Synopsis of the Species of Oreodontidæ. By E. D. Cope.

(*Read before the American Philosophical Society, January 18, 1884.*)

The tribe Ruminantia first appears in the White River Miocene period in North American geological history. It is represented there by a number of genera, which pertain to several family types. The most aberrant of these, the *Oreodontidæ*, includes the largest number of forms, generic and specific. The *Poëbrotheriidæ* certainly embraces but few species, while a third group of genera, represented by Leptomeryx, which are intermediate between the *Tragulina* and *Pecora*, and should be perhaps regarded as aberrant *Tragulidæ*, also includes a small number of species.

The *Oreodontidæ* constitute a family related to the *Anoplotheriidæ* of the later Eocene, but representing a more specialized condition of the structure of the molar teeth, in the full development of the selenodont type, which is rudimental in the *Anoplotheriidæ*. Their feet, on the other hand, are less specialized than in the latter family. As a family, the *Oreodontidæ* display very little tendency in their limbs to the specialized condition of the *Ruminantia*, but are more like those of the suilline groups, and, among recent families, of the *Hippopotamidæ*.

OREODONTIDÆ.

Dentition; superior incisors present; molars selenodont. Cervicals with the transverse processes perforated by the vertebrarterial canal. No alisphenoid canal. Ulna and radius, and tibia and fibula distinct. Metapodial bones four on each foot, with incomplete distal trochlear keels. Lunar bone not supported by magnum. Navicular and cuboid bones distinct.

The preceding synopsis of its characters should furnish a basis for the definite location of the *Oreodontidæ* in the system. Dr. Leidy called its species Ruminating hogs, and created a family for Oreodon and the allied genera, under the name of *Oreodontidæ*. This family is adopted by Prof. Gill who includes in it the *Agriochoeridæ* of Leidy, and places it in his division *Pecora*, which is more comprehensive than the *Pecora* of Prof. Flower, being nearly identical with the *Selenodonta* of Kowalevsky. More precise expression of its affinity to the existing families is not given, excepting to place it under a division "incertæ sedis."

As a selenodont type, this family is excluded from the *Artiodactyla omnivora*, and as having its metapodial bones distinct, it cannot be placed in any recent family excepting the *Tragulidæ*. From this family it is distinguished by the distinct ulna and radius. We then turn to the extinct families *Poëbrotheriidæ* and *Anoplotheriidæ*. The former agrees with the *Tragulidæ* excepting in its Cameloid cervical vertebræ, while the latter differs from the *Oreodontidæ* in the structure of the feet. The *Anoplotheriidæ* are didactyle in front, and tridactyle behind. The posterior foot has a well-developed second digit directed

more inwards than the others, which it is supposed supported a natatory web. In the Oreodontidæ all the feet are regularly tetradactyle.* The Anoplotheriidæ differ also in the presence of an additional cusp on the inner side of the superior molars, accompanied by an imperfect development of one or both pairs of the internal crescents. In *Anoplotherium* the internal crescents of the inferior molars are incomplete, and more or less represented by tubercles. In the *Oreodontidæ* there are two pairs of fully developed crescents, and no internal tubercles. The details of the structure express various affinities. The axis is intermediate between that of the suilline and ruminant *Artiodactyla;* the other cervicals are suilline, while the remaining vertebræ are ruminant. The scapula is ruminant, not suilline; while the humerus is like nothing but *Anoplotherium.* The radiocarpal articulation is intermediate between that of hogs and ruminants. The unciform supports the lunar bone. The sacrum is ruminant, the ilium suilline. The femur and tarsus are much like those of the peccary.

The genera of this family known to me are the following:

I. Orbit incomplete; last premolars in both jaws with two external crescents or Vs.

Premolars three. ..... *Coloreodon.*
Premolars four ..... *Agriochoerus.*

II. Orbit complete; premolars four, the fourth with one external crescent.

a. No facial vacuities.

Premaxillaries distinct; otic bullæ not inflated. ..... *Oreodon.*
Premaxillaries distinct; otic bullæ inflated. ..... *Eucrotaphus.*
Premaxillaries coössified; otic bullæ inflated. ..... *Merycochoerus.*

aa. Facial vacuities present.

Premaxillaries coössified, dentigerous; vacuities prelachrymal only..... *Merychyus.*
Incisors six above, persistent; vacuities prelachrymal and prefrontal; nasal bones much reduced..... *Leptauchenia.*
Incisors very few, caducous; vacuities very large..... *Cyclopidius.*

III. Inferior premolars three.

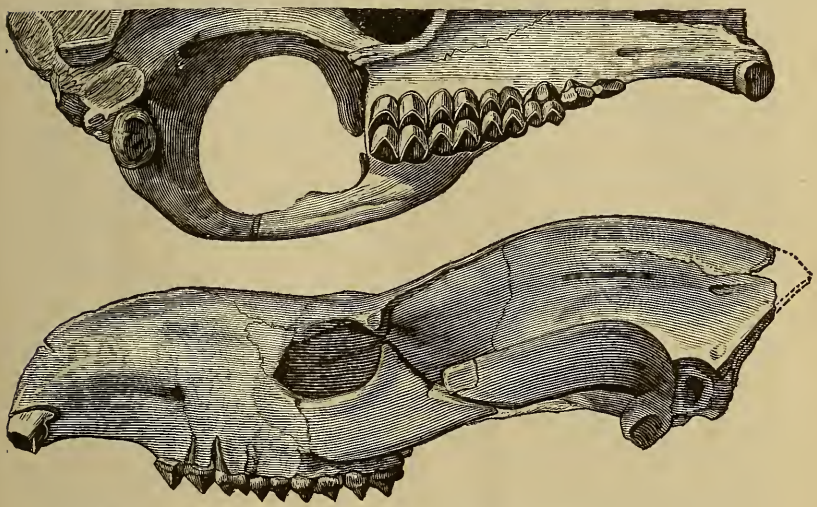
True inferior canine functional; inferior incisors one on each side. *Pithecistes.*

The number of species referred to these genera in the succeeding pages is as follows:

Oreodon	3
Eucrotaphus	3
Merycochœrus	7
Merychyus	6
Leptauchenia	3
Cyclopidius	2
Pithecistes	3
Agriochoerus	6
Coloreodon	2
	35

* I have observed this in the genera Oreodon, Eucrotaphus, Merycochœrus, and Merychyus.

The present paper is chiefly devoted to the proper distinction of these species and genera or cranial characters only. Figures of all will be given in my volume which embraces this subject, in the Report of the U. S. Geological Survey of the Territories.



Coloreodon ferox Cope, one-half natural size. Original; from Report U. S. Geolog. Survey Terrs., vol. iii, F. V. Hayden in charge.

OREODON Leidy.

Proceedings Academy Philadelphia, 1857, p. 238. Ancient Fauna of Nebraska, Smithsonian Contrib. to Knowledge, 1853, p. 29. Extinct Mammalia Dakota and Nebraska, 1869, p. 72. Report U. S. Geological Survey Terrs., 1873, I, p. 201. *Merycoidodon* Leidy, Proceeds. Acad. Philada., 1848, p. 47 (nomen nudum). *Cotylops* Leidy, Loc. cit., 1851, p. 239.

Premaxillary bones distinct from each other. Otic bullæ not inflated. No lachrymal vacuity of the face; nasal bones normal. Premolars four in both jaws.

Dental formula I. $\frac{3}{3}$; C. $\frac{1}{1}$; P-m. $\frac{4}{4}$; M. $\frac{3}{3}$; the series uninterrupted. Crowns of the molars robust, well distinguished from the roots. Grinding surface of the true molars simply selenodont, *i. e.*, with but two pairs of crescents. Superior premolars composed of a single external compressed cusp with crescentic section, and internal cingula or crescent. The fourth premolar with a well developed internal crescent; the first three with rudimental internal crescents in the form of basal cingula. Superior canines distinct. Inferior premolars of two kinds; the first canine-like in form and function; the others consisting of a single external cutting edge rep-

resenting two crescents, of which the anterior has its posterior horn developed as an obliquely transverse crest directed inwards. Last true molar with a heel composed of two columns.

In the superior temporary dentition the last premolar has the form of the first permanent true molar. The third premolar has five lobes, *i. e.*, four crescents and an anterior odd one. The other temporary premolar resembles that of the permanent series. The last inferior temporary premolar has the three pairs of lobes usual in the *Artiodactyla*, and the two which precede it resemble the corresponding permanent teeth. Says Leidy :* "The permanent true molars successively protrude and occupy their functional position before any of the deciduous molars are shed. The displacement of the latter by their permanent successors appears to begin with the eruption of the last of these, which is followed by those in advance. The first permanent premolar of the upper jaw appears to have protruded after the deciduous teeth, and occupied a position with them in the functional series, but remains after these are shed."

The cranial characters which belong to *Oreodon* as a genus are the following : Orbit completed behind ; temporal fossæ separated by a sagittal crest. A lachrymal fossa, but no facial nor frontal vacuities. Premaxillary bones distinct from each other and from the maxillaries. Nasal bones well developed. Auditory bullæ not inflated.

The preceding dental and cranial characters have been pointed out by Leidy in his various palæontological works. On account of the absence of the necessary material he was unable to give the characters of the remaining parts of the skeleton. These are of course necessary to a correct estimate of the affinities of the genus, and I will endeavor to add such information as my material will permit. This consists of numerous more or less complete skeletons found in connection with the skulls by myself in Colorado in 1873.

Vertebræ. The *cervical* vertebræ are rather short, and the character of the articulation of the centra slightly opisthocoelous, and the articular faces are quite oblique. The axis is the longest vertebra ; the three last centra are subequal in length. In one of my series the seven cervicals are preserved. In all of these, excepting the seventh, the bases of the diapophysis are perforated by the vertebrarterial canal. In the sixth vertebra, the decurved parapophyses are especially robust. The axis and three succeeding centra display strong hypapophyses at their posterior extremities, which are carried forwards as strong median keels. The odontoid process is depressed so as to have a lenticular section ; it is not excavated above, but in my largest specimen the internal borders of the facets for the atlas are continued so as to enclose a short groove on each side at its base. In one smaller and immature specimen this is wanting. The vertebrarterial canal of the axis is enclosed as in the other cervicals. The canal for the second spinal nerve has a narrow roof, but there are no canals

* Ancient Fauna of Nebraska, p. 41.

for the succeeding pairs of nerves perforating the neural arches. The atlas is not very elongate. The base of the diapophysis has a perforating canal, which issues in a large inferior fossa. The vertebrarterial canal then perforates the diapophysis upwards anterior to the middle of the base, and then soon enters the neural canal just posterior to the superior margin of the cotylus of the occipital condyle.

The centra succeeding the cervicals increase gradually in length posteriorly. Those of the anterior part of the dorsal series are quite depressed, but the vertical diameter rapidly increases, so as to be equal to the transverse in some of the lumbars. A trace of the opisthocoelous articulation exists throughout the dorsals but is very little marked in the posterior centra. There are no hypapophyses on the dorsals, but on one of them, probably the third, the inferior and lateral faces are separated by a strong angle, which is strongest anteriorly, giving the articular face a subquadrate outline. The rib-bearing diapophyses are robust. On the posterior dorsals the capitular and tubercular surfaces are confluent, forming a narrow facet on the anterior face of the diapophysis, in a manner not seen in *Cervus elaphus* or *Sus scropha*. The centra of the lumbars, after lengthening, become shorter immediately in front of the sacrum. The vertical diameter of one or two posterior ones is less than that of the anterior ones. The greater number of the lumbars display a small compressed hypapophysis at their anterior extremity; but this is wanting on the posterior ones. The neural arches of the dorsal and lumbar vertebræ are nowhere perforated for the spinal nerves.

The lumbar prezygapophyses embrace the articular faces of the posterior ones, which have a section of one side (below), the end (external), and a half the other side (above), of a transverse ellipse. The superior recurved surface does not appear.

The sacrum consists of five vertebræ, with very depressed centra. The ilium is attached to the diapophysis of the first, and a small anterior portion of that of the second. That of the fourth is flat and free. The anterior zygapophysis of the first displays a slight degree of the superior incurvature general in *Artiodactyla*. The caudal vertebræ were numerous, forming a long tail. The proximal ones are moderately depressed, while more distal ones with wide diapophysis and complete neural arch, are subcylindric, and more elongate. The number of vertebræ preserved in the most complete of my specimens, is as follows :

	Cv.	D.	L.	S.	Cd.
O. culbertsoni ad.	7	5	6	4	4
O. culbertsoni juv.	5	8	6	2	1
O. gracilis	4	5	3	*	*
O. g. coloradoënsis	7	8	6	5	3

An anterior, perhaps second, *sternal segment* is flat and subquadrate in outline, with large hæmal articular face of the lateral margin anteriorly, and a small one posteriorly. No inferior carina.

The spine of the *scapula* rises abruptly from the neck as in Ruminantia, and the coracoid process is short and obtuse. The spine continues to the distal extremity, which is regularly convex.

The most perfect *innominata* in my collection are deficient in the symphysis. The form of the ilium is more that of a hog than of a ruminant. The peduncle is even stouter, and the superior border is abruptly expanded below the middle of the length of the bone. The superior and inferior borders are subparallel as in the hog, and not divergent as in the ruminants. The anterior edge is acute, and uninterrupted by an anterior inferior fossa or spine. The pubis is robust and transverse, and without prominent basal pectineal tuberosity. The incisura acetabuli invades the base of the pubis a little, but the ischium more extensively. The obturator foramen is quite large. The distal border of the ischium is obliquely truncated as in many other Artiodactyla, and more nearly resembles that of the peccary than any other recent form I have observed. The tuber proper is a convex edge, not thickened, and its superior edge is continued into a strong up-looking tuberosity. This region is not so robust as in most recent forms.

The *humerus* of *Oreodon* is readily distinguished from that of recent *Artiodactyla* by several peculiarities. The greater tuberosity is large, rising above the head; and is incurved, terminating inwards in an acuminate apex. Its border at the base is thrown into an obtuse angle. The lesser tuberosity is small, and is well separated from the greater by a deep and wide bicipital groove. The deltoid ridge is distinct. The condylar extremity is more transversely extended than in any recent Artiodactyle, owing to the fact the posterior interior distal tuberosity is placed interior to the trochlea instead of partially behind it, and that there is, in addition, an internal epicondyle not seen in the recent suilline or ruminant members of the order. The intercondylar ridge is strong, and wider than in most recent ruminants; in the suillines it has nothing like such a development. Another peculiarity is the flange-like free border of the external trochlea, which is especially recurved at its superior part.

The *radius* is distinct from the ulna throughout. The relation of the ulnar to the radiocarpal surface is posterior as well as exterior; the common suture of the two, making an angle of 45° with the long axis of the radiocarpal surface. The head is a transverse oval, with the inferior face forming a regular curve without notch. Its articular surface is divided into three portions in adaptation to the internal and external humeral trochleæ and the wide median ridge. The external face is beveled forwards above, to fit the flange-like projection of the external trochlea. The shaft of the radius is not very stout, and has a nearly equal transversely oval section to near the distal expansion. Here are wide grooves for the extensor tendons, one superior, the other obliquely exterior. The carpal articular facet has the general ungulate characters. The scaphoid facet is concave above, convex and condyloid below, and is only distinguished from the

lunar facet by a contraction of the anterior and posterior borders. There is no indication of distinguishing ridge between the lunar and cuneiform facets. The posterior border at their junction is prominent, enclosing a fossa with the scaphoid condyle, which does not, however, excavate the intervening surface. The scaphoid condyle is not divided by a ridge.

The *ulna* gradually contracts distally from a robust olecranon. The shaft beyond the humeral cotylus has an oval section, with its long axis forming an angle of 45° to the perpendicular. The olecranon is short and compressed, its posterior border rising nearly as high as the coronoid process. The edges of the humeral cotylus are not flared beyond the shaft.

In the *carpus* the unciform nearly reaches the scaphoid, which is supported by the magnum and trapezium.

The great trochanter of the *femur* is not produced beyond the line of the head, and is well recurved, enclosing a large fossa. The little trochanter is large. The *fossa ligamenti teris* is submedian, subround and large. Distally, the patellar trochlear groove is quite elevated ; its lateral crests are of equal prominence, and nearly equal superior prolongation. The patellar groove is continued some distance above the crests, but there is no fossa in this region as in the hog. The popliteal fossa is well marked, and the condyloid articular surfaces are not entirely cut off from the rotular. The external linea aspera terminates first in a rugose muscular insertion, and then in a shallow fossa a short distance above the condyle. There is no crest nor deep fossa. This element is more like the corresponding one in *Dicotyles torquatus* than in any other mammal. The patella is a short wide bone, with a large anteroposterior diameter. One extremity is acute, the opposite one truncate.

The head of the *tibia* is also like that of *Dicotyles*. The spine is divided as usual, and not much elevated ; the crest is prominent, but is wide and truncate above at the head. It is not excavated as in *Sus*. The external tendinous notch is well marked. The external margin of the shaft does not display any sutural surface for the fibula. The surface of attachment of an external malleolus is distinct. The internal malleolar process is narrow and is produced well downwards. The anterior intertrochlear angle is prominent ; the posterior only convex. The trochleæ are deep, the outer being both the wider and the deeper.

The *astragalus* presents well marked characters. The distal extremity displays the two usual parallel trochleæ, which are separated by a pronounced angle. The cuboid trochlea slopes somewhat backwards, while the navicular is strongly concave. The tibial trochleæ are unequal, the internal being smaller than the external. It is separated from the latter by a constriction which is well rounded and not angulate as in the hog. The external side of the astragalus displays a wide malleolar band, a wide posterior and narrow anterior calcaneal facets, and an undivided concavity intervening between the latter. On the inner side, the malleolar face

descends to below the middle, as in *Hypertragulus*, and there is no vertical nor horizontal distal crest. The inferior calcaneal facet is undivided and not grooved, and does not extend over the internal border of the inferior side of the bone. It exhibits an acute border on the external side. The calcaneum is rather elongate, and the free portion is compressed and with obtuse margins above and below. The transverse astragalar process is not large and is not produced beyond its facet. The ascending plate is well developed and has a superior, uninterrupted convex facet for the fibula, with a narrow facet on its inner side. The inner distal astragalar facet extends the entire length of the cuboid facet. There is a longitudinal ridge on the external side of the distal end of the calcaneum.

