many new species as I have described. I have described none however that I could classify with the species already found; though it is sometimes difficult to settle the matter by the short descriptions and

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* For general history of these lake basins see Livingston and Three Forks folios of the U. S. Geological Survey.

measurements without illustrations that have sometimes been given. I recognize the fact that species making is only the beginning of the work of the palaontologist, but it is the beginning.

The fossils described were found by myseif with the exception of one, for which due credit will be given in the proper place.

Though this is only a preliminary paper, and I hope in the near future to publish something more complete, I wish to heartily thank those who have taken an interest in the work without whose help I could not have even done as well as I have done. Especially am I indebted to Dr. Oscar J. Craig and Prof. Fred D. Smith, of the Montana State University, who have taken such an interest and done so much to help me in my work; and to Prof. M. J. Elrod for his constant enthusiasm, encouragement, and practical assistance in more ways that I can mention. To Dr. W. B. Scott, of Princeton University, I owe a debt of gratitude for his generosity and willingness at all times to give advice and assistance. My friend Mrs. H. C. Irish, of St. Louis, Mo., inked the drawings, but she is not responsible for any incorrectness in them. To the many others who have given so much help and shown so much kindness I can only express my gratitude in a general way.

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# DESCRIPTIONS OF SPECIES.

## ARTIODACTYLA.

### GOMPHOTHERIUM SERUS, N. SP.

PLATE I.

This species is represented by the anterior part of a mandible, with alveoli of incisors and canine, the coossified symphysis, a first and second premolar nearly complete, a broken third premolar, a complete fourth premolar, and a small portion of the first molar. One side of the mandible is broken back of the symphysis, and the other below the first molar.

The symphysis is rather long and completely coossified. The incisors were large, apparently decreasing somewhat in size from the first to the third. The canine was close to the third incisor. The *foramen mentale* is below the front part of first premolar. Premolar 1 is a simple cusp, but with two strong roots. It is placed nearly equally distant between the canine and the second premolar.

From premolar 1 the upper border of the ramus rises gently and then more abruptly to premolar 2. The second premolar is compressed laterally with a longer cutting edge but is only a trifle longer at the base than the first. Premolar 3 is considerably larger than premolar

2, and premolar 4 still larger than premolar 3. The last premolar is much like that of *Procamelus occidentalis* Leidy, and of *P. lacustris* to be described later. The ramus is rather slim. The incisors were nearly procumbent.

Found by myself in a clay cliff in bluffs on the east side of the Madison valley, Gallatin Co., Mont.

MEASUREMENTS.

| | M. |
|---|---|
| Length of diastema between canine and first premolar....... | .015 |
| Length of diastema between first and second premolars..... | .017 |
| Length from front of jaw to second premolar................. | .056 |
| Length of premolars 2, 3 and 4............................ | .029 |
| Length of first premolar.................................. | .0065 |
| Length of second premolar................................. | .008 |
| Length of third premolar.................................. | .0105 |
| Length of fourth premolar................................. | .0112 |
| Depth of ramus beneath premolar 2......................... | .021 |
| Depth of ramus beneath molar 1............................ | .025 |
| Length of symphysis ...................................... | .040 |

## PROTOLABIS MONTANUS, N. SP.

PLATE III.

Represented by the entire superior dentition of the right side, with the exception of the first incisor, which has fallen out of the alveolus.

All the incisors were large, well developed teeth. The first, judging from its alveolus, was as large as the second.

The species was larger than *P. transmontanus* Cope* from Cottonwood Creek, Oregon. I will give the main points of difference between this and Cope's specimen.

In the present species the distance between the third incisor and the canine is twice as great. The height of the crown of incisor 3 is greater. In *P. transmontanus* molar 2 is as wide as long. In the present species the anteroposterior diameter is greater than the transverse. This is also true of molar 3. Premolar 2 is two-rooted but is small as compared with premolar 3, which is a trifle longer than premolar 4.

In the present specimen there are two first premolars of almost the same shape and size. They are closely crowded. The anterior one is slightly larger than the other, and perhaps should be taken for the permanent tooth. This, measuring from the roots of the teeth,

*Bulletin U. S. Geol. Surv. of Territories, Vol. V., No. 1, p. 67.

would much more evenly divide the space between the canine and premolar 2 than in *P. transmontanus,* where premolar 1 is only about a third the distance from the canine. If the posterior tooth be taken as the permanent one, then the conditions would be reversed and premolar 1 would be a little more than a third the distance from premolar 2 to the canine.

Incisor 3 is a long (high) robust tooth, much larger than the canine, but much like it in shape, being pointed, slightly curved forward, and subround in section. The first premolar is smaller than the canine antero-posteriorly, is not so high and is more flattened on the inner side. Only the top is coated with enamel.

Premolar 2 has nearly the form of a half cone.There are two slight concavities on the inner side, one anterior and one posterior to the median line. On the outside of premolar 3 is a small anterior ridge, posterior to this a broad convexity on the protocone, and back of this a smaller one and a well developed posterior ridge.

The molars are so much like those of *Gomphotherium cameloides* figured by Wortman (Extinct Camelidae of North America,*) that if only the molars had been found they would have been taken for teeth of that species. The length of the last three premolars and the molars is about one-fifth greater in *Protolobis Montanus.*

The last two molars differ from the corresponding ones of *P. Transmontanus* in being less quadrate, the posterior portion being narrower than the anterior.

Dug from a clay cliff, Miocene lake beds, lower Madison valley, Montana.

Portions of the posterior part of the lower jaw were found, including a mutilated third molar.