The *navicular* and *cuboid* bones are distinct from each other and from the ectocuneiform. The astragalar ligamentous fossa is in the naviculocuboid suture. The inferior proximal angle of the cuboid is produced posteriorly, and the peroneal process well forwards. The ectocuneiform is distinct, and much wider than long. The mesocuneiform is exterioposterior in position, and the transverse diameters are small. It is produced distally, overlapping the head of the second metatarsus. Entocuneiform wanting. The metapodial bones are entirely distinct. The lateral metatarsals are well developed. The second articulates with both the ecto- and mesocuneiform bones, by a proximal extremity which is laterally compressed. The third and fourth are subequal in width, and articulate exclusively with the ectocuneiform and cuboid respectively. The fifth metatarsus is compressed proximally, and the external part of its extremity articulates with a lateral fossa of the cuboid. The distal articular extremities of the metapodials are separated from the anterior face of their shafts by a transverse groove ; and they have a well marked articular fossa on each side. The trochlear tongue only exists on the posterior face, where it is prominent and compressed. It disappears on the middle of the distal end, and is wanting on the anterior face. The phalanges are depressed proximally, the penultimate ones distally also. The ungues are rather depressed and have convex external borders. There is a pair of sesamoid bones below the distal articular extremity of the metatarsals.

History. The dental and cranial characters of this genus were fully described by Dr. Leidy in 1852, as already cited. In the Extinct Mammalia of Dakota and Nebraska, published in 1869, Dr. Leidy added the following points in the osteology of the skeleton of the *Oreodontidæ* (p. 72) : "What are supposed to be the bones of the forearm and leg are discrete, as in the hog, and the bones of the feet correspond in number with those of this animal." In 1873* Prof. Marsh confirmed these statements so far as regards the metacarpal bones, and added that "the navicular and cuboid bones were loosely coössified or separate." The structure of the vertebræ, and of the greater part of the scapular and pelvic arches,

* Amer. Journ. Sci. Arts, p. 409.

with the carpus, tarsus and feet, with the exceptions above noted, are now described for the first time.

This genus appears first in time in the known history of the family, and presents us with its primitive or least specialized characters, or those nearest the average condition of the ordinary primitive ungulate.

Species. The species of this genus are difficult to discriminate from the evidence of crania alone, and their true number will remain uncertain until we can study entire skeletons. My material enables me to make some progress in this direction. After the removal of the forms with inflated bullæ to the genus *Eucrotaphus*, there remain the two species originally referred to Oreodon by Leidy, the *O. culbertsoni* and the *O. gracilis*. To these Leidy subsequently added two others, the *O. affinis*, which is intermediate in size between the two named, and the *O. hybridus*, of larger size than either. As the condition of the otic bullæ in the last is unknown, its generic reference is not certain. All these forms are from the White River epoch of Dakota, Nebraska and Wyoming.

My material is largely from the White River beds of Colorado. I find from this region the true *O. gracilis* and the *O. culbertsoni*, abundantly represented. Besides these there is a form intermediate between the *O. gracilis* and the *O. affinis*, which is nearer the former than the latter. Of *O. gracilis* there are two skulls complete; of the form next larger, which I call *O. gracilis coloradoënsis*, two complete crania (one with skeleton), and a face with teeth. Of a form between the *O. affinis* and the *O. culbertsoni*, there are four skulls complete (two with skeletons); and of *O. culbertsoni* proper, numerous parts of skulls with teeth, but none complete. No other regions which I have explored have produced these species; not even the Ticholeptus beds, where they might have been reasonably expected to occur.

The distinction of the previously known species will remain as Leidy has left it, with certain reservations in the matter of dimensions; while I add two sub-species.

Nasal bones obtuse posteriorly; frontals little produced on either side of them; true molar teeth not exceeding M. .035 in length; canine and premolars .030; width of front .046. *O. gracilis*.

Nasal bones obtuse posteriorly, frontals little produced on either side of them; true molar teeth not exceeding .037 in length; canine and premolars .039; width of front at middle of orbits .046. ..... *O. coloradoënsis*.

Nasal bones obtuse posteriorly, frontals little produced on either side of them; true molar teeth not exceeding .038; front at orbits .057 in width. ..... *O. affinis*.

Nasal bones acute posteriorly; frontal produced to an acute apex on each side of them; molar teeth .040; front, .056. *O. periculorum*.

Nasals and frontals as last; molar teeth .047; front, .050+.. *O. culbertsoni*.

PROC. AMER. PHILOS. SOC. XXI. 116. 3M. PRINTED JUNE 6, 1884.

From this table it may be seen that the passage from the small *O. gracilis* to the large *O. culbertsoni* is accomplished by a series of intermediate steps. That these extreme forms belong to one species cannot be admitted without evidence of more complete transition than we yet possess. As above remarked, groups of specimens represent each form and adhere to the definitions given with considerable fidelity. The largest of the specimens I refer to, the form *O. periculorum*, however, reaches .042 in the length of the true molar teeth, and the smallest of the *O. culbertsoni* measures .046. These I must consider as sub-species only. As regards the three remaining forms the length of the true molar series shows a complete gradation. The size of the cranium, as indicated by the interorbital width, is in the *O. affinis* as large as that of the *O. culbertsoni* according to Leidy, and the combination of characters presented by this form, would seem to entitle it to specific rank as suggested by Leidy. On the other hand the form *coloradoënsis* agrees in interorbital width with the small *O. gracilis*, differing from it in the greater length of the muzzle and of the cranium. But here, while the proportions of the premolar teeth distinguish the forms well, the length of the brain-case does not coincide exactly with the other measurements. The measurements of four skulls are as follows: *O. gracilis* No. 1, length of skull M. 114.5; No. 2, .130. *O. coloradonësis* No. 1, .129; No. 2, .135.

Oreodon gracilis Leidy.

Proceedings Academy Philada., 1851, 239; 1853, 392; 1854, 157; 1857, 89; Owen's Report Geolog. Survey, 1852, 550, Pl. XI, figs. 2–3; Pl. XIII, figs. 5–6. Ancient Fauna Nebraska 1853, p. 53, Pl. V, figs. 3–4; VI, figs. 1–7. Extinct Fauna Dakota and Nebraska, 1869, 94, Pl. VI, figs. 2–3.

Abundant in the White River beds of Dakota, Nebraska, Colorado and Wyoming.

The two sub-species are distinguished as follows:

Length of superior premolar series, M. .023..... *O. g. gracilis*
Length of superior premolar series, M. .029..... *O. g. coloradoënsis.*

Oreodon gracilis gracilis Leidy.

Dakota, Nebraska and Colorado.

Oreodon gracilis coloradoënsis Cope.

Colorado.

Oreodon affinis Leidy.

Extinct Mammalia Dakota and Nebraska, p. 105; Pl. IX, fig. 3.

Probably from the White River beds of Nebraska.

Oreodon culbertsoni Leidy.

Owen's Report Geological Survey, 1852, 548, Pl. X, figs. 4–6; XIII, figs. 3–4; Ancient Fauna Nebraska, Smithsonian Contrib. to Knowledge, 1853, 45; Pl. II, III, IV, figs. 1–5, V, figs. 1–2, VI, figs. 8–11; Proceeds.

Academy Philada., 1853, 392; 1854, 35, 157; 1857, 89; Bronn Lethæa Geognostica, 1856, 930. Extinct Fauna Dakota and Nebraska, 1869, p. 86; Pl. VI, fig. 1; VII fig. 2; IX, figs. 1–2. *Merycoidodon culbertsoni* Leidy, Proceeds. Acad. Phila., 1848, 47, Pl. II; 1850, 121; 1851, 239. *Oreodon priscum* Leidy, Proceed. Phila., Academy 1851, 238; *Cotylops speciosa* Leidy, Ibidem 239; *Oreodon robustum* Leidy, Ibidem 276.

The White River epoch of Dakota, Nebraska, Colorado and Wyoming.

The two sub-species are defined as follows:

Length of superior true molar series from M. .040 to .042. ..... *O. c. periculorum.*

Length of superior true molar series from .046 to .050.... *O. c. culbertsoni.*

Oreodon culbertsoni periculorum Cope.

This smaller race or sub-species has as yet only been found in the White River beds of Colorado and Wyoming. I do not detect any differences between it and the Nebraska form other than those of size. The largest measurement of the *O. c. culbertsoni* given in the above table is derived from Leidy; my largest specimen gives .047 as the length of the true molar series.

Oreodon culbertsoni culbertsoni Leidy.

Very abundant in the White River formation of Dakota, Nebraska, Colorado and Wyoming.

EUCROTAPHUS Leidy.

Proceedings Academy Philada., 1850, p. 92. Ancient Fauna of Nebraska, Smithsonian Contrib. to Knowledge, 1853, p. 56. *Eporeodon* Marsh, Amer. Journ. Sci. Arts, Vol. ix, 1875, p. 249.

Premaxillary bones distinct from each other. Otic bulla swollen. No prelachrymal or nasal vacuities.

This genus presents us with the first step in the series of modifications which the primitive form underwent with the advance of geological time. It appeared contemporaneously with the earliest representatives of the family, *i. e.*, in the White River epoch, but in small numbers. In the succeeding or John Day epoch the genus Oreodon had disappeared, and the present form had multiplied enormously in individuals, if not in species. Subsequent to that epoch it is unknown.

The greater number of the Oreodont remains found in Oregon belong to this genus. The *Eucrotaphus jacksoni* bore the same relation to the Oregon John Day fauna, as the *Oreodon culbertsoni* did to that of the White River epoch.

The species of Eucrotaphus are distinguished as follows:

I. Palatonareal border well posterior to posterior edge of maxillary bones.

a. Infraorbital foramen above front of P-m. iii.

Skull depressed, muzzle short; paroccipital process behind bulla and not separated from it by grooves; bulla grooved to apex for styloid ligament, etc.; zygoma more robust. *E. trigonocephalus.*

II. Palatonareal border in line with posterior edges of maxillary bones.

aa. Infraorbital foramen above posterior part of third premolar.

Paroccipital process behind otic bulla, the internal border of its base opposite that of the bulla. ..... *E. jacksoni.*

Paroccipital process external to the middle of the otic bulla; generally larger. ..... *E. major.*

The name here employed for this genus is the one first given with a definition. The typical species, *E. jacksoni*, was widely distributed, and appears under several varietal forms and sizes, some of which have received names. Subsequently to the original description, Dr. Leidy added to the genus a second species, which probably belongs to the genus Agriochœrus. On this account Leidy inclined at one time to combine the two genera, but afterwards abandoned the idea.

Eucrotaphus trigonocephalus, sp. nov.

This distinct form is only known to me from a single skull of an old animal. In the character of its otic bulla it has resemblance to the species of Agriochœrus, while the maxillary part of the skull has the posterior position of a true Oreodon.

The muzzle is rather depressed, and the premaxillary alveolar border is almost transverse. The position of the canine alveolus is swollen laterally, and between it and the infraorbital foramen the side of the face is slightly concave. The expansion leading to the malar bone commences as the posterior slope of the concavity mentioned, and spreads laterally, without interruption, beginning to project beyond the superior alveolar border at the fourth superior premolar. In the *E. jacksoni* this is not apparent anterior to the first true molar. The top of the muzzle and the front are wider than in that species, and are gently concave in the transverse direction. The anterior temporal ridges are well defined, and concave in outline, uniting early to form a prominent sagittal crest. The malar bone is a little concave below the orbit. The malar process of the maxillary projects downwards in an obtuse angle, opposite the penultimate superior molar. In *E. jacksoni* the malar is convex, and the tuberosity is opposite the last molar. The squamosal process is deeper than in the *E. jacksoni*, and sends a more robust apex into the malar bone, the apex not extending in front of the posterior border of the orbit. The supraoccipital crests are well developed, and project beyond the vertical plane of the condyles; they continue into well marked posttemporal crests, as in the other species of the genus, as well as send an obtuse ridge downwards on each side towards the foramen magnum. The median supraoccipital plane disappears downwards in a wedge-shaped apex, which causes the transverse section

above the foramen magnum to be obtuse angulate instead of broadly flattened as in *E. jacksoni*. The mastoid crests are roughened and are vertical, but do not continue directly into the paroccipital processes, but are separated from them by a deep excavation of the external margin, due to the internal position of the base of the process.

The long diameter of the base of the paroccipital process runs outwards and backwards, and it is attached to the bulla at the middle of the posterior extremity without any intervening grooves such as are seen in the other species of the genus. The bullæ are ovoidal in anteroposterior section, the regularity interrupted, however, by the presence of a ridge on the external side directed posteriorly, enclosing a groove which is continuous with the stylohyoid fossa. The ridge continues into the inferior crest of the tympanic bone. The sphenoid bone is regularly convex in transverse section, while the basioccipital is concave on each side with a narrow median keel, which commences opposite the anterior edge of the paroccipital processes. The basicranial axis is not quite in line with the basifacial, but does not present such an angle with it as is seen in the species of Merycochœrus, where the skull is known to me. In this respect it agrees with the other species of the genus. The postglenoid processes are less prominent than in *E. jacksoni*, but have a base more widely extended outwards. The external border is very oblique, since the apex is narrowed. The glenoid region is more extended, both transversely and anteroposteriorly than in the *E. jacksoni*. The anterior border is continued as an alisphenoid angle which becomes prominent, and overhangs the foramen rotundum. The descending alisphenoid ridge commences within the anterior border of the foramen ovale. The pterygoid angle is anterior to the middle of the palatosphenoid wall of the nareal foramen, and in front of it the edge of the processus pyramidalis is marked by a shallow fossa or mark of insertion of the internal pterygoid muscle. The nareopalatal border is as far posterior to the line connecting the posterior edges of the maxillaries as the width of the second molar tooth. The palate is everywhere nearly flat. The malar bones spread well away from the maxillaries on each side, the anterior border of the zygomatic foramen being a segment of a circle. The squamosal part of the zygoma is more widely expanded than the malar part. In *E. jacksoni* the shape of the zygomatic foramen is quite different. Its anterior outline is interrupted by the projection of the maxillary bone posteriorly, which gives its anterior outline a bilobate form. It is longer than wide in that species, and wider than long in the *E. trigonocephalus*.

The infraorbital foramen is small. There are two lachrymal foramina; one larger, within the preorbital border, the other smaller, below the tuberosity on the rim of the orbit. The frontal foramina are separated by a space equal to one-fourth the entire frontal width. The supraorbital notches are wanting. The preorbital fossæ are well marked, are distinctly defined above, and extend as far as the anterior border of the lachrymal bone. The orbit is round, and looks upwards as well as outwards and

forwards, on account of the prominence of the zygomatic arch. There are two postparietal foramina, one below and behind, the other on the parieto-squamosal suture. The mastoid foramen is not small. The incisive foramina are large, are longer than wide, and are separated by a rather wide isthmus. The palatine foramina are opposite the third premolars. There is a foramen immediately below the postfrontal process. The optic foramen issues posterior to the line of the posterior border of the orbit, and in front of the anteroinferior angle of the alisphenoid. The foramen rotundum is large and round, and is immediately below and within the ridge above mentioned, and is not overhung by a transverse ridge of the same, as in the species of Merycochœrus known to me. The f. rotundum doubtless includes the f. sphenoörbitale. The f. ovale is smaller and is separated by a considerable interval from the f. lacerum. The latter is subtriangular in form and is rather small, since the base of the otic bulla is in close sutural contact with the sphenoid and basioccipital for a considerable distance. The f. jugulare is subtriangular in outline and is smaller than the f. rotundum. It is entirely distinct from the f. condyloideum, which is the size of the f. ovale. No f. supraglenoideum. In comparing these foramina with those of the *E. jacksoni*, a general resemblance is to be seen. The frontal foramina in that species are *generally* closer together than in *E. trigonocephalus*, and the palatine foramen is *generally* opposite the fourth premolar instead of the third. The foramen magnum is slightly notched on its superior border in both.

The posterior outline of the nasal bones is truncate; it is more or less acuminate in all the specimens of *E. jacksoni* and *E. major* accessible to me. The prolongation of the frontal on either side of the nasals is also short and truncate in this species, and narrow and acuminate in the *E. jacksoni* and *E. major*. The lachrymal is deeper than long; in the species last named it is of variable size and form, but is usually as long as deep. There is no distinct ridge along the parieto-squamosal suture. The alisphenoid has a considerable contact with the parietal. The palatomaxillary suture is irregularly convex backwards on each side of the median line. It crosses the palate as in the *E. jacksoni*, at the front of the second maxillary tooth.

The teeth are much worn, and the first and last true molars with several of the premolars have been lost, indicating the age of the animal. The incisors are small and have round roots. The canines are large and of the usual form. The space between them and the first premolar is short. The fourth premolar is small. The second true molar is wider than long, and has no internal cingulum except between the lobes, and has a trace of anterior cingulum.

Measurements.	M.
Axial length from occipital condyles to premaxillary border	.187
Axial length from occipital condyles to postglenoid process	.031

Measurements.	M.
Axial length from occipital condyle to postfrontal process	.076
Axial length from occipital condyle to palatonareal border	.079
Axial length from occipital condyle to end of last molar	.091
Diameters of orbit { vertical	.031
Diameters of orbit { horizontal	.027
Depth malar bone at middle of orbit	.016
" zygomatic process posteriorly to glenoid face	.028
" skull (right angles to profile) at glenoid face	.045
" " " " orbit	.046
" " " " P-m. i	.030
Elevation of occiput from foramen magnum	.044
Width top of muzzle at preorbital fossæ	.040
" at middle of supraorbital border	.059
" " postfrontal process	.075
" " malar below orbit	.110
" " zygomatic process of squamosal	.145
" of occiput at condyles	.066
" " occipital condyles	.039
" " palate at palatonareal foramen	.028
" " " at M. ii	.032
" " " " canines	.030
Length of superior dental series with canines	.088
" " premolar series	.047
" " true molar series	.036
Diameters canine at base { anteroposterior	.009
Diameters canine at base { transverse	.010
Diameters P-m. iv. { anteroposterior	.009
Diameters P-m. iv. { transverse	.013
Diameters M. ii. { anteroposterior	.014
Diameters M. ii. { transverse	.018

The typical specimen of this species was found by Charles H. Sternberg on the North Fork of the John Day river. The horizon is probably somewhat different from that of the true John Day epoch.

Eucrotaphus jacksoni Leidy.

Proceedings Academy Philadelphia, 1850, p. 92. Ancient Fauna of Nebraska, Smithsonian Contributions to Knowledge, 1852, p. 56, Plate VII, figs. 4–6. *Oreodon bullatus* Leidy, Extinct Mamm., Dakota and Nebraska, 1869, p. 106. Report U. S. Geol. Survey, Terrs. 1873, I, p. 318. *Oreodon occidentalis* Marsh, Amer. Journal Sci. Arts, 1873 (May), p. 409. *Eporeodon occidentalis* Marsh, Loc. cit., 1875, p. 250. *Eucrotaphus occidentalis* Cope, Bulletin U. S. Geol. Survey Terrs., V, p. 59.

Comparison of numbers of crania from the White river and John Day

formations fails to reveal any characters distinguishing them as more than one species. In fact the variation in various respects is greater among the individuals of the John Day epoch, than between those of the two epochs. This was by far the most abundant mammal of the John Day epoch while it appears to have been rare during that of the White River.

Specimens differ in the size of the preorbital fossa irrespective of other differences. In some specimens it is wide and profound, including the lachrymal bone; in others it is less extensive and is shallow, involving but part of the lachrymal. It is never wanting or obscure. For estimation of other characters, I select ten crania, nine from Oregon and one from Dakota, as expressing the greatest range of variation. Of these, three display a peculiarity in the form of the otic bulla. Instead of being contracted backwards in front, it is protuberant and full at its inferior anterior part. Five other crania, agreeing with these three in other respects, possess the normal form of bulla. In one cranium, which is rather more robust than the others, the infraorbital foramen is a little posterior to its usual position, being above the anterior part of the fourth premolar. This tooth is also distinctly smaller than in other specimens of otherwise similar dimensions. The majority of specimens range nearly alike in dimensions, but there are forms distinctly larger and smaller, which may represent distinct species. This question can be better decided when the skeletons are known. I give three sub-species which are defined as follows:

Length of cranium M. .197; of molar series M. .086; long diameter of base of paroccipital process transverse; its posterior base flat..... *E. j. jacksoni.*

Length of cranium M. .219; of molar series M. .091; paroccipital process as above..... *E. j. pacificus.*

Length of cranium, M. .235; of molar series, M. .099; paroccipital process strongly compressed, its posterior base angulate on the middle line..... *E. j. leptacanthus.*

The above measurements of length are made from the occipital condyles to the premaxillary border inclusive.

The three forms may represent good species. The *E. j. jacksoni* is of the size of the *Oreodon culbertsoni;* the *E. j. leptacanthus* is larger than the *E. major,* while the *E. j. pacificus* is intermediate between the two.

Eucrotaphus jacksoni jacksoni Leidy.

The typical specimen of the *Oreodon bullatus* Leidy agrees so nearly with the original type of *Eucrotaphus jacksoni,* that I cannot doubt their pertinence to the same species. There are two specimens in the collection of the Philadelphia Academy, besides the last named, and at least one in the museum at Princeton. A specimen from the John Day, Oregon, cannot be distinguished from these. It agrees with Marsh's measurements and description of his *Oreodon occidentalis,* and no doubt represents it. Its

identity with his *O. bullatus* has already been surmised by Leidy (Report U. S. Geol. Survey Terrs., I, p. 318).

Eucrotaphus jacksoni pacificus Cope.

This form is materially larger than the last named, equaling in dimensions and resembling in general form the *Eucrotaphus major* Leidy, of the White River beds. It is no doubt the form which has been identified under that name by Leidy in his report on John Day Fossils in the Report of the U. S. Geological Survey of the Territories, Vol. I. It is different from that animal in the form and position of the paroccipital process, as already pointed out. I have eight crania disengaged from the matrix which agree in dimensions and other characters assigned to this sub-species. In one of them the paroccipital process presents an approach to the form of that of the *E. j. leptacanthus*. A specimen from the White Buttes of Central Dakota agrees with those from Oregon in all the essential characters, and is the second one of the sub-species I have seen which is not Oregonian. I have many crania of this sub-species not yet entirely cleared of matrix.

From John Day river and Crooked river, Oregon ; C. H. Sternberg and J. L. Wortman ; White river of Nebraska, Mus. Princeton.

Eucrotaphus jacksoni leptacanthus Cope.

This is the largest form of the genus, exceeding the typical *E. major* in the length of the skull by 23 mm. It is thus far represented in my collection by two very perfect crania. There is considerable reason for anticipating that this form will turn out to be a valid species. Besides the peculiar form of the paroccipital processes, the typical specimen presents the following characters :

The frontal region is flatter than in the two other sub-species, and is concave on the median line in transverse section. This concavity is probably partly abnormal. The profile of the sagittal crest instead of presenting a gently convex outline, is concave, rising posteriorly. The lateral occipital crests instead of being angulate are truncate behind, and the inferior angle projects much beyond the vertical line of the occipital condyles. As this part is broken off in most of my specimens of the *E. j. pacificus*, I cannot decide as to its value. The inferior carina of the tympanic bone extends forwards to contact with the internal extremity of the postglenoid process. It does the same in the Oregon specimen of *E. j. jacksoni*, and in the Dakota specimen of the *E. j. pacificus*. In two of the latter, from Oregon, where the part is cleaned, the keel does not extend so far forwards or inwards.

The typical specimen is from the John Day beds of John Day river, Oregon, and was found by Jacob L. Wortman.

Eucrotaphus major Leidy.

Oreodon major Leidy, Ancient Fauna of Nebraska, 1853, p. 55, Pl. IV, fig. 6. Proceedings Academy Philadelphia, 1853, 398 ; 1856, 164 ; 1857, 89.

Extinct Mammalia, Dakota and Nebraska, 1869, p. 99, Pl. VII, fig. 1; VIII. *Eporeodon major* Marsh, Am. Journ. Sci. Arts, 1875, p. 250.

I find this species to differ in the external position of the paroccipital process, as related to the otic bulla, from the *E. jacksoni*. I might add that it differs in dimensions from all excepting the *E. jacksoni pacificus*. In the *E. jacksoni* the base of the paroccipital process is in the same line as the interior base of the otic bulla. In the Oregon form of the *E. major* the base of the paroccipital process is much flattened, so as to be transverse, and its internal border is on the external side of the extremity of the large swollen bulla. This species differs also from the *E. jacksoni* in the median vertical carina of the occipital bone above the foramen magnum, a region which is in the *E. jacksoni* broadly flattened. Besides these points I do not notice any divergence from the *E. jacksoni*, with which it agrees in the various characters in which the latter differs from the *E. trigonocephalus*.

The Nebraska and Oregon forms do not agree in all respects. Thus, while the dimensions of the dental series are the same in both, the frontal region is more elongate in the Oregon animal, giving greater length to the skull. The third superior premolar has a somewhat different form in the two. They may then be characterized as follows:

Dental series M. .125; skull .224; third superior premolar, subtriangular.....*E. m. major.*

Dental series M. .125; skull .240; third superior premolar subquadrate.....*E. m. longifrons.*

Eucrotaphus major major Leidy.

Known only as yet from the White River epoch of Nebraska and Dakota.

Eucrotaphus major longifrons Cope.

Known from a single skull from the North Fork of the John Day river, Oregon, found by Charles H. Sternberg. It may be observed here that the Oreodontidæ of this locality are mostly distinct from the species of the John Day river proper.

MERYCOCHŒRUS Leidy.

Report U. S. Geol. Survey Terrs., I, 1873, p. 202. Bettany, Quart. Journ. Geol. Soc. London, 1876, p. 262; Cope, American Naturalist, 1884, p. 281. Leidy, Extinct Mammalia of Dakota and Nebraska, 1869, p. 110 (nomen nudum). Proceedings Academy Philadelphia, 1858, p. 24 (nomen nudum).

As indicated in the analytical table at the head of this article, I can only distinguish this genus from *Eucrotaphus* by the confluence of the premaxillary bones. The position of the external infraorbital foramen cannot be regarded as furnishing generic characters, especially as it displays considerable variation and gradation. Some of the species are in this respect quite identical with species of Merychyus (*M. superbus*), while others

possess the widely different position ascribed to this genus by Leidy. Few if any of the characters given by Mr. Bettany as those of the genus, can be regarded as other than characters common to several of its species. Perhaps the most important of these is the angle formed by the basifacial with the basicranial axis, by which the face is presented as much forwards as upwards. The species present considerable variety in form. The genus embraces the largest species of the family, such as *M. macrostegus, M. superbus,* etc. The characters of the species are as follows :

I. Foramen infraorbitale above middle of fourth superior premolar ; posterior part of zygoma expanded ; palate moderately produced posteriorly.

Squamosal part of zygoma less expanded anteriorly and with rounded border; head elongated; premaxillary bone not produced ; otic bulla larger, compressed, extending anterior to postglenoid process ; size large ..... *M. superbus.*

Head shortened occipitally, so that a line drawn through postglenoid and paroccipital processes makes 90° with the middle line ; malar bone openly grooved below orbit ; angle of mandible obliquely truncate. ..... *M. leidyi.*

Squamosal part of zygoma most expanded in front, and elevated behind, so that the cranium is as wide as from the paroccipital process to the canine tooth ; its posterior angle rising to a level with the sagittal crest ; its inferior edge spread outwards ; its superior edge truncated ; occiput not shortened ; malar flat below orbit ; postglenoid process marking front of bulla..... *M. chelydra.*

II. Foramen infraorbitale above the first true molar. Palate greatly produced posteriorly.

Squamosal part of zygoma much expanded, and with truncate edge ; malar bone robust, prominent ; skull, width equal length from condyles to first premolar ; maxillary produced anteriorly ; frontal plane, transverse diamond-shaped ; bulla small, conical, posterior to anterior edge of postglenoid process..... *M. macrostegus.*

Squamosal part of zygoma little expanded upwards or laterally, edge rounded ; malar bone flat ; bulla large, extending in front of postglenoid process ; front longitudinally diamond-shaped, decurved at orbit..... *M. montanus.*

III. Foramen infraorbitale above anterior border of second true molar.

Zygoma originating above second molar ; large ; incisors small (fide Leidy). ..... *M. rusticus.*

Zygoma originating above third true molar ; larger ; incisors large (fide Leidy). ..... *M. proprius.*

Of the above seven species, four are represented in my collection, some of them by a large amount of material. The latter are from the John

Day and Ticholeptus Miocene horizons. The *M. rusticus* of Leidy is only known to me from the descriptions of that author. It is from the Sweetwater river, Wyoming, from a bed of probably Ticholeptus age. The *M. proprius* Leidy, also unknown to me by autopsy, is from the head of the Niobrara river, Nebraska, from a bed said by Hayden to be intermediate between the Oreodon or White River and Procamelus, or Loup Fork horizons, and therefore probably of Ticholeptus age also. The *M. leidyi* I only know from the description of Mr. Bettany. It is from the John Day beds. Mr. Bettany also describes an *M. temporalis*, which I cannot distinguish from the *M. superbus* Leidy.

Merycochœrus superbus Leidy.

Oreodon superbus Leidy, Proceedings Academy Philadelphia, 1870, p. 109. Extinct Mam. fauna, Dakota and Nebraska, 1869, p. 211 ; Plate I, fig. 1 ; II, fig. 16 ; VII, figs. 7–11. *M. temporalis* Bettany, Quar. Journ. Geol. Soc., London, 1876, xxii, p. 269 ; Pl. XVII.

Of this fine species I have nine crania extracted from the matrix, and a good many not yet cleaned. As the specimen described by Leidy is in a very imperfect condition, the characters of the species, and even its generic position, have remained hitherto very obscure.

As compared with the allied species, the *M. superbus* is slightly exceeded in size by the *M. macrostegus* and *M. montanus*. Its posterior zygomatic expansion is less pronounced than in the *M. macrostegus* and *M. chelydra*, and its border is rounded, even when, as is sometimes the case, it is greatly thickened. In the first and last named of the above species, its border is separated by a distinct angle from both the internal and external faces, forming thus a distinct truncate face which looks upwards. The otic bulla is larger than in the two species mentioned, and extends anterior to the postglenoid process. The nareal fissure extends well down towards the alveolar border of the premaxillaries, which are therefore more extensively separated than Leidy represents to be the case in the *M. rusticus*. The external face of the malar bone below the orbits is flat. The anterior extremity of the zygomatic process is not so prominent as in *M. chelydra*, and is rounded instead of being flared out below, as in that species. The greatest width of the skull is at the glenoid surfaces, and not anterior to them, as in *M. chelydra*. In only one of seven crania, where the parts are preserved, does the posterior squamosal angle rise as high as the sagittal crest.

I cannot detect any difference between the specimen described by Mr. Bettany as the type of his *M. temporalis*, and those of the *M. superbus* in my possession. The shallowness of the preorbital fossa described by Mr. Bettany is repeated in one of my crania, and its depth is very variable in the others. As regards the *M. leidyi* of Bettany, I have none exactly like it, although the type specimen does not differ much from the *M. superbus*, to judge from the figure and description given in the Quarterly Journal of the Geological Society, 1876, p. 270. The two distinctive

characters, which appear most tangible among those mentioned by Mr. Bettany, the shortness of the occipital region, as measured by the angle made by a line drawn through the postglenoid and paroccipital processes, with the middle line, and second, the grooved character of the suborbital part of the malar bone, are not found in any of my specimens of *M. superbus*. The anterior extremity of the squamosal process of the zygoma is protuberant in one of them, as in the *M. leidyi*. Another character is suggested by Mr. Bettany's figure, but is not mentioned in the text. The angular border of the mandibular ramus extends obliquely forwards instead of being prominently convex as in the best preserved entire mandible of the *M. superbus* in my possession. Nevertheless in another specimen, where a good deal of the posterior border is preserved, the outline is nearly as oblique as in the *M. leidyi*. The species, however, is distinct so far as now known.

John Day epoch, Oregon, C. H. Sternberg and J. L. Wortman. Localities, John Day river, Bridge creek, and Camp creek of Crooked river.

Merycochœrus leidyi Bettany.

Quarterly Journal of the Geological Society of London, xxxi, 1875, p. 270; Plate XVIII.

Defined and discussed under the preceding species.

John Day epoch, Oregon; Lord Walsingham. John Day river.

Merycochœrus chelydra, sp. nov.

This species is known to me by a skull without mandible, which is entire, except that the extremity of the nasals and the border of the premaxillary bones are broken off. It is unfortunate that I have no second skull to confirm its characters, but my numerous specimens of the *M. superbus*, to which it is most nearly allied, do not present any approximations which suggest transitions between the two.

The striking character of this cranium is its great breadth at the temporal region, as compared with its length and other dimensions. The forms of the otic bulla differ from those of the *M. superbus*. One method of expressing the width of the skull is as follows. The point of the frontal bone which is equidistant from the supraoccipital notch and the external edge of the zygomatic arch, measured in a horizontal plane, is directly above the posterior or nareal palatal border, when the skull rests on the teeth. In the *M. superbus*, in the most robust examples, this point is above a point which is a good deal nearer to the line of the anterior edge of the glenoid surfaces than to the palatal border, and at least 30mm. posterior to the latter. That this relative shortness of the basicranial axis is not due to a shortening posterior to the glenoid surfaces, as is the case in *M. leidyi* Bett., is proven by the fact that a line drawn through the postglenoid and paroccipital process makes an angle of 90° with the middle line, as in *M. superbus*.

The muzzle is compressed and its superior surface is regularly rounded

The side is divided by the gentle convexity continued forwards from the malar region. Below this and above the premolars the face is concave. Above it the preorbital fossa is well marked, though not deep, and gradually fades out anteriorly. The interorbital region is flat, as in *M. macrostegus*, and the supraorbital border is not decurved, as it is in *M. superbus* and *M. montanus*. The supraorbital and preorbital borders of the front are, however, not continuous as in *M. macrostegus*, though nearly in the same line, which they are not in *M. superbus*. The orbits are more oblique than in *M. superbus*, looking more upwards and forwards, and their vertical exceeds their transverse diameter. The malar bone though oblique, is more vertical than the orbit below the latter, and has an uninterrupted gently concave surface. The postorbital bridge is narrow, and consists one-half of the malar and one-half of the frontal bones. The inferior edge of the malar is thin and is slightly convex downwards, and passes behind the protuberant squamosal at a point behind the line of the postfrontal process. The anterior extremity of the squamosal is not protuberant below the orbit and only begins to rise gradually below the line of the postfrontal process. It then expands rapidly downwards and outwards in a strong curve, with its flat surface looking upwards as much as outwards. After making a short downward turn it rises steeply, contracting gradually inwards, and presenting a convexity posteriorly, with its truncate edge looking outwards. Its apex is nearly on a level with the sagittal crest. The inner or descending edge of this process is concave, so that the apex overhangs a little the posterior outlet of the temporal fossa. The anterior temporal angles are strongly marked and unite into a sagittal crest. The edge of the crest is thickened, so that its section is a letter T.