MEASUREMENTS.

| | M. |
|---|---|
| Length of dental series from front of base of first incisor..... | .195 |
| Diastema between incisor 3 and canine, length.............. | .012 |
| Length of incisor 3, anteroposterior........................ | .0095 |
| Width of incisor 3, transverse.............................. | .009 |
| Diastema between canine and premolar 1............. .015 or | .021 |
| Diastema between premolar 1 and premolar 2.......... .019 or | .014 |
| Length of three contiguous premolars....................... | .038 |
| Length of Premolar 2...................................... | .009 |
| Length of Premolar 3...................................... | .016 |
| Length of Premolar 4...................................... | .0148 |
| Width of premolar 3, greatest.............................. | .009 |

*Am. Mus. Nat. Hist.; Vol. X, Art. VII, p. 118.

| | |
|---|---|
| Width of premolar 4, greatest | .0133 |
| Length of true molar series | .066 |
| Length of molar 1 | .0208 |
| Width of molar 1 | .018 |
| Length of molar 2 | .025 |
| Width of molar 2, greatest; anterior | .0215 |
| Width of molar 3, posterior | .017 |
| Length of molar 3 | .025 |
| Width of molar 3, anterior | .022 |
| Width of molar 3, posterior | .0165 |

## PROCAMELUS MADISONIUS, N. SP.

### PLATE II.

This species is represented by a nearly complete cranium found by Mr. Dunbar of Gallatin City several years ago, at the foot of the bluffs bordering the Madison valley. The molars on one side had been broken away. I purchased the specimen and on clearing away the hard matrix found most of the cheek teeth on the other side in a good state of preservation. The skull is considerably broken and crushed anteriorly, and the roof of the brain case including the sagittal crest is gone.

The skull differs in many respects from that of *P. occidentalis* Leidy, found by Cope in the Loup Fork beds of New Mexico.

The skull is about one-fifth larger than that of *Camelus dromedarius* and is proportionally broader. The width between the second premolar and third incisor is more nearly uniform; but the palate widens much back of premolar 4. The malar ridge of the maxillary is almost obsolete; being represented by only a slight narrow prominence at the anterior-inferior border of the molar. The posterior part of the malar rises to the middle of the orbit; the anterior part does not rise as high as the middle of the orbit—only about one-third the height. The zygomatic process of the squamosal is higher relatively to the orbit than in Cope's specimen or in the modern camel and is arched upward being inserted obliquely into the notch of the malar just back of the lower half of the orbit. Though the skull is broken in this region I judge that the lachrymal sinus was small.

The anterior-inferior border of the basioccipital is not angulate, but is smoothly rounded, as is also the basisphenoid. In front of the occipital condyle there is a quite high, broadly sloping, transverse ridge, divided in the middle by an oblong fossa. Posteriorly this fossa is continued in the form of a suture which is evidently the division line between the imperfectly coossified occipitals. Above the *foramen* *magnum* on the median line of the occipital is an acute angular ridge.

The *foramen infraorbitale anterius* opens above the posterior part of the fourth premolar and the anterior part of the first molar.. The palatal notch is V-shaped and extends forward as far as the posterior part of the second true molar.

The third incisor is a small tooth in comparison with the canine which is large, robust, and oval in section. The second premolar is quite large being about four-fifths as long antero-posteriorly as premolar 3. Premolar 3 is almost the same in form as that of *P. occidentalis,* figured by Leidy. The exterior-anterior part of premolar 4 is slightly concave but back of that slightly convex. In the molars the anterior external ridges or horns of the crescents extend somewhat forward, overlapping the tooth in front; but they do not extend outward very prominently. The external ridges on the middle of the crescents are mostly feeble. The first premolar is one-rooted. It is a little longer than the third incisor.

## MEASUREMENTS.

| | M. |
|---|---|
| Total length of skull, about | .380 |
| Length of part preserved | .370 |
| Length of incisor 3 | .008 |
| Height of incisor 3 | .012 |
| Diastema between incisor 3 and canine | .014 |
| Length of canine antero-posterior | .015 |
| Width of canine | .011 |
| Canine to premolar 1 | .013 |
| Length of premolar 1 | .010 |
| Width of premolar 1 | .0082 |
| Premolar 1 to premolar 2 | .020 |
| Last three premolars | .045 |
| Length of premolar 2 | .014 |
| Length of premolar 3 | .017 |
| Width of premolar 3 | .010 |
| Length of premolar 4 | .0164 |
| Width of premolar 4 | .016 |
| Length of molar series ... about | .082 |
| Width between last incisors | .023 |
| Width between canines | .023 |
| Width between first premolars | .023 |
| Width between second premolars | .026 |
| Width between fourth premolars | .033 |
| Width between second molars, front | .0426 |
| Width between third molars | .058 |

| | | |
|---|---|---|
| Antero-posterior diameter of orbit | | .048 |
| Perpendicular diameter of orbit | about | .043 |

It is possible that this skull may belong to some species the inferior dentition of which has already been described; but in the same locality I have found two rami which I provisionally refer to the same species. These rami are different from anything with which I am acquainted. It is possible that these two specimens are from distinct species, but they are so nearly alike that I prefer to consider them as one until other parts are found.

Mandible. The specimen which I take as a lower jaw type consists of a horizontal ramus broken off a little back of the second molar, with a third incisor, the first premolar, and the first molar complete, and the larger part of the second molar, with parts of alveoli of incisors 1 and 2, of the canine, and complete alveoli of the third and fourth premolars, with a small portion of premolar 4.