The supraoccipital bone presents a wide flat convexity above the foramen magnum, in distinction from the stronger convexity of *M. superbus*, and the still stronger of the *M. macrostegus* and *M. montanus*. As in the other species, the posttemporal (= lateral occipital) crests are only present at the upper half of the occiput. Between them there are two ligamentous or tendinous insertions, but no median keel. The exoccipital and posttympanic borders form a tuberosity below the meatus auditorius, which passes upwards into a short convex posttemporal crest. The paroccipital process nearly reaches the postglenoid by its anterior external edge. The tympanic is complete, is not keeled below, and extends itself as a lamina over the posterior side of the postglenoid process. The section of the basioccipital is open V-shaped. The inferior flat surface of the sphenoid is produced backwards in a wedge-shaped prominence to a line connecting the anterior edges of the paroccipital processes. It has the same form in *M. macrostegus*, but in three skulls of *M. superbus*, where it is visible, the apex of the wedge does not extend posterior to the middle of the otic bullæ. The bullæ are small and subconical, and reach as far as the anterior edge of the postglenoid process. In the latter the transverse diameter exceeds the anteroposterior, which exceeds the vertical diameter. This process and the otic bulla are of about equal protuberance. In four

crania of the *M. superbus*, where both are well preserved and exposed, the bulla is considerably more prominent than the postglenoid process. The glenoid surface is well-defined and equally wide at both extremities. The inferiorly presented surface of the zygomatic arch, is wider than in any of the other species, including examples of *M. superbus* of superior dimensions in other respects. The surface is rugose. The length from a line connecting the median external columns of the last superior molar, to the posterior nareal border, enters three times into the distance from the latter to the border of the foramen magnum. In *M. superbus* it goes three to three and a half times; in *M. macrostegus* and *M. montanus* once only. Behind the molars the produced palatal roof is more concave than between the last two true molars. The palate becomes then more concave (convex), and between the first premolars and canines becomes flat, and expands laterally. The nareal fissure is not much contracted between the premaxilliaries.

The infraorbital foramen is above the anterior half of the superior fourth premolar, and is of moderate size. The frontal foramina are separated by a space which is less than half as wide as that which separates each one from the superciliary border. There is no supraorbital notch. The incisive foramina are large, are wider than long, and approach close to the bases of the canine teeth. The palatine foramina are minute or obsolete. The foramen ovale is isolated and is opposite the junction of the glenoid and postglenoid surfaces. The jugular foramen is isolated by the extensive contact of the otic bulla and the basicranial axis. Perhaps the condyloid foramen is included in it, as I do not find it in the usual position. The animal is so old that no sutures are visible.

The teeth are not all cleared from the matrix, which is hard and brittle. The first true molar is much worn. The first premolar is two-rooted, and is separated from the canine by a diastema equal in length to the long diameter of its crown.

Measurements.	M.
Length from occipital condyle to front of canine tooth.	.300
" " " " " postglenoid process...	.041
" " " " " postfrontal process. ..	.132
" " " " " palatonareal border ..	.118
" " " " " end of last molar.....	.146
Diameters of orbit { vertical.....	.0455
Diameters of orbit { transverse.....	.039
Depth of malar bone at middle of orbit.....	.034
" " zygomatic process to glenoid face behind.....	.088
Width of top of muzzle at preorbital fossa	.043
" at middle of supraorbital border.....	.094
" " malar below orbit.....	.160
" " middle of zygomatic arch.	.254
" of occiput at superior crests.....	050

Measurements.	M.
Elevation of occiput from foramen	.084
Width of occipital condyles	.063
Width of occiput at condyles	.095
Depth of skull at right angles to profile at glenoid face	.095
" " " " " " orbit	.087
" " " " " " P-m 1	.075
Length of superior dental series with canine	.159
" " premolar series	.061
" " true molar series	.065
Diameters M. i { anteroposterior	.0180
Diameters M. i { transverse	.0185
Diameters of canine { anteroposterior	.016
Diameters of canine { transverse	.020
Diameters P-m. ii { anteroposterior	.0155
Diameters P-m. ii { transverse	.090
Width of palate at m. i	.044
" " P-m. i	.057

The typical specimen was found on the John Day river, Oregon, by Mr. J. L. Wortman.

Merycochœrus macrostegus, sp. nov.

I have been able to discover in my collection as yet, but one cranium with entire mandible of this species. The very marked characters of this skull are such that no farther evidence of its reference to a peculiar species is needed. Its affinities, as expressed in the analytical key which accompanies the general discussion of this genus, are with the *M. montanus.* This is shown in the posterior positions of the infraorbital foramen, and of the posterior nares. As peculiar characters may be added the form of the frontal plane and of the otic bulla; also the prolongation of both the premaxillary and supraoccipital regions, and the forms of the zygoma, the angle of the mandible, and the first inferior premolar tooth. The skull reaches a greater length than that of any species, excepting the *M. montanus,* but is not nearly so robust as in the *M. chelydra,* resembling in this respect rather the *M. superbus.*

The muzzle is compressed, and there is a decided concavity just above the second premolar, above which the surface is a little convex. Above the infraorbital foramen, the face is abruptly convex, the convexity sloping upwards to the base of the median ridge formed by the convex nasal bones. Behind this the side of the face is a plane which slopes outwards as it descends, which is only interrupted by the rather small, but well defined, preorbital fossa. The fossa is better defined in front than in the other species, but I do not know whether the character is constant. The front is a transverse diamond-shaped area, bounded posteriorly by the anterior temporal ridges, and anteriorly by the lines of the supraorbital borders

produced to their point of intersection with each other. Such point of intersection is above the second true molar in this species ; in *M. superbus* and *M. chelydra* it is above the posterior part of the second premolar. The area in these species enclosed by the lines in question is half as long again as wide, instead of wider than long by 18mm. This difference is partly caused by the greater prominence and flatness of the postorbital angle of the frontal bone in the *M. macrostegus*, and the more anterior direction of the orbits, which I may add have none of the tendency to superior direction seen in *M. chelydra*. The wide triangular area thus enclosed on its external sides by the orbit and anterior temporal ridges, is perfectly flat. Such an area can hardly be defined in the other species, and the surface there is rounded and descending. The malar bone is deep, flat and a little oblique outwards, and the rim of the orbit projects a little, giving it a slight concavity. The orbit is deeper than wide. The anterior part of the zygomatic process of the squamosal is not protuberant below the orbit, but gradually rises outwards posteriorly, attaining its greatest expansion opposite the middle of the zygomatic foramen ; above, its course is for a time parallel with the middle line of the skull. The form of the zygomatic arch is more like that of *M. chelydra* than any other species, but it is not so much expanded, especially anteriorly. Its inferior and posterior surface is, however, widened, making an angle with the external or marginal surface, which is in turn separated by an angle from the superior and anterior surface ; at the middle of the arch the superior surface has a width of 19mm., and the external a width of 23mm. The posterior angle rises to the plane of the summit of the sagittal crest, and the apex, which is less than a right angle, stands above the external base of the postglenoid process. The preglenoid border is not exactly at right angles with the middle line, but makes a slight angle outwards and forwards. The long diameter of the zygomatic foramen is parallel with it. The ridge along the pariëtosquamosal suture is insignificent. The supraoccipital region is very prominent, and as in the other species of this genus is narrowed below by the disappearance of the posterior temporal or exoccipital crests. They are continued downwards and disappear, leaving a wide convex surface above the foramen magnum. This is separated by the usual lateral fossa from the posterior temporal angles.

The coössified mastoid and paroccipital processes much contract the auricular fossa below, but do not close it. The latter is contracted at the base of its terminal part, and is distally slender. The otic bulla is the smallest known in the genus, it is compressed and oval, and not produced beyond the postglenoid processes either forwards, backwards or downwards, in this differing much from the *M. montanus*. It is separated by wide and equal intervals from this process, the glenoid surface, and the basisphenoid. It sends a process backwards and inwards to a sutural junction with the basioccipital bone. The tympanic bone is flat below, and is united with the posterior base of the squamosal by a flat expansion. The postglenoid process is robust, and has the height and thickness equal,

while the width exceeds both. The basioccipital bone is prominently keeled on the middle line, so that the section is a V of a more compressed character than the section of the same in *M. superbus*. The median plane of the sphenoid is prominent, and is continued as a wedge with the apex opposite the posterior borders of the otic bullæ. The palatine borders are parallel, except where they form on each side an open angle at the junction of the descending process of the sphenoid, which is here directed forwards. Its external border is distinct from that of the palatopterygoid plate, and makes a groove with it. The maxillary bone is not produced posterior to the notch on either side of the base of the posterior production of the palatine bones. The middle line of the latter is deeply concave opposite the former, and the palate is also especially concave between the first true molars. The palate is flat between the first and second premolars. The inferior surface of the squamosal process of the zygoma is roughened for the origin of the masseter muscle. The inferior edge of the malar comes from its inner side, and is narrow and with a median groove. Its inferior edge is continued as a ridge of the maxillary as far as opposite the anterior lobe of the second true molar. The maxillary bones are more produced anteriorly than in any of the other species. The apex of the nasal bones stands above the posterior border of the canine in this species; above the anterior edge in *M. superbus*, *M. chelydra* and *M. leidyi* (fide Bettany). The posterior border of the nares is above the anterior part of the first premolar in the three species named, except *M. chelydra* where it is over the posterior edge of the canine: in *M. macrostegus* it is above the posterior edge of the longer first premolar.

The infraorbital foramen is large, and its posterior border is above the anterior root of the first true molar. The incisive foramina are large, and each one is a little longer than wide. The nareal opening contracts gradually to its inferior apex. There is a considerable maxillary foramen opposite the middle of the fourth superior premolars. The posterior nareal is not large; its anterior outline is regularly concave. Its lateral (sphenoid) borders reach to opposite the anterior faces of the postglenoid processes and bound the foramen ovale on the inner side. The latter is round, is rather small, and is opposite the middle of the postglenoid surfaces. The foramen rotundum on the other hand is large and vertically oval, and is bounded below by a transverse prominence of the base of the alisphenoid bone. It probably includes the sphenoörbital foramen, a foramen anterior to its inferior border probably communicating with the nareal chamber. The optic foramen is small, and is situated opposite the anterior two-fifths of the zygomatic fossa and a little above the line of the apex of the foramen ovale. The foramen lacerum is ovoid and not large. The posterior foramen lacerum is a transverse sigmoid, one extremity being the jugular foramen. The mastoid and postpariëtal foramina are of moderate and equal sizes. No postsquamosal or supra- or postglenoid foramina.

The animal described is too old to exhibit sutures.

The mandible possesses some distinctive characters. The angular border is not prominent posteriorly, extends forwards below, and projects below the general level of the inferior border of the ramus. Neither of these characters is observable in the only ramus of the *M. superbus* in which the lower part of this border is well preserved, but in some others of that species the superior part of the border is much as in *M. macrostegus*. The inferior edge of the ramus is straight, but there is a descending tuberosity of the symphysis which may be an individual peculiarity. The symphysis is very concave in profile, and the incisive border is produced in accordance with the prolonged muzzle. In the *M. superbus* it is sometimes convex, sometimes a little concave, but not so much so as in this jaw. The coronoid processes are small and slightly everted. The inner ridge of its anterior base is more prominent than the exterior, and encloses a fossa with it. The masseteric fossa is not noticeable. There is one large mental foramen below the third premolar. The dental foramen is large and oval, and when the mandible stands on a level surface is opposite the middle lobe of the third inferior molar tooth.

In dentition this species is distinguished by the relatively large size of the premolar teeth, of which the first, second and third are two-rooted in both jaws. Both the first and second in the upper jaw have short diastemata anterior and posterior to them, the largest being behind the canine tooth, and nearly as long as the premolar's crown. All the teeth are a good deal worn in the specimen. One can see two internal cingula inclosing fossæ on the third premolar. The true molars increase in size rapidly posteriorly and the third has a well-developed external heel. The molars have no internal cingula ; these are present in five of seven skulls of the *M. superbus* where these parts are cleaned. The most noteworthy point in the mandibular dentition is a very rudimental character of the internal vertical ridge of the crown of the first premolar. The posterior fossa of the fourth premolar is closed, and the anterior remains open, on wearing. In *M. superbus* both are closed in the specimen where visible. The anterior inner wall is represented in the second and third premolars by a cingulum. No cingula on the true molars. First premolar very robust, its section lenticular.

Measurements.	M.
Axial length from occipital condyles* to premaxillary border	.345
Axial length from occipital condyles to postglenoid process	.045
Axial length from occipital condyles to postfrontal process	.138
Axial length from occipital condyles to palatonareal border	.100

*The occipital condyles are broken off in the specimen, so I measure from the superior border of the foramen magnum, which is, in the other species, in the vertical line of the occipital condyles.

Measurements.	M.
Axial length from occipital condyles to end of last molar	.058
Diameters of orbit { vertical	.044
Diameters of orbit { transverse	.036
Depth malar bone at middle of orbit	.037
" zygomatic process to glenoid face behind	.077
" skull (right angles to profile) at glenoid face	.088
" " " " " " orbit	.088
" " " " " " P-m. i	.068
Elevation of occiput from foramen magnum	.084
Width top of muzzle at preorbital fossa	.038
" at middle supraorbital border	.109
" " postfrontal process	.137
" " malar below orbit	.166
" " middle of zygomatic arch	.243
" of occiput at superior crests	.050
" " " condyles	.101
Length superior dental series, with canine	.177
" " premolar series	.092
" " true molar series	.083
Diameters canine { anteroposterior	.013
Diameters canine { transverse	.018
Diameters P-m. i { anteroposterior	.017
Diameters P-m. i { transverse	.075
Diameters m. i { anteroposterior	.019
Diameters m. i { transverse	.0215
Diameters m. iii { anteroposterior	.038
Diameters m. iii { transverse (at middle column)	.029
Width of palate at P-m. i	.061
" " m. i	.053
" " middle of zygomatic arch	.047
Length of inferior dental series with canine	.179
" " premolar series	.088
" " true molar series	.088
" of ramus to posterior edge	.279
Depth of ramus mandibuli at condyle	.124
" " " m. iii posteriorly	.073
" " " m. i posteriorly	.048
" " " P-m. i (front)	.015
Diameters inferior P-m. i { anteroposterior	.019
Diameters inferior P-m. i { transverse	.0125
Diameters " P-m. iv { anteroposterior	.021
Diameters " P-m. iv { transverse	.013
Diameters " m. i { anteroposterior	.020
Diameters " m. i { transverse	.014

	Measurements.	M.
Diameters inferior m. iii	anteroposterior	.044
	transverse	.018

This fine species is from the John Day epoch of the Miocene. The typical specimen was found by my assistant, Charles H. Sternberg, on Bridge creek, Oregon. Much credit is due Mr. Sternberg for his unwearied exertions in the cause of science, which have been continued through many occasions of risk and discomfort.

Merycochœrus montanus, sp. nov.

This large animal is represented in my collection by a nearly entire skull with parts of both mandibular rami complete. Rami of another individual give the entire dentition of the lower jaw except the incisors. A third individual is represented by a symphysis with premolars, canines and incisors, and by various parts of the skeleton, including feet. Of the cranium mentioned, the muzzle to the preorbital fossa and the palate to the first true molar are wanting. The region of the larmier is lost, but the general resemblance of the species to the *M. macrostegus* in other respects, leads me to suspect that it is absent, and that the *M. montanus*, is rightly referred to the genus Merycochœrus. This course is indicated by the structure of the superior molar teeth, which have the character of those of this genus, rather than that found in Merychyus. That is, the posterior internal crescent sends its anterior horn to the external wall of the crown, thus cutting off the posterior horn of the anterior crescent. Dr. Leidy has shown that the reverse is the case in the *Merychyus major;* that is that the posterior horn of the anterior crescent reaches the external wall of the crown, cutting off the anterior horn of the posterior crescent. I have observed that this is also the case in the other species of Merychyus which have come under my notice.

The posterior position of the infraorbital foramen and the greatly produced palate distinguish this species from those of the John Day epoch, excepting the *M. macrostegus*, while in the *M. rusticus* and *M. proprius*, the infraorbital foramen is still further posterior. The palate of these species is unfortunately unknown.

The part of the maxillary bone posterior to the infraorbital foramen is nearly flat, and the proximal part of the malar bone is also flat. The inferior edge of the latter is narrow and is marked by a groove which terminates anteriorly in a shallow fossa. The ridge continuous with this edge terminates above the anterior lobe of the second true molar. The zygoma as far as the anterior border of the glenoid cavity is slender, and not convex, but flat in every direction, nor is it decurved as in *M. superbus*. The zygomatic foramen is relatively much smaller than in that species. Its posterior or preglenoid boundary is not at right angles to the sagittal crest as in that species, but is oblique outwards and forwards at an open angle. The obtuse median edge of the zygoma looks upwards, not outwards as it does in *M. superbus* and *M. macrostegus*, and the superior expansion is

opposite the internal extremity of the glenoid face, instead of the external as in *M. superbus*, or the middle, as in *M. macrostegus*. The border descending to the supraauricular crest is thin and vertical in direction, and the superior angle stands above the middle of the postglenoid process, not external to it, as in the two species above named. The postglenoid process is robust and has a convex posterior face. The paroccipital process is long and acuminate. An external truncate ridge on the front of its base partially embraces the meatus auditorius, and curving forwards becomes the anterior edge of the process, which is separated from the postglenoid by but a narrow interval. The tympanic bone forms a tube more distinct from the surrounding regions than in the other species here described, and has a longitudinal inferior keel, which is not visible in the *M. superbus* and *M. macrostegus*. It is separated at the meatus by but a short interval from the base of the postglenoid process. The supraauricular and mastoid crests unite and form a short acute crest, which does not continue into a prominent posttemporal, but descends into a mere angle, which continues as a fine line to the convexity of the true posttemporal crest above. The latter arises from the bifurcation of the sagittal crest, and after a strong convexity descends with its fellow to a narrow prominent convex ridge, which rises from the foramen magnum. Thus the occiput on either side of this prominent middle line is deeply excavated, and the fossa is bounded on each side and anteriorly by the low posttemporal angle, and the more prominent mastoid ridge. There is no median keel. The median ridge of the occiput is more prominent and not so flat as in *M. superbus*, but is more as in *M. macrostegus*. The sagittal crest is well developed, and has a straight superior border, which is not thickened as in *M. chelydra*. The anterior temporal ridges are represented by an angle which is nearly right. The superior squamosal suture is marked by a prominent ridge. The front is gently convex transversely, and the supraorbital border is more strongly decurved than in *M. superbus*, which are more so than in *M. macrostegus*.