The jaw is slender. The lower part of the anterior portion in front of the angle of the chin, is nearly horizontal but slightly concave to a point below the third incisor. Here there is a rather abrupt upward curve, but the exact shape of this portion is difficult to make out as it is somewhat broken and displaced. The third incisor is rather broad and thin, concave within, and convex on the outside. It is semiprocumbent, as were also the first and second incisors. There is a short diastema between the third incisor and the canine, which, judging by the portion of the alveolus remaining, was not a very large tooth. The distance between the canine and the first premolar is about 20 mm., and the distance from the first to the second premolar is about the same. The first premolar is small and thin with sharp edges and a long backward-curving root. The second premolar was small and one-rooted. Molar one has a high crown. The *foramen mentale* is near the angle of the chin, just in advance of premolar 1. There is another foramen beneath premolar 3. The jaw fits fairly well the skull just described.

MEASUREMENTS.

| | M. |
|---|---|
| Length of jaw from third incisor (anterior edge) to molar 3 | .192 |
| Canine to first premolar, about | .020 |
| First premolar to second premolar | .021 |
| Alveoli of premolars 2, 3 and 4 | .045 |
| Length of third incisor | .011 |
| Width of third incisor, transverse | .006 |
| Height of third incisor | .020 |

| | |
|---|---|
| Length of first premolar | .007 |
| Width of first premolar | .004 |
| Length of first molar | .031 |
| Width of first molar | .015 |
| Height of first molar (greatest) | .020 |
| Length of second molar | .035 |
| Depth of ramus behind third incisor, about | .033 |
| Depth of ramus behind premolar 1 | .0294 |
| Depth of ramus beneath premolar 2 | .031 |
| Depth of ramus beneath molar 1 | .0367 |
| Depth of ramus under molar 2, posterior part | .041 |

Found in clay cliff, lower Madison valley, Montana.

The second jaw fragment contains premolars 3 and 4 and molars 1 and 2, and a fragment of the mandible. The teeth are large but the ramus is even more slender than the corresponding part of the one previously described. Premolars 3 and 4 are about the same size. The latter has a posterior valley. This tooth does not fill the posterior part of its alveolus. The lower border of the ramus is nearly straight. There is a small alveolus under molar 1.

MEASUREMENTS.

| | Premolar 3. | Premolar 4. | Molar 1. | Molar 2. |
|---|---|---|---|---|
| | M | M. | M. | M. |
| Length.. | .0185 | .020 | .028 | .0347 |
| Breadth | .0085 | .009 | .018 | .020 |
| Height.. | .013 | .013 | greatest .022 | greatest .026 |

| | |
|---|---|
| Length of last two premolars and first two molars | .0965 |
| Depth of ramus beneath premolar 3, anterior | .028 |
| Depth of ramus beneath Molar 1, anterior | .028 |
| Depth of ramus beneath molar 2, anterior | .029 |
| Depth beneath molar 2, posterior | .032 |

Found in lower Madison valley, Montana.

### PROCAMELUS LACUSTRIS, N. SP.

PLATE I, Figure 2.

The type specimen of this species is the left mandibular ramus with all the teeth except the incisors. The dentition with the exception of the canine is nearly like that of *P. occidentalis* Leidy. The principal differences so far as I can determine are in the smaller and more compressed canine and the depth of the ramus, which is much slimmer than in *P. occidentalis.* Premolar 2 is also more robust than in the specimen figured by Leidy. There are some minor differences in the teeth which approach nearer to *P. angustidens* Cope, especially in the form of molar 3 and the inner surface of the molars; but the specimen is smaller; premolar 4 differs in width; and molar 1 is shorter. From Cope's description I judge that the diastemata are shorter.

There is a very large mental foramen, the posterior part of which is beneath the anterior part of premolar 1. It is very deep and oval in shape. There is also a small foramen below the line of contact between premolar 4 and molar 1. About one third the distance from the lower border of the jaw there is a depression extending beneath the last three premolars and the first molar. On the inner side one extends near the lower border under the molar series.

MEASUREMENTS.

| | M. |
|---|---|
| Length of first diastema | .0165 |
| Length of canine | .008 |
| Width of canine | .005 |
| Length of premolar 1 | .009 |
| Width of premolar 1 | .0047 |
| Length of second diastema | .012 |
| Length of premolar 2 | .0124 |
| Width of premolar 2 | .006 |
| Length of premolar 3 | .015 |
| Width of premolar 3 | .0065 |
| Length of premolar 4 | .0177 |
| Width of premolar 4 | .009 |
| Space occupied by all the premolars | .064 |
| Length of molar 1 | .022 |
| Width of molar 1 | .014 |
| Length of molar 2 | .0263 |
| Width of molar 2 | .0153 |
| Length of molar 3 | .035 |
| Width of molar 3 | .014 |
| Length of last three premolars and the three molars | .1236 |
| Depth of mandible below premolar 1 | .019 |
| Depth of mandible beneath premolar 2 | .0232 |
| Depth of mandible beneath premolar 4 | .0254 |
| Depth of mandible beneath molar 1, anterior | .026 |
| Depth of mandible beneath molar 3, front | .0335 |
| Depth of mandible beneath molar 3, back | .046 |

Found in the Loup Fork beds of the lower Madison valley, Montana.

Besides the camel remains above described there are many others which will be described in a future paper.

## PALAEOMERYX.

This genus is represented in my collection by portions of two mandibles, and, probably, by the superior dentition posterior to the second premolar. One ramus contains the six molars and premolars complete, and is in every essential character like the European *Paleomeryx* including the characteristic Paleomeryx fold. The other larger species is represented by a portion of the ramus containing the three molars, somewhat broken, but all showing this fold more plainly than in the preceding from which in it has nearly disappeared—especially on molar 1—on account of the teeth being much worn.