The basicranial axis makes a strong angle with the basifacial as in the other species of the genus, showing that the face was presented obliquely forwards, as in the peccary. The section of the basioccipital bone between the paroccipital processes is V-shaped, owing to the presence of a strong median angle. In *M. macrostegus* this bone is similar, but in *M. superbus* it is much flatter, and there is a weak median keel. The sphenoid is in line with the occipital and has a broadly rounded-truncate inferior face. The otic bullæ are large and compressed. They extend from the middle of the base of the paroccipital process to considerably in advance of the postglenoid process, and approach very near to the glenoid surface. The interval which separates them is small, equaling one-fifth the anteroposterior diameter of the bulla. This is very different from the *M. macrostegus*, where the space between the glenoid surface and the bulla, is equal to the anteroposterior diameter of the latter near the middle. As already pointed out, this species agrees with the species just named in the

great prolongation of the palatal floor of the nareal cavities. The distance from the foramen magnum to the nareal border equals the distance from the latter to the line connecting the median external vertical crests of the last superior molars. In *M. superbus* the former measurement is two and one-half times as great as the latter.

The mandible shows the nearer relationship to the *M. macrostegus* than to the *M. superbus*, in the anterior elongation and greater relative size of the premolar teeth. It agrees with the former in having the profile of the symphysis concave, and not convex as in *M. superbus*. It is less concave in my single specimen than in that of *M. macrostegus*. The position of the posterior extremity of the symphysis is below the middle of the third inferior premolar. The coronoid process is low, and of small size. Its compressed convex apex is directed at an angle of 45° from the middle line outwards and forwards. Its anterior face soon widens out and the internal edge becomes much more prominent than the external, with which it encloses a shallow, subtriangular, subvertical fossa. The external border is continuous with the external alveolar border. The masseteric fossa is small and has no distinct inferior border, and does not descend below the level of the line of the middle molar teeth. The inferior border of the ramus is nearly straight. The inferior incisive alveolar border is much more strongly convex than in the *M. superbus*. The condyle has the posterior articular face on the inner side, as in other species.

The infraorbital foramen is large and is above the anterior part of the first true molar tooth. The meatus auditorius is small. There are two postparietal foramina on the pariëtosquamosal suture. No supraglenoid or postglenoid foramina. There are two mental foramina, one not small below the anterior part of the first true molar, the other, quite large, below the posterior part of the third premolar. The dental foramen is situated on a level with the alveolar border and well posteriorly, its anterior border being a little in front of a line dropped vertically from the apex of the coronoid process. It is thus similar in position to that of *M. macrostegus* and different from that of *M. superbus*, where it is above the line of the apices of the molars, and is posterior to the line dropped from the apex of the coronoid.

In the superior true molars, the size increases rapidly posteriorly. The third is relatively of more elongate form than the first, but the posterior external column is but little produced. The other vertical ridges are quite prominent. The external faces of the external lobes are nearly flat. Besides the relation of the adjacent horns of the internal crescents already mentioned, the posterior horn of the posterior crescent in the first and second molars is cut off from the external wall of its own crown by the anterior horn of the anterior crescent of the crown next posterior. This does not exist in worn molars of *M. superbus* and *M. macrostegus*, but is observable in little worn teeth of the former. It does not look as though the character would disappear with wear in the *M. montanus*. The only

trace of cingulum on the superior molars is on the inner base of the anterior lobe, where it is weak, and in the interspace between the internal lobes, where it is a narrow tubercle. Enamel obsoletely vertically striate. It is wanting on the external side of the internal crescent, as Leidy has shown to be the case in certain species of Merychyus. The fifth lobe of the last inferior molar is well developed and has its two crescents separated by a groove. The adjacent horns of the external crescents are of about equal length. No cingula, except a trace on front and rear of crowns, and a tubercle between the bases of the external lobes. The fourth premolar has two fossæ isolated, one anterior to and the other posterior to the principal apex, which is double, and anterior to the middle. Before wear, each of these fossæ opens inwards. The crown of the third premolar has its inner face unequally divided by a crest behind the middle. Posterior to this the space is occupied on the inner side by two shallow fossæ of which the posterior is the narrower. Anterior part of inner face of crown concave. One principal angular cusp. The second premolar has a compressed triangular crown with a long base, and a weak vertical ridge on the internal side. The first premolar is a very robust tooth with a straight posterior border directed at 95° forwards, and is vertically truncate in the specimen by friction with the canine. Section of crown lenticular, rounded in front.

Measurements.	M.
No. 1.	
Length from occipital condyle to postglenoid process...	.049
" " " " " postfrontal process...	.135
Width of occiput at posttemporal crests.	.054
" " " condyles.....	.102
Elevation of occiput above foramen magnum.....	.084
Length from foramen magnum to palatal border.....	.060
Width between apices of otic bullæ.....	.042
Length from inferior m. iii to apex of coronoid process.	.075
" of superior true molar series..... ...	.084
Diameters m. i { anteroposterior	.026
{ transverse (at middle rib)	.025
Diameters m. iii { anteroposterior.	.034
{ transverse (at middle rib).....	.025
Length of inferior true molar series.....	.085
Diameters P-m. iv { anteroposterior.	.0205
{ transverse behind.....	.015
Diameters m. i { anteroposterior	.022
{ transverse.....	.016
Diameters m. iii { anteroposterior.....	.040
{ transverse..	.022
No. 2.	
Length of ramus mandibuli from incisive border to condyle (oblique).....	.280

Measurements.	M.
Length of dental series (straight line)	.191
" from last molar to apex of coronoid	.0735
" of premolar series	.085
" " true molar series	.084
" " second premolar on base	.021
" " first premolar on base	.0225
Depth of ramus at coronoid	.044
" " " end of m. iii	.073
" " " middle m. i.	.056
" " " P-m. i. vertically	.034

The specimens of this species were found by Mr. J. C. Isaac in the Ticholeptus beds of Deep river, Montana, during his Expedition of 1880.

Merycochœrus rusticus Leidy.

Report U. S. Geological Survey Terrs., 1873, i, p. 199, Pl. III, figs. 1–3; VII, figs. 1–5; XX, figs. 9–81. Proceedings Academy Philadelphia, 1870, 109.

The smallest species, characterized among other things by the closure of that part of the nareal fissure which separates the premaxillary bones below. According to Leidy's figure above quoted, the depth of the middle line of the undivided premaxillary is greater than the width of the bone, a state of things not approached by any of the species of this genus described in the preceding pages. The premaxillary in the *M. proprius* is not described.

From the ? Ticholeptus beds of the Sweetwater river, Wyoming.

Merycochœrus proprius Leidy.

Proceedings Academy Philadelphia, 1858, p. 24; Extinct Mammalia Dakota and Nebraska 1869, p. 110; Pl. X.

This large species represents the extreme form of the genus in the anterior position of its dental series as compared with the braincase. The zygomatic arch and infraorbital foramen are therefore more posteriorly placed than in any other species. The premaxillary bone is more prominent than in any other, and the incisor teeth have relatively larger dimensions. The size is about that of the *M. superbus*. I have not seen any other than the typical specimen.

From the Ticholeptus beds at the head waters of the Niobrara river, Nebraska.

MERYCHYUS Leidy.

Proceedings Academy Philad'a, 1858, p. 24, (nomen nudum). Extinct Mammalia Dakota and Nebraska, 1869, 115. Report U. S. Geological Survey Terrs. i, 1873, p. 202. Cope, American Naturalist, 1884, p. 281. *Ticholeptus* Cope, Bulletin U. S. Geolog. Survey Terrs., 1878, p. 380.

Premaxillary bones coössified; otic bulla swollen; a vacuity between

the maxillary, lachrymal, and nasal bones, or larmier. Nasal bones normal. First inferior premolar caniniform.

This genus has not been defined prior to the present article, although some characters common to the species of the genus known to him, have been given by Leidy. As now defined it is identical with genus *Ticholeptus* Cope. This group was distinguished by the presence of a larmier, a character whose presence in the species of Merychyus has been hitherto unknown. It is not yet reported indeed as present in any of the original species of the latter, but I think that there can be no reasonable doubt of its presence there. A character found by Leidy in the *M. major* I find to be present in one or more of the superior molar teeth in all the species. The posterior horn of the anterior internal crescent cuts off the adjacent or anterior horn of the posterior internal crescent from contact with the inner side of the external wall of the crown. It is the anterior horn of the posterior internal crescent which reaches the external wall, in the genera Merycochœrus, Eucrotaphus and Oreoden. In Leptauchenia the arrangement is generally as in Merychyus; see under the head of that genus.

This genus is confined to the Upper Miocene beds, the Ticholeptus and Loup Fork epochs. In size the species range from medium to large, the *M. major* equaling any species of the family in dimensions. They are distinguished as follows:

I. True molar teeth not prismatic.

Infraorbital foramen above fourth premolar; malar bone shallow; squamosal with superior zygomatic angle anterior; true molars M. .042 ..... *M. pariogonus.*

II. True molar teeth more or less prismatic.

a. Infraorbital foramen above third premolar.

Larmier a slit; front narrow ..... *M. arenarum leptorhynchus.*

aa. Infraorbital foramen above fourth premolar.

β. Zygomatic arch vertical, and with posterior angle small and rounded.

Larmier triangular; front wide; true molar series M. .044; face convex ..... *M. arenarum arenarum.*

ββ. Zygomatic arch expanded horizontally; posterior angle strong, acute.

Larmier large; true molars .051 ..... *M. zygomaticus.*

ββ. Zygomatic arch unknown.

Facial plate generally concave; true molars M. .045 ..... *M. elegans.*

True (inferior) molars, M. .069 ..... *M. medius.*

True (superior) molars (m. iii inferred), M. .095 ..... *M. major.*

Of the above species, the *M. arenarum* and *M. zygomaticus* are known from entire skulls. In the first named, the foramen infraorbitale appears to be partly above the posterior edge of the third premolar, as well as above the anterior edge of the fourth.

Merychyus arenarum Cope, sp. nov. Sub-species **leptorhynchus** Cope.

This species is represented by a skull which lacks of completeness only the extremity of the muzzle and the angles of the lower jaw. Its size is about that of the *Oreodon culbertsoni* or of the *Merychyus elegans*. The confluence of the premaxillary bones shows that the place of the species is with the last-named genus, and the sigmoid flexure of the masticating line of the superior dentition is a point of resemblance to the species of the same. The position of the external infraorbital foramen is one degree further posterior than in the species of Oreodon, and agrees with the position in two other species of Merychyus (*M. arenarum* and *M. pariogonus*), which is more anterior than in the other species of the genus. The foramen is in fact quite identical in position with that seen in most of the species of Eucrotaphus, to which genus the above named species must be regarded as the nearest in the genus to which they belong.

As in other species of the genus, the malar bone is deeper and less prominent laterally than in those of Oreodon. The preorbital fossa is wider and shallower. The orbit is closed behind.

The premaxillaries are convex in every direction, least so transversly. The fissure which separates them is quite narrow, and is separated from the alveolar border by a rather narrow isthmus of uninterrupted bone. At the canine tooth the direction of the surface becomes longitudinal by an abrupt turn, and the side of the face above the second premolar is uninterruptedly gently concave. The lateral convexity which bounds the preorbital fossa below, appears above the third superior premolar, and becomes more prominent posteriorly as it passes into the flat surface of the malar bone. The anterior orbital border is prominent and thin, and does not develop a distinct tubercle, although its edge is roughened. The profile of the muzzle is a straight line descending gently from the interorbital region. Above the middle of the orbits the frontal bones are gently convex; on the line of their anterior border, there is a concavity of the median line. The superior face of the nasal bones is flat, and is peculiarly narrowed, especially posteriorly, where the large preorbital fossæ approach each other.

The anterior temporal ridges are well marked, and after a gradual approach unite into a sagittal crest, which has a gently convex rising profile. After the posterior bifiurcation of the latter, the convex posterior temporal crests do not project beyond the occipital condyles when the inferior edge of the lower jaw rests on a horizontal plane, as in so many other species of this genus and of its allies. These crests continue without interruption above the auricular meatus to the posterior base of the postglenoid process. As compared with the *Oreodon culbertsoni*, the postorbital part of the cranium is short; it is also shorter than in any other species of Merychyus. Thus the length from the posterior border of the orbit to the convexity of the

posterior temporal crest, is as long as from the former point to the anterior base of the first premolar. In the *Oreodon culbertsoni*, the same measurement is equal to the length from the same point to the anterior base of the third incisor. This shortening posterior to the orbit is seen to involve the zygomatic fossa as well as the region posterior to it. Thus the horizontal diameter of the orbit in the *M. leptorhynchus* is exactly equal to the distance between the posterior border of the same and the anterior edge of the glenoid cavity. The posterior part of the superior edge of the squamosal zygomatic process is thin and strongly convex. The apex of the convexity is above a point just anterior to the posterior border of the glenoid cavity. The posterior edge of the process is nearly vertical, and if continued would reach the middle of the base of the postglenoid process. The latter is compressed and rather elongate, and its convex edge has considerable transverse extent. The paroccipital process is long and is flat on its posterior face. The postorbital process of the frontal is elongate wedge-shaped, with its truncate apex below joining a slight elevation of the malar bone, which is much less prominent than in *Oreodon culbertsoni*. It presents an angle outwards and forwards, as the orbital border. The anterior half of the zygomatic process of the malar bone is rounded-truncate below. The glenoid surface is plane transversely, and slightly convex, rising backwards, anteroposteriorly. The anterior border of the squamosal bone is not developed into a ridge.

The frontal bone extends forwards on either side of the nasals, forming a narrow process above the lachrymal bones. It overlaps the superior edge of the maxillary, of which a narrow splint appears between it and the nasal. The nasals are rather narrow, and each has the posterior border rounded. The latter fall above the middle of the first true molar tooth when the inferior edge of the mandible is horizontal. The lachrymal bone has greater anteroposterior than vertical diameter, extending nearly to the line of the infraorbital foramen, or much in advance of its position in *Oreodon culbertsoni*, *Eucrotaphus jacksoni*, or *Merycochœrus superbus*. The malar bone has a correspondingly large anterior extension, reaching to above the posterior part of the fourth premolar. It does not extend so far in the three species just named. The zygomatic process of the squamosal is more deeply received into the malar bone than in any of the three species mentioned, reaching to below the posterior third of the orbit.

The larmier in this species is small, and its anteroposterior diameter is more than twice as long as the vertical. More than half of its inferior border is formed by the maxillary bone. As it is exhibited in the specimen, its superior border is formed by the ascending process of the maxillary bone; whether this is overlapped by the laminar process of the frontal so as to bound the foramen, when in a perfect condition, is uncertain. The posterior edge of the larmier is the lachrymal bone. The external *foramen infraorbitale* is on one side double. The supraorbital foramina form notches at the anterior edge of the supraorbital border. The frontal

foramina are well separated from each other, as in the species of Merycochœrus. The space between them is about equal to that between each one and the superciliary border. There is a large postpariëtal foramen near the pariëto-squamosal suture. If the supraglenoid foramen be present it is not distinguishable in the specimen. The orbit is rounded subquadrate, with the inferior anterior angle a little produced.

The ascending process of the mandible is relatively elevated. The horizontal ramus narrows rapidly anteriorly, and the symphysis mandibuli is produced so as to rise at a very low angle. The alveolar portion is horizontal.

The superior incisors are small and their apices are but little expanded, the external the most so. They are directed vertically downwards. The superior canine is quite small; its crown exceeds in length that of the first premolar by but little, and is directed a little posteriorly as well as downwards. The roots of the first premolar are not as well distinguished as in many other species, and are united in their extra-alveolar part at least. The same is true of the second premolar. The apex of the cutting edge is in line with the anterior border of the crown; the rest of the edge rises obliquely backwards. In the third premolar there is a slight bevel in front of the apex, which is much better developed on the fourth. These teeth are more truncate than the corresponding ones of the species of Oreodon and Eucrotaphus, and the larger species of Merycochœrus. The external faces of P-m. i and ii are convex; that of P-m. iv is concave, but without the reverted vertical borders seen in *Oreodon culbertsoni*. The first true molar has long roots and a short crown. The last two molars have crowns of a more elongate character, with well developed anterior and middle ridges. The latter are not so prominent as those of the molars of the *Merychyus zygomaticus*.

The inferior incisors are directed upwards at an angle of about 30°. They are similar and closely packed. The inferior canine is in close contact with the third incisor, from which it differs in its larger, leaf-shaped crown. The inferior first premolar is a slender one-rooted caniniform tooth, with narrow crown and acute apex. The second premolar is one-rooted, and has a leaf-shaped crown, with acute-angled apex. The third is two-rooted, and has a wider and nearly symmetrical crown. The fourth is much larger, and its elongate crown laps inside of that of the third. Its low angular apex is median. The last inferior true molar is disproportionately larger than the others. No external cingula.

Measurements of Skull.	M.
Length from occipital condyle to premaxillary border..	.161
" " " " " postglenoid process...	.030
" " " " " postfrontal process...	.078
" " " " " preorbital border.....	.130
Diameters of orbit { vertical.....	.0250
Diameters of orbit { transverse.....	.0255

Measurements of Skull.	M.
Depth of malar bone at middle of orbit	.0195
" " zygomatic process at glenoid face (greatest)	.021
Width of top of muzzle at larmier	.0175
" at middle of supraorbital border	.051
" " malar bones	.077
" " zygomatic processes of squamosal	.0795
" of occipital condyles	.031
Elevation of occiput, including condyles	.054
Width of occiput at middle	.033
Depth skull at right angles to profile, at glenoid face	.046
" " " " " " orbit	.049
" " " " " " larmier, exclusive of teeth	.044
Depth of mandible at condyle	.071
" " " m. ii (middle)	.025
" " " P-m. iii	.022
Length of superior dental series	.0885
" to superior P-m. i	.0130
" " " m. i	.0470
" of " m. iii	.0180
" " " canine, crown	.009
" to inferior P-m. i	.012
" " " m. i	.0425
" of " dental series	.087
" " " m. iii	.022

The unique and beautiful specimen on which our knowledge of this species rests, was found in a formation of the Ticholeptus Miocene near Laramie Peak, Wyoming Territory, by my assistant, J. C. Isaac.

Merychyus arenarum, sp. nov. Sub-species **arenarum.**

This species was more abundant than the *M. leptorhynchus* during the Ticholeptus epoch, if we may judge from the number of specimens which have been procured. I enumerate here the five most important, viz.: No. 1, A skull which lacks the muzzle as far as the preorbital fossa, and the palate as far as the third premolar, and which has the mandible complete as far as the coronoid processes, and which is accompanied by fore and hind feet and other limb bones. No. 2, A muzzle and right side of the face including the orbit, with the entire dentition, including that of the premaxillary bone, and that of the right mandibular ramus as far as the second true molar inclusive. No. 3, A skull with a part of the mandible, of an immature individual, in which the last superior molar is just appearing, and the last two temporary molars are in place, and which is accompanied by a few bones of the limbs. No. 4, Palatal part of skull with nearly all the teeth, accompanied by perfect mandible with all the teeth, and a large part of the skeleton. No. 5, A skull from which the basi-

cranial region, zygomata, and left maxillary bone, have been lost. The measurements of No. 4 somewhat exceed those of the other specimens, so that it is doubtful whether it really belongs here.

The characters which distinguish this form from the *M. leptorhynchus* are not numerous. In the first place the front and muzzle are relatively wider. Secondly, the larmier is of a different form. Instead of being a horizontal slit, it is subtriangular, with the base above, and the angle below; thirdly the canine teeth are more robust in both jaws. But the position of the infraorbital foramen is slightly variable, and the width of the front in one specimen is about as in the sub-species *leptorhynchus*. The size of the canine is not invariable. I am therefore precluded from regarding the *M. leptorhynchus* as more than a sub-species.

As compared with the *M. elegans*, the strong convexity of the side of the face distinguishes it. The convexity continues from the malar region forwards above the infraorbital foramen, and nearly reaches the nareal opening. Judging from Leidy's fig. 11, Plate XI, of the Extinct Mammalian fauna of Dakota and Nebraska, the premaxillary bone of the *M. elegans* is flatter than in the *M. arenarum*. The infraorbital foramen has a more anterior position in the latter than in the former.

The size is always a little larger than in the type specimen of *M. leptorhynchus*.

Measurements.	M.
No. 1.	
Length from occipital condyle to postglenoid process	.037
" " " " " postfrontal process	.076
" " " " " preorbital border	.105
Transverse diameter of orbit	.030
Depth of malar bone at middle of orbit	.019
" " zygomatic process at glenoid face (greatest)	.019
Width at middle of supraorbital border	.062
" " malar bones	.096
" " zygomatic process of squamosal	.100
" of occipital condyles	.034
" " occiput at middle	.036
Elevation of occiput including condyles	.054
Depth of skull at right angles to profile at glenoid face	.041
" " " orbit (exclus. teeth)	.051
" of mandibular ramus at m. ii	.030
" " " " P-m. iii	.022
Length of last five superior molars	.064
" " true molars	.043
Diameters P-m. iii { anteroposterior	.010
Diameters P-m. iii { transverse	.010
Diameters m. i { anteroposterior	.013
Diameters m. i { transverse	.013

Measurements.	M.
No. 1.	
Diameters m. iii { anteroposterior.	.019
Diameters m. iii { transverse.	.015
Length of inferior dental series (axial)	.098
" " premolar series (axial).	.038
Long diameter of crown of canine	.007
" " " P-m. i.	.0086
" " " P-m. ii	.0084
Diameters P-m. iv { anteroposterior.	.012
Diameters P-m. iv { transverse.	.009
Diameters m. ii { anteroposterior.	.0147
Diameters m. ii { transverse	.010
Diameters m. iii { anteroposterior.	.0223
Diameters m. iii { transverse.	.010

The specimens all came from the Ticholeptus beds near Laramie Peak, Wyoming, and were discovered by my assistant, J. C. Isaac.

Merychyus pariogonus, sp. nov.

The generic position of this species is uncertain, and it may belong to Merycochœrus or even to Eucrotaphus, as its otic bullæ are inflated. The doubt as to its position is due to the fact that the anterior part of the skull of the typical specimen is lost as far back as the anterior border of the orbit, and the second molar tooth. I place it here provisionally because the internal crescents of the superior molars are arranged as in *M. major* and *M. arenarum, i. e.,* with the anterior crescent excluding the posterior at the point of junction of the two.

The *Merychyus pariogonus* is about the size of the *Oreodon culbertsoni.* The braincase is full, so that the internal side of the temporal fossa is strongly convex, but without very prominent ridge along the pariëto-squamosal suture. The anterior temporal ridges unite at an acute angle, but the sagittal crest is obsolete as far as a point above the posttympanic process, where it gradually rises. The posterior temporal ridge is prominent superiorly, but is not produced beyond the line of the occipital condyles. It is discontinued in the direction of the supraauricular ridge, but continues downwards as an obtuse ridge on each side towards the foramen magnum. Between this and the squamoso-occipital angle is a large open fossa which is present in the species of this genus, of Merycochœrus and of Eucrotaphus, but is wanting in *Oreodon culbertsoni.* In the obsolescence of the posterior temporal crest it agrees with the last named species, and with some of those of Merycochœrus, but differs from *Eucrotaphus jacksoni* where it is low, and from *Merychyus leptorhynchus,* where it is well developed. In the size of the lateral occipital fossæ this species exceeds any of the others of this family. Below the depression, the posterior temporal crest rises abruptly, forming a convex edge which continues downwards nearly obsolete, on the suture between the post-

tympanic and paroccipital processes. It is not distinctly continuous over the auricular meatus. The paroccipital process is elongate and acuminate, and becomes compressed so as to be anteroposterior for the greater part of its length. The auricular meatus occupies but a small part of the space between the posttympanic and postglenoid processes. It is partially enclosed by the robust rounded ledge of the squamosal bone, which separates it from the postglenoid process. This ledge is much more developed than in any other species of this family known to me. The bulla of the petrous bone is longer anteroposteriorly than transversely, and its anterior and posterior borders coincide with the anterior border of the postglenoid process, and that of the paroccipital process. The postglenoid process is robust, much as in the large species of Merycochœrus, and not compressed as in *Merychyus leptorhynchus* and *M. xrenarum*. The zygomatic arch is slender. The elevation of the posterior part of the zygomatic process of the squamosal has a different form from that seen in the species last named. It is angulate, not rounded. The position of the angle is different from that in *M. zygomaticus* in being more anterior, marking a point well in front of the anterior base of the postglenoid process. The border which connects the angle with the supra-auricular crest is then not vertical as in the species just mentioned, but is oblique, and it is also somewhat concave. The malar bone is shallow and stout, with truncate edge below. The squamosal process enters it to below the posterior third of the orbit. The postfrontal process is slender, and the postorbital process of the malar is elongate, meeting the former opposite the middle of the orbit. It is thus longer than in any species of the family known to me.

The frontal foramina are separated by an interspace equal to four-fifths the distance between each and the superciliary border. The pariëto-squamosal suture ascends posteriorly in a nearly straight line to within M. .015 of the posterior zygomatic crest. The posterior squamosal suture then turns directly downwards, reaching the depressed portion of the crest where it bounds the huge mastoid fossa and foramen.

The posterior part of the mandibular ramus, shows a regularly convex angular border commencing just below the condyle. The coronoid process is quite small and the short connecting edge between it and the condyle is not excavated below the level of the latter. The articular face of the condyle is directed upwards, and on the internal third, presents a face posteriorly also. The ramus diminishes rapidly in depth anteriorly. The masseteric fossa does not descend below the level of the second true molar, and is not sharply bordered anywhere. The internal pterygoid fossa on the other hand occupies the entire inner face of the angle between the condyle and the inferior border, and anteriorly to the line of the last inferior molar tooth.

The superior true molars have short crowns, as in Eucrotaphus and Oreodon. The anterior and median vertical ridges are very prominent, and the posterior vertical border of the posterior column projects to a slight

extent posteriorly. Enamel smooth. The last inferior molar is not so disproportionately larger than the second as in *M. leptorhynchus*, *arenarum* and *elegans;* and with the second, has little of a prismatic character. No cingula.

Measurements.	M.
Length from occipital condyle to postglenoid process...	.047
" " " " " postfrontal process. ..	.101
Vertical diameter of orbit.....	.036
Depth of malar bone at middle of orbit.	.012
" " zygomatic process at posterior angle.	.024
Width at middle of supraorbital border.....	.060
" " malar bones.....	.090
" of occipital condyles.....	.032
" " occiput at lateral crests.	.036
" " " " condyles.....	.061
Elevation of occiput with condyles.	.054
Depth of skull at glenoid surface.....	.058
" " " " orbit, exclus. malar.	.054
" " mandible at condyle.....	.075
" " " " coronoid.....	.083
" " " " posterior edge of m. iii.	.042
Depth mandible at middle of m. ii.....	.028
Diameters superior m. ii { anteroposterior.	.016
{ transverse.....	.016
Diameters superior m. iii { anteroposterior.....	.020
{ transverse.	.0155
Diameters inferior m. ii { anteroposterior	.015
{ transverse.....	.012
Diameters inferior m. iii { anteroposterior.....	.0225
{ transverse.....	.0115

A second specimen of this species consists of the occipital, pariëtal, and part of the frontal regions, with the right maxillary bone, and fragments of the left maxillary, of the mandible, etc. The latter demonstrates the position of the infraorbital foramen to be above the anterior border of the fourth superior premolar. The middle line of the occiput presents a keel on its superior half. The basioccipital bone between the paroccipital process is expanded laterally, and is without median angle or groove. Between the bullæ it is compressed, and its middle line forms a narrow truncation. Opposite the posterior third of the bulla, this surface ascends at an angle, and gradually widening, spreads into the general flattened convex inferior face of the sphenoid. The anterior part of the sagittal crest is a little better developed than in the typical specimen. The worn teeth indicate an old individual. The canine is large, and the first premolar has its roots well distinguished. The facial plate of the maxillary concave above second premolar. No appreciable diastema.

Measurements.	M.
Length of molar series	.081
" " premolars on bases	.041
Width of canine posteriorly	.010
Diameters P-m. iv anteroposterior	.010
Diameters P-m. iv transverse	.012

Of this species I have but two specimens, which were obtained from the Ticholeptus beds of Deep river, Montana, by my assistant, J. C. Isaac.

Merychyus elegans Leidy.

Proceedings Academy Philada., 1858, p. 24. Extinct Mammalia Dakota and Nebraska, 1869, p. 118, Pl. XI, figs. 1–11.

Niobrara river, Nebraska.

Merychyus zygomaticus Cope.

Ticholeptus zygomaticus Cope, American Naturalist, Feb. 1878. Bulletin U. S. Geolog. Survey Territories, 1878, p. 380.

This species is peculiar in having the posterior expansion of its zygomatic arch horizontal instead of vertical. It has a thickened external edge which continues into a strong posterior angle which projects behind the posterior margin of the postglenoid process. The auricular meatus is directed posteriorly in a way quite peculiar, resembling somewhat the position seen in some of the hogs. The malar bone is very prominent. The infraorbital foramen is above the contact of the third and fourth superior premolars. The larmier is large and its maxillary border descends posteriorly.

In size this species is between the *M. elegans* and the *M. medius*. If my identification of New Mexican specimens is correct, this species differs from the *M. medius* in the much less production of the premaxillary region, besides the smaller size.

Ticholeptus beds of Deep river, Montana ; J. C. Isaac.

Merychyus medius Leidy.

Proceedings Academy Philad'a, 1858, p. 25. Extinct Mammalia, Dakota and Nebraska, 1869, p. 119, Pl. XI, figs. 12–14. Cope U. S. Expl. Surv. W. of 100th Mer., G. M. Wheeler, iv, pt. ii, p. 324.

Niobrara river, Nebraska, Hayden ; Santa Fé, New Mexico, Cope.

Merychyus major Leidy.

Proceedings Academy Philada., 1858, p. 26. Extinct Mammalia, Dakota and Nebraska, 1869, p. 121, Pl. X, figs. 15–16.

This species, known hitherto from Leidy's descriptions of four of the superior molars, is the largest of the genus, and perhaps of the family. More information regarding it is much to be desired.

Headwaters of the Niobrara river ; from Loup Fork beds, according to Hayden.

LEPTAUCHENIA Leidy.

Extinct Mammalia of Dakota and Nebraska, 1869, 122. Proceedings Academy Philad'a, 1856, 88, (nomen nudum). loc. cit. 1656, 163 (nomen nudum).

As already remarked by Leidy, this genus is characterized by the presence of enormous vacuities of the superior surface of the muzzle. The genus might be described as lacking the usual superior osseous wall of the nasal cavities and maxillary sinuses. The generic diagnosis is as follows:

Otic bullæ inflated. Four premaxillary teeth. Nasal bones excessively contracted, leaving a wide interspace between them and the maxillaries. Symphysis mandibuli coössified.

This genus has but a short range in time, not having been yet found out of the Ticholeptus beds. It shows in its deficient ossification, and smaller size, that this line of the family was approaching its extinction, its decadence having already commenced in the genus Merychyus. The genera which follow in systematic order, Cyclopidius and Pithecestes, exhibit the last steps in the downward course.

I. Infraorbital foramen above P-m. iii.

"Three inferior incisors; nasal sinuses to middle of orbit; true molars .043; skull .135." (Leidy).....*L. major.*

"Nasal sinuses not extending so far posteriorly as in *L. major;* true molars .032; skull, .101." (Leidy).....*L. decora.*

"Nasal sinuses reaching to front of orbit; true molars .020; skull .085." (Leidy).....*L. nitida.*

Leptauchenia major Leidy.

Proceedings Academy Philad'a, 1856, p. 163; 1857, 89. Extinct Mammalia, Dakota and Nebraska, 1869, p. 124, Pl. XII, figs. 1–5.

Tributaries of White river, Nebraska.

Leptauchenia decora Leidy.

Proceedings Academy Philadelphia, 1858, p. 88; 1857, p. 89. Extinct Mammalia of Dakota and Nebraska, 1869, p. 127, Pl. XII, figs. 6–20.

Tributaries of White river, Nebraska.

Leptauchenia nitida Leidy.

Extinct Mammalia of Dakota and Nebraska, 1869, p. 129; Pl. XII, figs. 21–22.

White Earth creek, Dakota, tributary of the White river.

CYCLOPIDIUS Cope.

Proceedings American Philosophical Society, 1877, p. 221. *Brachymeryx* Cope, Ibidem, p. 220.

Dental formula: I. $\frac{0}{2}$: C. $\frac{1}{1}$; P-m. $\frac{4}{4}$; M. $\frac{3}{3}$. Premaxillary bones much reduced; mandibular rami coössified. Otic bulla inflated. Prelachrymal vacuities present, and confluent with enormous nasal vacuities, which are due to the excessive reduction of the nasal bones. Orbit closed behind.

This genus is Leptauchenia without superior incisor teeth, and with but two on each side below. I originally asserted the presence of superior incisor teeth, and it is true that there is in early life a minute tooth in each premaxillary bone, as indicated by the alveoli in a specimen which contains the full deciduous molar dentition. I have not seen the teeth themselves, and it is evident that they are early shed. In an adult specimen of *C. simus* it seems that the alveolar portion of the premaxillary bone has been absorbed.

The meatus auditorius externus occupies a more elevated position in this genus than in any other of the family. It is also directed somewhat posteriorly. There are postparietal foramina.

The cerebral hemispheres are not large, and scarcely rise above the plane of the summit of the large cerebellum. Convolutions three on each side, weakly defined.

The concavity of the superior border of the premaxillary bones, together with their upward production, leads me to suspect that the external nares were superior in position. This is the indication of an aquatic habit of life, such as is led by the hippopotamus. Like that animal, the nostrils in Cyclopidius were probably valvular to prevent the ingress of the water. The animals probably passed much of their time in the water, and the nostrils could be brought to the surface for the purpose of respiration, while the remainder of the head and body remained concealed. The prominent rim of the auditory meatus suggests a similar valvular closure of the organ of hearing, and is also a provision for its easy approximation to the surface of the water when necessary.

The milk dentition is like that of Artiodactyla in general. That is, in the superior series the third molar is more elongate and complex than its permanent successor, and the fourth is like the first permanent true molar in constitution. In the inferior series the anterior three teeth resemble the permanent premolars, while the fourth is trilobate.

In the loss of the incisor teeth and the subprismatic molars, we observe in Cyclopidius the same evidences of specialization already known in other types of Ungulates.

I know of but two species of Cyclopidius.

Cyclopidius simus Cope.

Proceedings American Philosophical Society, 1877, p. 221. *Brachymeryx feliceps* Cope, Ibidem, p. 220 (immature).