There is now little doubt that the name *Palaeomeryx* as now used applies to American as well as Old World species; but this is no cause for surprise as its discovery has been expected. Though these jaw fragments belong to the genus called *Palaeomeryx* yet it does not settle all the points of doubt respecting this genus. A series of upper teeth in my possession correspond in size with the portion of mandible of the smaller species; and though they were not found together, I have little doubt that they belong to the same species. These upper teeth are very much like those of *Blastomeryx antilopinus* Scott, so I think that, as Scott mistrusted, *Blastomeryx* is really *Palaeomeryx*, if as Schlosser suspected the type of the latter possessed horns, or, if the possession of horns is not of generic value.

Note.—Since writing the above I have found a skull, which, though still in the matrix, is evidently almost like Cope's *Blastomeryx* and is about the same size. With it is a mandibular ramus and other bones. I partly cleared the matrix from the mandible and find that it differs little from the two mandibles here described except that it is larger than either. This much is certain that the skull of the so called *Blastomeryx* has been found associated with a mandibular ramus that differs in no important particular from the European *Palaeomeryx*. In camp near Drummond, Mont., July 18,1899.

### PALAEOMERYX AMERICANUS, N. SP.

PLATE IV, Figures 2 and 3.

Lower jaw. The horizontal ramus is slim and nearly uniform in width from premolar 2 to molar 3, with a regular downward curve, being in this respect almost like *P. sansaniensis.* * There is a small

* See Filhol's Etude sur les mammiferes fossils de Sansan P. 255 Pl. 26.

mental foramen a little in advance of premolar 2. From in front of this foramen a depression extends backward nearly parallel with the inferior and superiors borders of the ramus, to where the ramus is broken off beneath molar 3. This depression is nearer the inferior margin, being about one-third the distance from the inferior to the superior borders. In front of premolar 2 the upper margin of the jaw slopes downward to where it is broken. Looking from above the ramus is slightly sigmoid.

Premolar 2 is much like the corresponding tooth in *P. sansaniensis* On the anterior-interior face of the tooth is a concavity looking inward and upward. The protocone on the inner face is nearly conical. It is joined on the anterior-external side by a sharp ridge forming the outer boundary of the anterior depression. Opposite this on the posterior-internal side of the protocone a short ridge joins the two posterior lobes, or connects with the anterior horn of the crescent. The valley between the limbs of this crescent looks more backward than in *P. sansaniensis.* This is also true of premolar 3. In the latter tooth the two anterior lobes are more separated, that is, form a greater angle, than in the specimen figured by Filhol, in this respect being more like premolar 4 than in Filhol's specimen. In the American specimen instead of there being an enclosed depression on the posterior part of the tooth there is a gully opening inward. In premolar 2 the middle lobe is directed obliquely backward as in *P. sansaniensis.* This lobe in premolar 3 is directed forward. Premolar 4 is little different from Filhol's specimen except that there is a narrow gully opening inward which would be obliterated on further wear. Premolar 2 is slightly, premolar 3 more, and premolar 4 considerably worn; while molar 1 is much worn, molar 2 less and molar 3 only slightly so.

The enamel is smooth on the interior and somewhat rugose on the outside, but more especially so on the outside of the true molars.

MEASUREMENTS.

| | Premolar 1. | Premolar 2. | Premolar 3. |
|---|---|---|---|
| | M. | M. | M. |
| Length | .0088 | .011 | .011 |
| Width | .0042 | .006 | .007 |
| Height | .005 | .007 | .007 |

On account of its worn condition the anterior enamel lake in molar 1 is partly obliterated, making two small ones. The enamel of the small median external lobe is continuous with the posterior outer crescent. This crescent is still entirely separated on the grinding surface from the rest of the tooth, but a little more wear would make it confluent with the posterior internal crescent on the posterior internal angle of the tooth. The Palaeomeryx fold on account of the worn condition of the tooth is represented by only a slight deflection of the enamel. There is a cingulum on the anterior outer part of each molar.

In molar 2 the Palaeomeryz fold is seen as a slight bulging of the enamel, and the median pillar is flat on top as if worn by contact of another tooth; but it does not extend as high as the other part of the tooth. In section it is a sharp oval with the narrow part pointing inward. This in the third molar is a small pillar ending in a point. There is a minute one between the second and third lobes. The characteristic fold is plainly seen on the third molar, extending from the inner point of the anterior crescent almost perpendicularly into the median valley.

MEASUREMENTS.

| | Molar 1. | Molar 2. | Molar 3. |
|---|---|---|---|
| | M. | M. | M. |
| Length | .0125 | .014 | .020 |
| Width | .010 | .0104 | .0105 |
| Height | .006 | .008 | .010 |

The depth of the ramus under the teeth is .016 to .017 M. From Loup Fork beds, lower Madison valley, Montana.

Upper teeth. With the inferior dentition above described I have associated a series of five upper teeth—the molars and last two premolars. They are very much like the corresponding teeth of *Blastomeryx antilopinus* Scott, and it may prove to belong to the same species. In size these teeth match with those of the lower jaw above described; and there is the same roughening of the enamel on the molars; but they are rugose on the inside instead of on the outside. The outside of the molars is more smooth as are also the premolars.

In the molars the transverse diameter is greater than the antero-posterior. On molar 2 the enamel on the internal crescents is perfectly simple except that on the anterior side of the posterior crescent just exterior to the termination of the posterior horn of the anterior crescent there is a small projection of the enamel toward the posteror-interior side of the antero-external crescent. This descends obliquely and joins the latter. There is a similar pillar on the corresponding part of molar 3 but the enamel does not appear to be continuous with that of the crescent.

Molar 1 is much worn so as to nearly obliterate the enamel lakes. The antero-interior part of the tooth is broken off so the median pillar is not shown. In molar 2 this pillar stands more obliquely than in Cope's representation of *Blastomeryx borealis.** The pillar is broken on molar 3, but it is evidently longer than on molar 2.

*The Artiodactyla Amer. Nat. March, 1899, p. 123.

MEASUREMENTS.

| | |
|---|---|
| Length of premolar 3 | .0115 |
| Width of premolar 3 | .012 |
| Length of premolar 4 | .010 |
| Width of premolar 4 | .0125 |
| Length of molar series, about | .044 |
| Length of molar 1 | .014 |
| Width of molar 1 | .016 |
| Length of molar 2 | .016 |
| Width of molar 2 | .017 |
| Length of molar 3, about | .016 |
| Width of molar 3 | .016 |

From the Loup Fork beds of the lower Madison.

### PALAEOMERYX MADISONIUS, N. SP.

Besides the teeth and jaw described under *P. americanus* I have an upper third premolar, and part of a mandible, found in different localities. These belong to a larger species. This is evidently a younger animal than the smaller one just described. The teeth are higher, being less worn. The enamel is roughened as in that species. The Palaeomeryx folds are plainly seen on the three molars, which are the only teeth preserved. The median internal pillars are smaller proportionally. There is a small one between the second and third crests of molar 3. This ramus lacks the long depression near the lower border, but there is a broad, shallow concavity on the inner side.

MEASUREMENTS.

| | Molar 1. | Molar 2. | Molar 3. |
|---|---|---|---|
| | M. | M. | M. |
| Length, about | .013 | about .015 | about .023 |
| Breadth | .0095 | .010 | .0103 |
| Height | .0085 | .010 | .0115 |

The upper third premolar differs from the corresponding tooth of *P. americanus* in its greater size and the greater wear has divided the long enamel lake into two smaller ones, and the small lake on the posterior side is narrow, longer, and more crescentic. The association of this tooth with the above described jaw fragment is simple presumption.

### COSORYX AGILIS, N. SP.

PLATE IV, Figure 1.

In the bluffs which lie on the eastern side of the lower Madison valley, I found several fragments of small animals related to the antelopes. Two or three jaw fragments are like *Blastomeryx gemmifer*

Cope. Other portions of jaws and horns appear to belong to *Cosoryx furcatus* Leidy, and *C. necatus* Leidy. In one place I discovered a nearly complete skull, and a complete mandible of a Cosoryx which I believe to be a new species. These were associated with a manus and pes, lacking part of the phalanges, a radius and ulna, part of pelvis, three lumber, one sacral and three dorsal vertebrae, portions of ribs and other fragments. The animal was young and probably not quite full grown.

In the skull both zygomatic arches are broken off and the upper part of the face is injured anterior to the orbits. The animal was probably a female, as there are no signs of horns.

The last upper molar had recently protruded and had not yet reached the height of the others. On the left side the three temporary molars had recently been shed and the three permanent ones were all just protruding. The last premolar, which was double, like the true molars, was shed but caught between the upper and lower teeth, from which I removed it. On the right side only the first milk premolar is shed. The next one (premolar 3) is more triangular than the last temporary premolar or the permanent molars; the antero-interior lobe not being so well developed. The permanent premolars have each one external and one internal crest. In premolar 3 a limb runs outward and backward from the inside of the internal crescent.

The molars are long vertically like those of *Antilocapra*. The anterior horns of the external crescent do not project quite so strongly but the median rib of the antero-external crescent is very much more prominent, and is large in proportion to the size of the tooth. The orbit is lower than in *Antilocapra* and is placed farther forward, the anterior border being above the posterior part of the second molar. A ridge begins at the antero-inferior border of the orbit, and extends forward branching above the first molar—one branch descending and dying out above premolar 3, the other extending forward to the mental foramen which is just in front of a line passing upward from premolar 2. Above this ridge in front of the eye is a concavity.

The facial vacuities were large and occupy about the same position as in *Antilocapra* In the center of the forehead between the front parts of the orbits is a depression situated somewhat farther forward than the corresponding one in the prong buck. Back of this the shape of the skull is very different in the two animals. In Cosoryx, instead of a broad transverse ridge which connects the horns, in the former there is a high center sloping gently fore and aft, and slightly less so laterally. Above the orbit where the broad rims, which form the roof of the orbit connect with the other part of the skull, are two elliptical depressions extending in the direction of the long axis of the skull. In the posterior part of these depressions open the *supra-orbital fora-*

*mina* which are small. The back of the skull is more rounded, narrower, and proportionally longer than in *Antilocapra*. From the upper posterior part of the orbit narrow depressions extend backward and unite on the parietal bone half way between the suture which separates that bone from the frontal, and the inion. At their junction a low ridge representing the sagittal crest begins and extends back to the occupit. The upper posterior portion of the skull is more like that of *Oreodon* than of the deer, prong buck or sheep. It is much like that of the camel. In *Camelus dromedarius* the sagittal crest is more strongly developed, is longer, the downward slope toward the occiput is not so sharp; and the inion projects more superiorily and posteriorly. In the region of the inion it is almost like the corresponding part of the cat.

The *otic bullae* are very large as is also the *meatus auditorius externus*. The orbits are also large and extend outward very prominently.

The lower jaw is complete with all the teeth except the canine and the third incisor of the left side.