The specimens of this species in my possession embrace a complete skull with one zygoma and half of the brain-case wanting; a left maxillary bone with all the teeth; and three mandibular rami with dentition, all of adults. Of immature individuals, I have two muzzles with dentition of both sides, and six mandibular rami; in all, parts of thirteen individuals. The following description of the skull is taken from the specimen first named, which is the type of the species.

The cranium is wide and depressed, and the muzzle is short. The pro-

file descends at the orbits into the nasal vacuities, which cause a deep excavation of the facial plate of the maxillary region. The small nasal bones form a promontory below the level of the orbits, whose superior borders are convex. The maxillary bones rise at the end of the muzzle, forming, probably, with the confluent premaxillaries, a subquadrate projection. The superior side of this process is concave on its interior aspect forming a curved suture of an expanded nasal bone. Its anterior edge is also concave on their inner side, as though adapted to a forward-looking nareal opening. This anterior border is produced downwards into a free conical process which bounds the canine alveolus in front. This I suppose is all that there is of the alveolar portion of the premaxillary bone. The corresponding part of the other side is lost. There is a well-marked preorbital fossa. Its supero-interior border bounds the huge nasal vacuity on each side. The nasal bones form a narrow promontory, with convex superior face, which extends a little beyond a line connecting the middles of the preorbital fossæ. The vacuities excavate the frontal bones as far back as a line connecting the middles of the supraorbital borders. The frontal bone is thus of a Λ-shape. The anterior temporal ridges are well defined, but do not reach the free edge of the frontal bone. Their union into the sagittal crest is gradual. The brain-case is moderately elongate, the postorbital process of the malar bone marking the middle of the total length. In profile the posterior part of the skull is nearly straight. The sagittal crest is gently convex, and is not so deeply bifurcated posteriorly as in most other forms. The posterior temporal crests are expanded laterally, and continue well developed to above the meatus auditorius, into the superior edge of the zygoma. They are not continued downwards on the occiput, as in most of the other genera of the family, but resemble the species of Merychyus more than any others in this respect. The temporal fossa has a wide floor, due to the lateral extension of the meatus auditorius, and the glenoid portion of the squamosal. The superior edge of the zygomatic process of the squamosal is little elevated, and is regularly convex. The process is not produced as far anteriorly as the posterior border of the orbit. The malar bone is remarkable for its depth, exceeding in this respect any species of the family yet known. Its external face slopes obliquely outwards below, but not very much, and is slightly and uniformly convex. Its inferior edge is thickened and descends anteriorly, and then thins and rises continuously to the zygomatic process of the squamosal.

The occipital aspect of the skull is wide and low. Its superior region is slightly convex and roughened on each side of the median line. From and below this valley, the middle line presents a sharp carina, which disappears in a narrow convexity above the foramen magnum. Between this convexity and the meatus auditorius, the surface is concave. The occipital condyle is small, and the exterior half is more extensive than the posterior half. The paroccipital process is large. Its base diverges from the occipital condyle, and is adherent by its anterior face to the otic bulla,

without intervening ridge. The posttympanic mass is broken away. It is inferior in position to the auricular meatus. The latter, being directed posteriorly, is considerably produced behind the postglenoid process, leaving a wide postglenoid fossa. The postglenoid process is rather small, and its posterior face is entirely covered by the tympanic bone, while its interior edge is in close contact with the otic bulla. The bulla is of enormous size, and is a slightly compressed oval placed anteroposteriorly. It fills the entire space between the postglenoid process and the basicranial axis, and reaches anteriorly almost to the line of the anterior border of the glenoid region. The pterygoid process adheres to its internal wall for half its length, and it sends forwards on the external side of the pterygoid, a narrow acuminate apex. The internal extremity of the glenoid cavity is concave, and the surface descends, forming a robust peduncle, as large as the postglenoid process, to which the anterior part of the otic bulla is attached. This is a character I have not seen in any other species of the family. A wide surface, continuous with that of the glenoid face, extends on the external side of the pterygoid ala of the sphenoid, to the angle where it unites with the pyramidal process of the palatine. It there terminates abruptly, but the external angle marks the end of a ridge, which extends upwards and forwards to the postorbital process of the frontal. Anterior to this line the cranial wall is concave; posterior to it, convex. The processi pyramidales are divergent, and have thickened and rounded inferior edges. The maxillary bones are produced a little beyond their bases, leaving a notch between. The palatal surface is uniformly moderately concave.

The incisive foramina are large; the septa are wanting in my specimens, perhaps accidentally. The infraorbital foramen is above the middle of the fourth premolar tooth. The frontal foramina are further apart than in any other species of the family, being equidistant between the median line and the supraorbital border. There is an internal orbital foramen below the postorbital process, as in other species of the family. There are three postpariëtal foramina, two of which are on the squamosal suture. Below the anterior of these two is a large postsquamosal foramen. No supra or postglenoid foramina. The meatus auditorius externus looks equally externally and posteriorly. It is large and of oval outline, the long diameter being parallel to the superior border, which is the usual suprameatal crest. Its tympanic or anterior border is very prominent, while the posterior border is a little less so. A posttympanic tuberosity marks the middle of the inferior edge. Posterior to the meatus is the rather large mastoid foramen, which is above the internal base of the paroccipital process. The basicranial bones being lost, the characters of the basal foramina are not determinable. The posterior nares are deeper than wide. The palatonareal border is a Gothic arch, of which the apex is opposite the posterior border of the last molar tooth. I perceive no palatal foramina.

The median and posterior nasal sutures remain. The latter is a V with

the apex opposite to the frontal foramina. Lambdoidal suture confluent. The malosquamosal suture marks the posterior edge of the posterior orbital rim at the middle of the orbit. The pariëto-squamosal suture has an inferior position in front. Opposite the front of the postglenoid process it converges inwards in line for the occipital bifurcation, and is continued as the pariëtoöccipital suture, nearly to that point. The squamosal border, however, extends in a Z-form to the posterior temporal crest half-way between the bifurcation and the meatus auditorius. It embraces an area of the posterior face of the skull, and the posterior half of the rim of the auricular meatus.

The typical specimen presents only the alveoli of the canine and first premolar teeth; otherwise the dentition is perfect. The crowns of the second and third premolars are obliquely quadrate in horizontal section, both a little wider posteriorly than anteriorly. This is due to the presence of a half crescent of the internal side, whose posterior horn is attached to the external wall, while the anterior is free. The external faces of these premolars is slightly convex; of the fourth premolar is slightly concave. The first true molar is decidedly smaller than the second, and the second is smaller than the third. The external sides of the external columns are flat in the first true molar, but become more concave on the third. The anterior edges of the columns project; forming ridges; or in section, projecting angles. No intermediate ridges, nor cingula. The third superior true molar has a prismatic crown, no roots being visible in either of the adult specimens, of which the typical one is rather old, as indicated by the wear of the teeth. In the latter specimen the roots of the second true molar are apparent, although the crown is elevated. The first true molar is not prismatic, although the crown is not low. The specimen represented by the left maxillary bone contains the teeth which are wanting from the typical one. The section of the crown of the canine is a semicircle, the truncate face being posterior internal. It is not a large tooth, and is separated from the first premolar by a diastema equal to its diameter. The first premolar is one-rooted, the root with a groove on the internal side. The section of the base of the crown is a triangle, the faces being anterior, external, and posteroïnternal. Its inner face is concave above the base.

None of the separate mandibular rami are complete, all lacking the angle and condyle. The former is full and round, judging from a fragment in my possession. The ramus diminishes regularly in depth forwards. The symphyseal region is short, and its anterior face is very steep, except at the alveolar region, where it is everted forwards. No trace of suture. The internal pterygoid fossa is large and strongly marked, so that the inferior edge of the ramus is inverted, so that the surface is convex externally. The last molar is placed somewhat obliquely. The first and second premolars are directed outwards and forwards, and the incisors directed forwards.

There are two incisors on each side of the symphyseal line. They are very small and subcylindrical, and are closely packed between the canines.

The canines are much larger, with cylindric root and flat, incisor-like crown. The first premolar is still larger, and is of about the same form as the canine, from which it is only separated by a slight divergence of the crowns. There are no diastemata. The second premolar has a compressed triangular crown, with a median ridge on the internal side. Its long diameter is diagonal, running outwards posteriorly. The long axis of the third premolar is similar, while the other teeth are more nearly in line. In the third premolar the fossa interior to the median internal heel is much deeper than that posterior to it. The corresponding fossa is still larger in the fourth premolar, while the crown has a heel in the form of a transverse curved crest, separated from the median heel on the inner side by a fissure. The true molars increase rapidly in size posteriorly, but not so abruptly as in the *Pithecistes brevifacies*. The internal crescents are very flat, and the posterior edges of their columns project moderately. The external crescents are very convex. The prismatic character of the teeth increases much posteriorly, so that the roots of the third tooth are short, and the crown long. The enamel is minutely rugose.

The third superior temporary molar has two pairs of crescents. The anterior pair are, however, not so well developed as the posterior pair and the two valleys are soon obliterated by wear. The crescents are equal in the fourth temporary molar. The fourth permanent premolar is protruded at least as soon as the third true molar, sooner than the posterior column of the latter. In this it differs from the *Oreodon culbertsoni*, where the last true molar is protruded first, and is a cotemporary of both the third and fourth deciduous molars ;* and the *O. gracilis*, where the last true molar is a cotemporary of the third deciduous.

In the inferior temporary dentition, the lobes of the last molar are subequal, the posterior one being a little the larger. The protrusion of the last true molar is also probably delayed until the shedding of the deciduous series, as in the superior series ; but my specimens are either very young or fully adult, and therefore I cannot demonstrate this point as fully as in the case of the superior series.

Measurements of Skull.

	M.
Length from condyle to front of canine inclusive.....	.117
" " " " otic bulla (axial).....	.010
" " " " palatonareal notch,.....	.0575
" " " " anterior line of glenoid cavity.	.038
Depth of occiput, including condyle.....	.041
" at middle of orbit, exclusive of teeth.....	.037
" " infraorbital foramen " "	.016
" " premaxillary border " "	.023
Width at " " above.....	.022
" between orbits.....	.038

*Leidy. Ancient Fauna of Nebraska, 1853, p. 51, Pl. IV, figs. 1, 2.

Measurements of Skull.	M.
Width at malars below orbits	.086
" " zygomata at middle	.092
" " auricular meatus	.070
" of occipital condyles	.0275
" at middle of last molars inclusive	.049
" " " second premolars inclusive	.030
Diameters otic bulla { anteroposterior	.023
Diameters otic bulla { transverse	.018
Diameters otic bulla { vertical	.019
Diameters of nasal bones { length of fragment of	.024
Diameters of nasal bones { width at base	.0125
Length of dental series	.062
" " premolar series	.025
" " true molar	.033
Diameters P-m. iii { anteroposterior	.007
Diameters P-m. iii { transverse	.0065
Diameters m. i { anteroposterior	.0085
Diameters m. i { transverse	.0085
Diameters m. iii. { antereposterior	.0146
Diameters m. iii. { transverse (greatest)	.011
Depth of mandibular ramus at m. iii	.031
" " " " P-m. iv	.019
Length of symphysis	.0245
" " premolar series	.022
" " true molar	.035
" " of total dental series	.063
Diameters P-m. iv { anteroposterior	.0085
Diameters P-m. iv { transverse	.006
Diameters m. i { anteroposterior	.009
Diameters m. i { transverse	.0068
Diameters m. iii { anteroposterior	.016
Diameters m. iii { transverse	.0062

The second specimen with permanent dentition is of smaller size than the type, and the canine teeth are small. It may have been a female. The dental series, including the canine, measures M. 0.59; the premolar series, 0.23; the true molars, 0.31.

The number of specimens of this animal found in the restricted area of the Ticholeptus bed of Deep river, Montana, shows the former abundance of the species. It was probably gregarious, in the manner of the other Oreodontidæ. We can depict it as seeking the swamps of the shore for its vegetable food, and spending much of its time in the water when not feeding. It was doubtless a good swimmer, and the characters of its feet will be sought for with interest for light on this point. The use of the huge superior nasal vacuity of the skull of this genus and Leptauchenia can

only be guessed. Perhaps it supported an inflatable bladder like that of the crested seal, or a swollen muzzle like that of the saiga antelope.

Cyclopidius emydinus, sp. nov.

This species is represented in my collection by a nearly perfect cranium. It indicates an animal of about the same size as the *C. simus*. The differences between the two species may be enumerated in advance of the detailed description. Firstly, the external vertical ridges or crests of the true molars are directed obliquely forwards so as to overlap the external wall of the anterior crescent much more extensively than in *C. simus*. (2) The crowns of the true molars have a relatively greater transverse diameter. (3) There is a peculiar process at the external base of the otic bulla, between the paroccipital and postglenoid processes, which may be called the subtympanic process. (4) There is no median occipital keel. (5) The maxillary bone is prolonged posterior to the last superior molar, which it is not in *C. simus*. (6) The oblique orbitosphenoid ridge is wanting. (7) The otic bullæ are shorter and wider in their form. This character will require confirmation by examination of many individuals.

The skull is singularly depressed and expanded laterally, so as to present an outline not unlike that of some river turtles. The orbits are in the anterior half, and look forwards and upwards, as well as outwards. The muzzle is short, so that its lateral borders approximate rapidly to a narrow truncate extremity. The maxillary borders do not contract quite so abruptly, and are visible outside of the canthus rostralis, when the skull is viewed from above. The brain-case is depressed, and is expanded posteriorly, and narrowed at the anterior line of the zygomatic foramina. The posterior temporal ridges are much expanded, forming a wide rim round the brain-case posteriorly, which is continued into the squamosal processes of the zygoma on each side. The anterior temporal ridges approach each other very gradually on the middle line, and only reach the union into a sagittal crest a centimeter posterior to the frontoparietal suture. The edge of the crest is truncate, and it is not bifurcate posteriorly, as in most Oreodontidæ.

The occiput is broad and low, and differs in character from that of most other members of the family. Its posterior face is flat, only interrupted by a fossa on each side, just within the posterior edge of the meatus auditorius externus. This edge is continued downwards into the external border of a distinct mastoid process, which is also the external border of the occiput, deflected a little forwards. The paroccipital process is flat at the base, and is applied to the external half of the otic bulla. Its free extremity is subround. The mastoid process forms a prominent ala of its external side, having a transverse width equal to that of the base of the paroccipital. Its inferior edge is truncate obliquely outwards and downwards to a subacute angle. The occipital condyles are relatively small.

The external meatus of the ear looks outwards and backwards at an angle of 45° to the middle line. The prominent edge of the mastoid pro-

cess is directly below its anterior border. Thus the tympanic bone is directed obliquely downwards and forwards. Posteriorly it is separated by a groove from the mastoid process. Anteriorly it is separated by a fossa from an osseous mass which occupies the space between it and the postglenoid process. Before the skull was reconstructed from its fragments, this mass was observed to be entirely distinct from the postglenoid process, which it equals in height. Continuous with it, there descends another osseous body to near the line of the extremity of the mastoid process, with a truncate inferior edge, which is separated from the otic bulla by an open groove. The stylohyal ligament is probably inserted into a fossa at the anterior extremity of this groove. The postglenoid process is low and more extended transversely. The anteroposterior diameter is small. The glenoid surface is much extended transversely and terminates externally in a slight thickening. The zygomatic process of the squamosal bone is at first expanded horizontally and has a low convexity of the thin superior edge. Its vertically compressed portion is entirely supported by the malar, and does not extend so far forwards as the anterior edge of the zygomatic foramen. The malar bone is remarkable for the depth of its suborbital portion, which fully equals the diameter of the orbit. Its inferior edge presents a thickened angle downwards below the anterior part of the last superior molar. Its superoanterior angle terminates in a prominent rib of the side of the face, which extends along the inferior edge of the facial vacuity. Beneath the anterior part of the latter the face is concave. Above this concavity the ascending plate of the maxillary is convex in the vertical section, turning inwards at the apex to unite with the lateral part of the extremity of the nasal bone. The preorbital fossa is small and looks forwards and upwards.

The otic bullæ are larger than in any other Oreodontid. They are of a short oval form, somewhat truncate anteriorly and posteriorly. Thus they differ from those of *C. simus*, where they are elongate-oval. They only reach as far anteriorly as the middle of the internal extremity of the glenoid surface; while in *C. simus* they reach the line of the posterior outline of the zygomatic foramen. They terminate near the inferior internal point, in a little acute osseous apex, which is smaller than in *C. simus*. The bullæ approach so closely together that the bassioccipital is much narrowed, and the sides of its inferior surface are excavated so as to reduce the middle line to a narrow acute keel. The lateral excavations follow the posterior internal base of the bullæ, leaving a median table, which is itself excavated by a shallow fossa, which extends from the median keel to the foramen magnum. The median keel disappears anteriorly. The sphenoid is protuberant downwards as a narrow convex rib, which rises and disappears in the presphenoid. The descending sphenoid ala forms the posterior boundary of the posterior nareal trough, and makes a strong angle with the pyramidal process of the palatine, which is turned outwards. The pterygoid squama terminates in an apex which points downwards and posteriorly towards the apex of the otic bulla. The palatonareal border is

V-shaped, and is in line with the posterior edge of the maxillary bone. The latter projects beyond the last molar tooth as far as the anteroposterior diameter of the latter. It has no projection in the *C. simus*. There is no notch between the maxillary bone and the processes pyramidalis of the palatine. The palate is of nearly equal width from the last molar to the third premolar; its roof is gently concave posteriorly; nearly flat anteriorly.