The incisors are of nearly the same size and shape, being slightly spatulate or wider on the cutting edge, which is round and sharp. The canine has nearly the same form but is smaller. It joins the third incisor as in modern ruminants. The disastema is long and the ramus slim beneath. The *foramen mentale* is situated about one-fourth the distance from incisor 3 to premolar 2. There is another small foramen just forward of premolar 2. It is a little farther forward on the left than on the right side.

Permanent premolar 2 is just protruding. The other premolars are of the deciduous set. Temporary premolar 3 is three lobed, as is also premolar 4 which is much longer.

The molars are prismatic and differ little from those of Antilocapra. The mandible and inferior dentition differ from Scott's description of *Cosoryx furcatus* * in the following respects. The mandible is more convex both on the outside and inside than in Antilocapra making the jaw more robust. The valleys of the molars are proportionally as wide and as long as in that genius. The second incisor is slightly the largest. The first molar is as large as the second. The chin is different from Scott's figure, not being at all prominent. The angle is formed by a slight descent beneath the *foraman mentale*. It then continues forward horizontally until it ascends abruptly beneath the incisors. The foot bones are nearly like those of Blastomeryx described by W. B. Scott. **

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*Bull. Mus. of Comp. Zool. 1890. Vol. XX, No. 3, p. 82.

** Ib. page 80.

MEASUREMENTS.

| | M. |
|---|---|
| Length of skull back anterior part of Premolar 2............. | .108 |
| Length of molar—premolar series, upper..................... | .045 |
| Length of molars, upper.................................... | .0275 |
| Length of mandible ........................................ | .115 |
| Length of inferior molar premolar series................... | .048 |
| Length of inferior molar series ........................... | .029 |

## PERISSODACTYLA.

### ACHITHERIUM VON MEYER.

In my collection from the lower Madison valley are two specimens consisting of the five upper posterior cheek teeth and a mandibular ramus of another individual. The jaw fragment contains the symphysis and the incisors, some of which are broken. I refer both of these fragments to the same species, as they correspond in size, and there is no reason to believe that they belong to separate species. I use *Anchitherium* in the restricted sense in which Scott has used it. The Madison species thus being, so far as I know, the second found in America. It is much smaller than *A. aurelienense* Cuv., or *A. equinum* Scott.

### ACHITHERIUM MINIMUS, N. SP.

This species differs from A. equinum in the following respects. In upper premolar 3 the cross crests are united by an isthmus across the median valley, this forming two enamel lakes as in the modern horses. This is not the case in premolar 4, and the anterior transverse cross-crest does not reach the outer wall of the crown, but perhaps would on further wear. The posterior pillar is proportionally larger than in Scott's specimen. There is a small pillar at the entrance of the mediam valley in premolar 3.

In molar 1 the median transverse cross crest is more sigmoid than in *A. equinum.* The posterior pillar is connected with the hypocene. It has a single enamel loop extending outward. The outer crescents have rather faint median ridges, the anterior being the more prominent.

All the teeth are considerably worn except molar 3, in which the external crescents are unworn, simple, and separated from the external ones by deep valleys. The animal was much smaller than *A. equinum*

MEASUREMENTS.

| | M. |
|---|---|
| Length of upper posterior five cheek teeth................... | .067 |
| Length of upper molar series .............................. | .0415 |

| | |
|---|---|
| Length of upper third premolar | .015 |
| Width of upper third premolar | .0194 |
| Length of upper fourth premolar | .013 |
| Width of upper fourth premolar, about | .018 |
| Length of upper first molar | .0135 |
| Width of upper first molar | .0173 |
| Length of upper second molar, about | .013 |
| Width of upper second molar, about | .0163 |
| Length of upper third molar | .0135 |
| Width of upper third molar | .017 |

Lower jaw.—The incisors are nearly uniform in size and are semi-procumbent. There is no disastema between the incisors and canine; but the one between the canine and the first premolar is much longer than in *A. equinum*, both relatively and actually; and the canine is proportionately higher, projecting high above the grinding surface of the incisors. The symphysis is very long. The alveolar border is elevated above the anterior border of the jaw. The first premolar is a small, simple, flattened, subconical tooth. In the second premolar there is a slight valley on the anterior-external side. The tooth is a little more worn than in the specimen of *A. equinum* figured by Scott, but is nearly of the same shape. The other premolars and molars are also of nearly the same form.

### MEASUREMENTS.

| | M. |
|---|---|
| Length of mandible to molar 3 | .111 |
| Width of second lower incisor | .0055 |
| Length of third lower incisor, about | .0055 |
| Length from canine to premolar I, between alveoli | .0325 |
| Length of premolar series | .0445 |
| Length of lower first premolar | .006 |
| Width of lower first premolar | .0032 |
| Length of second lower premolar | .0136 |
| Width of lower second premolar | .0077 |
| Length of lower third premolar | .013 |
| Width of lower third premolar | .0095 |
| Length of lower fourth premolar | .012 |
| Width of lower fourth premolar | .0103 |
| Length of lower first molar | .0108 |
| Width of lower first molar | .0097 |
| Length of lower second molar | .0106 |
| Width of lower second molar | .009 |

Both the above specimens were found in the Loup Fork formation in the lower Madison valley.

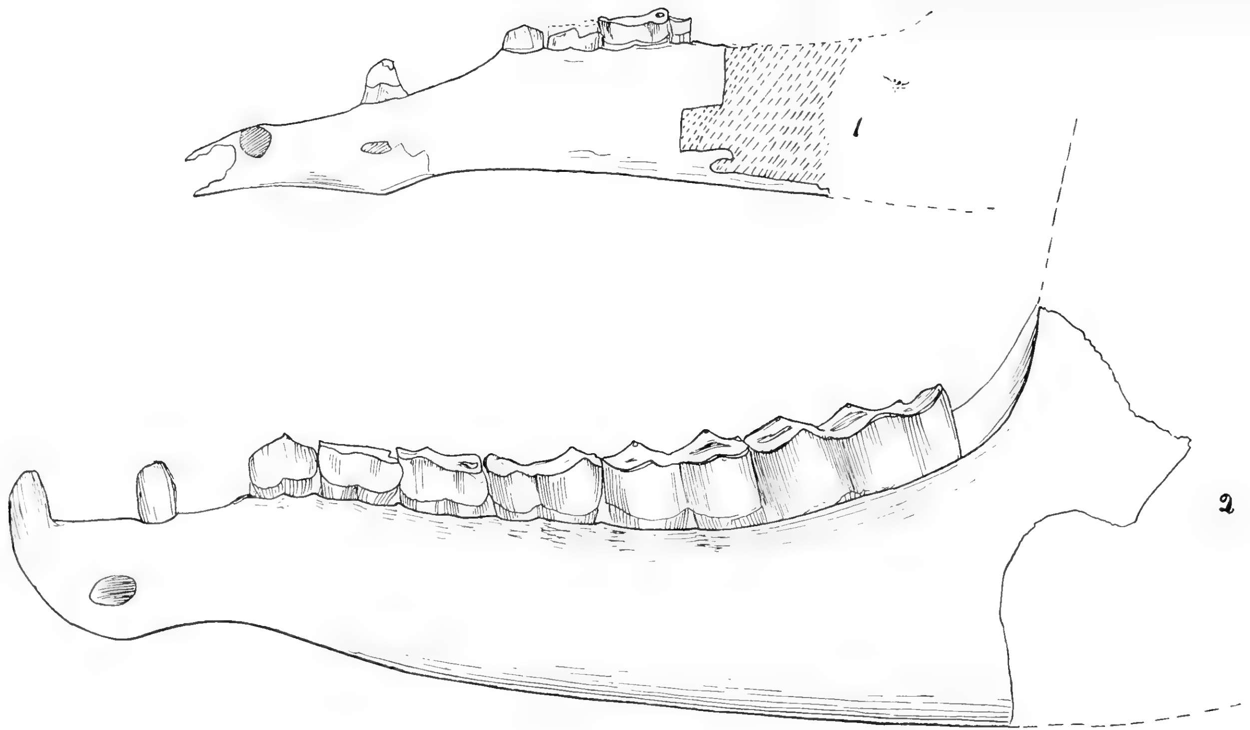
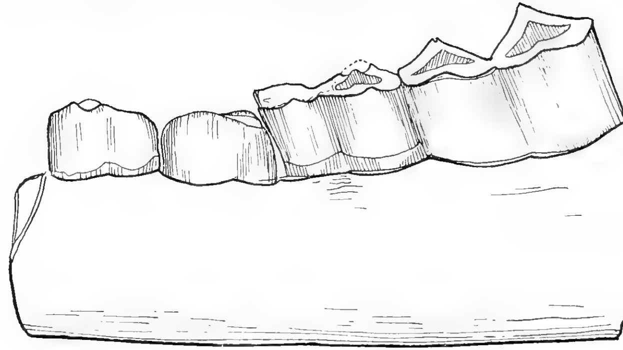



PLATE I.

Fig. 1—Gomphotherium serus, n. sp. Part of left mandibular ramus, x$\frac{4}{5}$, Page 12. Fig. 2—Procamelus lacustris, n. sp. Left mandibular ramus, x$\frac{3}{4}$, Page 18.



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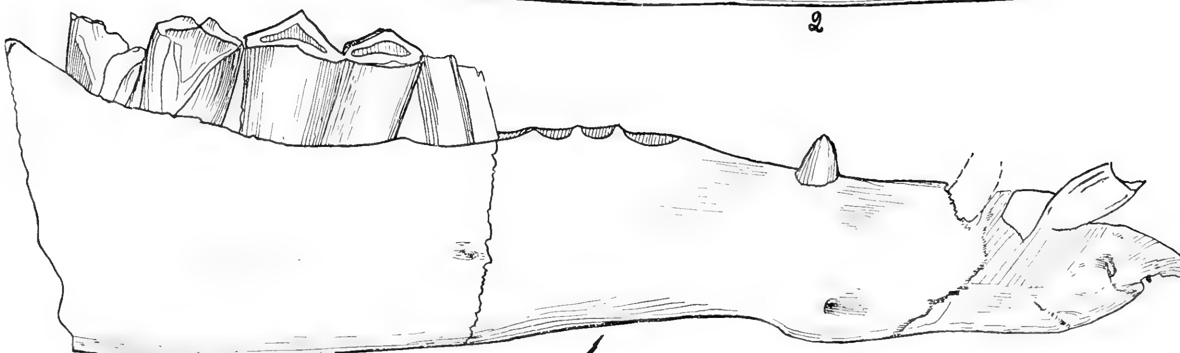

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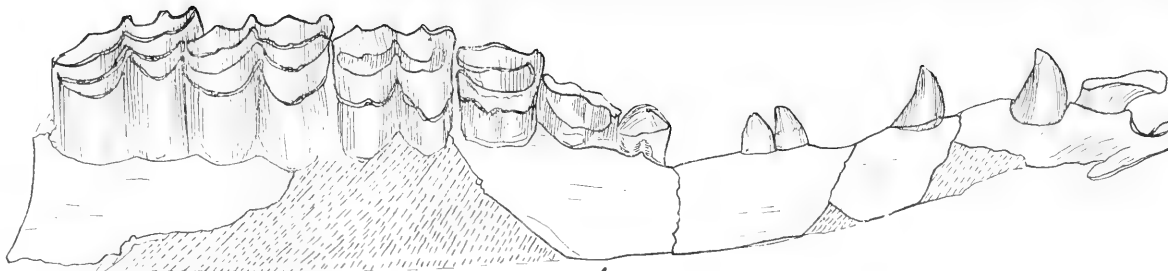
PLATE II.

Fig. 1—Procamelus madisonius, n. sp. Right mandibular ramus, $x\frac{3}{4}$, Page 15.
Fig. 2—Procamelus madisonius, part of left mandibular ramus of another individual, $x\frac{3}{4}$, Page 15.



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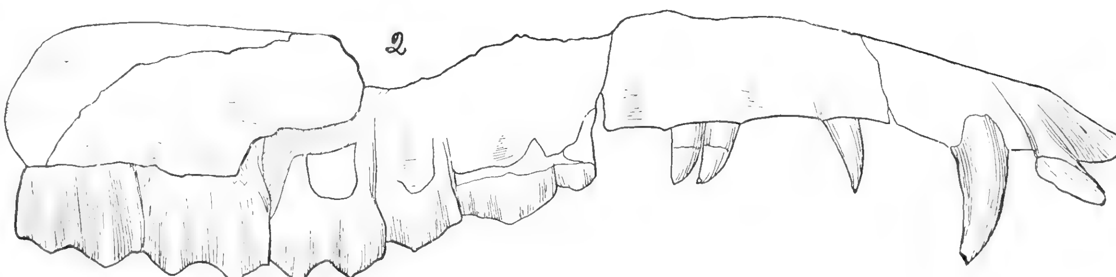

2

PLATE III.

Fig. 1—Protolabis montanus, n. sp. Upper dentition, $x\frac{3}{4}$, Page 13. Fig. 2—Same as above, side view. $x\frac{3}{4}$

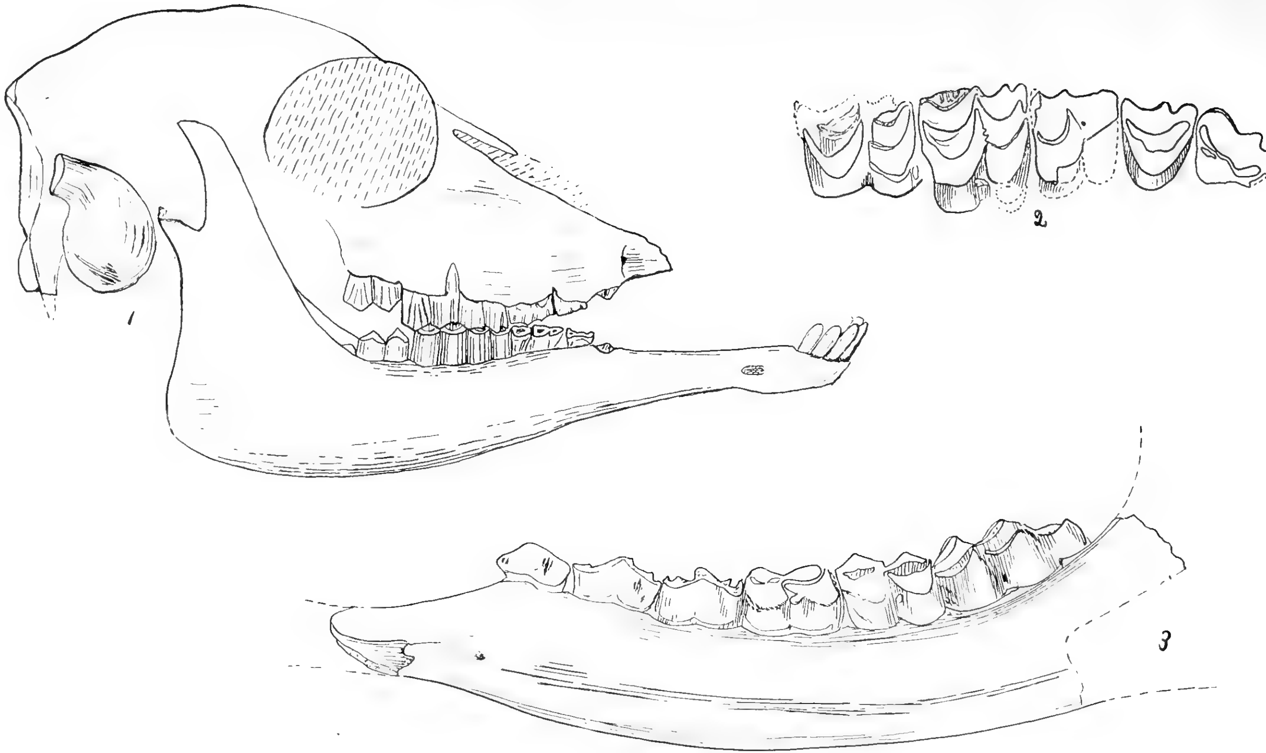


PLATE IV.

Fig. 1—**Cosoryx** agilis, n. sp. Skull and mandible, x$\frac{2}{3}$. A young individual. Page 23. Fig. 2—Palaeomeryx americanus, n. sp. The upper molars and last two premolars, x$\frac{2}{3}$. Page 20. Fig 3—Palaeomeryx americanus, n. sp. Left mandibular ramus, x$\frac{2}{3}$, Page 20.