The premaxillary bone is a narrow strip which rises nearly vertically from its short alveolar border, and is curved outwards above in agreement with the expansion of the anterior edge of the maxillary, to which it is united by simple suture. The nasal bones are of remarkable form. Together they enter the anterior part of the frontals in a V-shape, and extend forwards in a narrow shaft. Opposite the anterior borders of the orbits the shaft begins to widen gradually, and the surface to flatten, until they reach the posterior angle of the ascending part of the maxillary. Each one then expands outwards, terminating in a semi-disc which fits the concavity of the superior edge of the maxillary above mentioned. The entire shape of the nasal bones is that of a spade with a triangular apex to the handle, and the short blade at the opposite (anterior) extremity. The frontal bone is V-shaped, the angle posteriorly directed, and engaged between the parietal bones, and each branch terminating above each orbit. Narrow prolongations extend anterior and posterior to the orbit, joining the lachrymal and malar bones respectively. Its median suture is, like that of the nasal bones, well defined. The alisphenoid and parietal have extensive connection. The parietosquamosal suture is horizontal in front; it then gradually rises. It is not associated with a ridge as in some other species. The occipital forms the posterior five millimeters of the sagittal crest.

The nasal opening is subtriangular, with the base above, and is directed anteriorly. The facial vacuities are enormous, and excavate the frontals to a point which make the anterior third of the orbit's diameter. They are only separated on the median line by the very narrow isthmus of the nasal bones. The infraorbital foramen is above the anterior part of the fourth surperior true molar. The frontal foramina are small, and are not symmetrical. That of the left side is half-way between the median suture and the superciliary border; the other is nearer the superciliary border. No supraglenoid foramen. Postsquamosal present; that part of the cranial walls is injured. The anteroposterior diameter of the orbit exceeds the vertical. The auricular meatus is the largest known in the family, and it has a prominent border and regularly oval outline. Its long diameter rises posteriorly from the horizontal. It is more laterally and less posteriorly directed than on the typical and only skull of *C. simus*. The foramen magnum has an openly angulate superior border. Jugular, condyloid, and carotid foramina not obvious, owing to the close contact of the otic bulla with surrounding bones. *Foramen ovale* larger than the *F. lacerum anterius*, and external to it in position. *F. rotundum* still larger, inferior in position, bounded on the external side by a

tuberous projection of the angle from the anterior edge of the glenoid surface. There is a deep fossa at the internal base of the postglenoid process, which possibly enters a foramen. No postglenoid foramen.

Although the skull of the *Cyclopidius emydinus* is more robust than that of *C. simus;* the length of the tooth-line is the same. The incisive edge of the premaxillary bone displays one empty alveolus, from which the single incisor was easily shed. The canine is not large, and the base of the crown has a regularly convex anteroexternal face; apex lost. The diastema posterior to it is equal to its diameter. The crowns of the premolars are worn; they are of about the size and proportions of the *C. simus.* The true molars differ, as I have already pointed out, in their greater transverse diameter, and the greater anterior prolongation of the anterior horns of the posterior external crescents. The deep notch which is enclosed between this fold and the wall of the crescent in front of it is filled with cementum. As to the form of the true molars, the transverse diameter of the first considerably exceeds its anteroposterior diameter; in the *C. simus* the former diameter is equal to the latter. In *C. emydinus* the last true molar is as wide as its length without the heel; in the *C. simus,* the transverse diameter is much less. In *C. simus* the heel is more prominent, and is recurved into a vertical ridge, which is wanting in the *C. emydinus.* In *C. emydinus* this tooth shows but little of the prismatic character, as the roots are of usual length.

The lower jaw of this species is not yet known.

Measurements.

	M.
Length of skull along base	.129
Length from condyles to posterior edge of zygomatic foramen	.042
Length from condyles to palatonareal foramen	.063
" " " " line of last true molar	.071
" " occipital crests to line of orbits	.074
" " " " " facial vacuities	.084
" " " " " ascending process of maxillary bones	.115
Length from occipital crest to free end of nasal bones	.126
Elevation occiput, including condyles	.045
" of front at middle of orbit, without molars	.035
" " maxillary bone at P-m. iii	.015
" " " " " P-m. i	.025
Width of skull at occipital condyles	.0675
" " " " superior edge of meatus auditorius	.057
" " " " middle of zygomatic foramina	.092
" " brain-case at middle of zygomatic foramina	.029
" " skull at orbits	.083
" " ,, between orbits	.047
" " muzzle at superior edge of nares	.0215

Measurements.	M.
Diameter external nares { vertical	.014
transverse above	.017
Diameter of a facial vacuity { anteroposterior	.030
tranverse	.013
Diameter of orbit { anteroposterior	.023
vertical	.019
Diameter of zygomatic foramen { anteroposterior	.053
transverse	.026
Diameter of foramen magnum { vertical	.0095
transverse	.013
Diameter of meatus auditorius { vertical	.009
anteroposterior	.011
Diameter of otic bulla { vertical	.025
anteroposterior	.025
transverse	.022
Width between canine teeth	.008
" " last true molars	.0285
Length of dental series	.065
" true molar series	.0343
" premolar	.0254
Diameters P-m. ii { anteroposterior	.0056
transverse	.0050
Diameters P-m. iv { anteroposterior	.0070
transverse	.0080
Diameters m. i { anteroposterior	.0075
transverse	.0110
Diameters m. iii { anteroposterior	.017
transverse (with external rib)	.012

The only specimen of this remarkable species known to me was found in the valley of Deep river, Montana, by my assistant, Mr. J. C. Isaac. The wear of the true molars shows that the animal was of full age, though not old.

PITHECISTES Cope.

Proceedings American Philosophical Society, 1877, p. 219.

This genus represents the final term in the decadence of the once powerful and numerous family of the Oreodontidæ. It is unfortunately established on a mandibular ramus only, and although some maxillary bones are referred to it with much probability, they are not preserved in such a way as to demonstrate the presence of the large nasal sinuses characteristic of Leptauchenia. I, however, suspect that they occur. The genus further resembles Leptauchenia in the coössification of the mandibular rami, and the reduction in number of the incisor teeth. In *P. brevifacies* there is but one inferior incisor tooth on each side. As reduction in the superior incisors usually precedes reduction in

those of the lower jaw, I suspect that the former were absolutely wanting in this genus. If so, we have in the Orcodont line the same process of reduction above, as has taken place in other lines of Artiodactyla at the latest or modern stage of their history.

In Pithecistes the inferior canine is caniniform, and masticated in contact with the superior canine, owing to the great abbreviation of the symphyseal region.

The diagnosis of the genus is as follows :

Inferior premolars three ; incisors one. Canine caniniform, masticating with the superior canine. No diastema. Symphysis coössified.

Two species are referred to this genus without conclusive evidence as to the number of their premolars. It is probable that they have but three, since their superior fourth premolars are of reduced size and incomplete type of form.

Pithecistes brevifacies Cope.

Proceedings American Philosophical Society, 1877, p. 219.

Ticholeptus beds of Deep river, Montana. Discovered by J. C. Isaac.

Pithecistes decedens Cope, sp. nov.

Established on a right maxillary bone, which contains the fourth premolar, the first and second true molars, and part of the alveolus of the third true molar. The last named tooth was not probably entirely protruded. This, with the moderate wear of the fourth premolar, indicates that the animal was fully grown, though young.

The species differs from all the members of the family whose dentition is known to me in the small size and simplicity of structure of the fourth premolar. The internal crescent of this tooth bounds only the posterior three-fourths of the external wall, and therefore leaves the anterior edge of the latter free. It is, moreover, not very convex, and its edge is not so elevated as is that of the external wall. The latter is flat on the external side, and its anterior marginal angle corresponds with the point of junction of the anterior extremity of the internal crescent. The true molars have the anterior horns of their crescents prominent, being sections of well-developed vertical columns. In this they differ from those of the *P. heterodon*, where these ridges are very weak.

The malar process of the maxillary bone is robust and prominent, and begins to expand opposite the first true molar. It presents a tuberosity downwards. The infraorbital foramen issues above the front part of the fourth premolar.

Measurements.		M.
Diameters P m. iv	anteroposterior	.006
	transverse	.005
Diameter m. i	anteroposterior	.0087
	transverse	.0077
Diameters m. ii	anteroposterior	.0115
	transverse	.008

Ticholeptus beds, Deep river, Montana. J. C. Isaac.

Pithecistes heterodon Cope.

Cyclopidius heterodon Cope, Proceeds. American Philos. Society, 1877, p. 22.

In this species the fourth premolar has the same form as in *P. decedens*, but the first true molar differs much in the more prismatic shape, and the absence of the external vertical ribs. It is quite possible that it does not belong to this genus.

Ticholeptus beds of Deep river, Montana. J. C. Isaac.

AGRIOCHŒRUS Leidy.

Proceedings Academy, Philadelphia, 1850, p. 121. Extinct Mammals Dakota and Nebraska, 1869, p. 131 (as family *Agriochœridæ*).

Orbit not closed behind. Fourth superior premolar with two external Vs. Fourth inferior premolar like true molars. Otic bulla inflated. Premaxillary bones distinct; no vacuities in the facial bones.

This genus commences cotemporaneously with the genus Oreodon, and persists longer, viz.: to the close of the John Day epoch. It represents a distinct line of succession from that which we have been considering, and one which contains but two known terms. Next to Agriochœrus comes, in this line, the genus Coloreodon Cope, which outlasted its predecessor so far as is yet known. It commenced with it in the John Day epoch, and continuing into the North Fork beds, which are of later age, did not appear later. This series Leidy regarded as a family distinct from the Oreodontidæ. For the present I prefer the view of Gill, that it constitutes a subfamily, the Agriochœrinæ.

This genus presents us with one of the very few cases in the suborder Artiodactyla, in which the last premolar approaches (above) or accomplishes (below) identity of structure with the true molars. This degree of complication was attained at the same period by both the equine and rhinocerontic lines of Perissodactyla, and all existing members of that order exhibit it. In the Agriochœridæ it made a beginning, but soon disappeared from the earth, and no Artiodactyle has developed such permanent premolars successfully since.

In the characters of the skull this genus is less robust than the Oreodontidæ; but the general skeleton remains unknown.

Five species have been described which are referable to this genus, and two others are now added. One of the former is without premaxillary or superior incisor teeth, and I therefore regarded it as representing a distinct genus under the name of *Merycopater*. It, however, appears that no specimens exist in our museums which exhibit this part of the skull in other species of the genus, so it is absolutely uncertain whether Agriochœrus possesses those teeth or not. The species may then be distinguished as follows:

I. Otic bullæ compressed, base anteroposteriorly ovoid.

a. Foramen infraorbitale above junction of P-m. iii and iv.

Front narrower; internal wall of fourth premolar not complete.....*A. antiquus.*
Front wider; skull shorter and higher; internal wall of inferior P-m. iv complete.....*A. latifrons.*
aa. Foramen infraorbitale above junction of P-m. ii and iii.
Front medially concave, laterally descending to orbits; sagittal crest short.....*A. trifrons.*
II. Otic bullæ mammiform with triangular base.
Front convex; nasal bones acute posteriorly; fourth inferior premolar complete; infraorbital foramen above junction of P-m. iii and iv.....*A. guyotianus.*
III. Otic bullæ oblong, constricted at the middle.
Infraorbital foramen above junction of P-ms. ii and iii; front plane; nasal bones truncate posteriorly; postglenoid process robust.....*A. ryderanus.*

Besides the above, Leidy has described an *A. major** as near to the *A. antiquus*, but of larger size. Marsh has described a small species from the Uinta formation under the name of *A. pumilus*.† Lydekker figures and describes a superior molar tooth from India as probably belonging to this genus.‡ It is stated by him to have been found in the earlier pliocene formation. If this determination be correct, it represents the latest known species, as the *A. pumilus* of Marsh is the earliest. Owing to incompleteness in the descriptions of these species I cannot include them in the above synoptic table.

Agriochœrus antiquus Leidy.

Proceedings Academy Philadelphia, 1850, 121; 1853, 392; 1854, 157; 1857, 89. Ancient fauna of Nebraska, 1853, p. 24, Pl. I, figs. 5–10. Bronn Lethæa Geognostica, 1856, 933; Leidy Extinct Mammalia Dakota and Nebraska, 1869, 132, Pl. XIII, fig. 4.

White River epoch of Nebraska and Dakota.

Agriochœrus major Leidy.

Proceedings Academy Philadelphia, 1856, p. 164; 1857, 89. ? *Eucrotaphus auritus* Leidy, Owen's Report Geological Survey, 1852, p. 563, Pl. XV, figs. 1–3. Ancient Fauna of Nebraska, 1853, p. 56; Pl. VII, figs. 1–3. Bronn Lethæa Geognostica, 1856, 931.

White River formation of Dakota and Nebraska.

Agriochœrus latifrons Leidy.

Proceedings Academy Philadelphia, 1867, p. 32. Extinct Mamm. Dakota, Nebraska, 1869, p. 135, Pl. XIII, figs. 1–3.

White River epoch of Dakota and Nebraska.

* Extinct Mammalia of Dakota and Nebraska, p. 134.
† Amer. Journal Science and Arts, 1875, p. 250.
‡ Paleontologica Indica.

Agriochœrus trifrons sp. nov.

This species is known to me by a single cranium of an immature individual. It lacks of perfection only the basioccipital, the pterygoid, and the alveolar border of the premaxillary bones. It retains the third and fourth deciduous premolars, while the third true molar is still in its alveolus, where it is exposed in place.

Although the specimen is immature, its characters will not permit me to place it with any other species known to me. I have specimens of like age of the *A. guyotianus*, and these are quite different. From *A. ryderanus* it differs in the form of its otic bulla, etc.

The muzzle and front form a flat horizontal profile, while the pariëtal region is convex. The profile descends gently to the supraoccipital border, or inion. The muzzle is compressed above and below the canine alveolus, and there is a concavity above the third and fourth premolars, and behind the foramen infraorbitale above this fossa the lachrymal region is convex. The nasal bones are lost, so that the form of their posterior suture cannot be ascertained. The frontal bones are gently concave in transverse section between two lines produced forwards from the anterior extremities of the temporal ridges, that is at the postorbital constriction of the cranium. These lines are represented by a rounded longitudinal angle, from which the frontal bone descends to the superciliary border on each side. A trace of this form is seen the *A. ryderanus*. The supraorbital borders diverge outwards and backwards to the postorbital processes. These are prominent horizontally, and are abruptly decurved at the apex. The temporal ridges enclose an urceolate area, having a gentle convexity in their direction before they unite at a point more posterior than in the other species, that is above a line connecting the anterior borders of the postglenoid processes.

The malar bone is slightly concave on the external face, and is moderately deep, and not thick. The squamosal part of the zygoma is rather slender, and does not rise above the postglenoid process. Its superior edge continues without interruption into the posterior temporal crests, and so into the supraoccipital. The postglenoid process is like that of *A. guyotianus*, narrow and produced downwards. Paroccipital lost. The otic bulla is large, its anterior edge extending anterior to the postglenoid process. It is nearly twice as large as in *M. guyotianus*, and extends much further forwards. It presents two flat sides, one external, the other outwards and forwards, and a convex side inwards and backwards. These sides meet at an angular edge below, which runs outwards and backwards. The sphenoid bone is convex between the bullæ. Basioccipital lost. The palatonareal border is convex, and is opposite the middle of the second true molar. In the mature skull it would be probably more posterior. The palate is everywhere concave in transverse section.

The frontopariëtal suture is broadly convex, and is opposite the anterior edge of the glenoid surface, and 25 mm. in advance of the sagittal crest. The anterior processes of the bone on each side of the nasals are wide and truncate, and do not extend beyond the interior suture of the lachrymal

bone. The latter is about as long on its superior sutures as it is deep at the orbit. It presents a distinct preorbital angle above a prominent tubercle. The occipito-pariëtal suture extends well forwards, 30 mm. in advance of the crest. The squamosal does not reach to the lateral occipital crest.

The infraorbital foramen occupies the position it has in the *A. ryderanus*. In a young specimen of *A. guyotianus* it has the same position as in the adult. The frontal foramina are about as far apart as each is from the supraorbital border. There is a postpariëtal foramen on the pariëto squamosal suture, and there are three postsquamosals, two of them near together, and near the posterior suture, the other below the postpariëtal foramen. *Foramen ovale* oval, about as large as the *F. rotundum*, and separated from the foramen lacerum by the produced base of the inferior ala of the sphenoid bone. Palatine foramen opposite the third deciduous premolar.

Superior canine teeth robust, bases of crown one-half lenticular, the posterior face truncate. A considerable diastema anterior to first premolar, and a short one behind it. Other teeth in continuous series. First and second premolars two-rooted; absolutely simple. Third and fourth crown of first of usual form. First true molar smaller than second. Enamel minutely roughened.

Measurements.	M.
Length from supraoccipital crest to canine inclusive	.180
" " " " " front of bulla	.036
" " " " " penultimate molar.	.108
" " " " " orbit (axial)	.105
" " " " " front of orbit	.126
" of sagittal crest	.046
" " superior molars (last included)	.076
" " premolars	.036
Diameters M. i { anteroposterior	.063
Diameters M. i { transverse	.014
Diameters M. ii { anteroposterior	.0165
Diameters M. ii { transverse	.020
Width of skull at postglenoid inclusive	.077
" " " middle of zygomas	.050
" " " fundus of canine alveolus	.038
" between canines	.020
" " second true molars	.033
" of skull at postfrontal processes	.076
" " " between anterior rims of orbits	.066

The label from this specimen is lost. It is, however, from Oregon, and to judge from the color, from the true John Day epoch, rather than the North Fork bed.

Agriochœrus guyotianus Cope.

Hyopotamus guyotianus Cope, Proceedings American Philosophical Society, 1878, p. 77. *Merycopater guyotianus* Cope, American Naturalist, 1879, p. 197, Proceeds. Amer. Philos. Soc., 1879, 375.

Three crania, one with nearly entire mandible, and numerous fragments with mandibles, represent this species in my collection. It is the most abundant species of this genus in the John Day beds of Oregon.

The cranium is of peculiar form. It is elongate from the orbits backwards. The muzzle is elevated and compressed, so that the profile is horizontal, with subordinate irregularities. The occiput is therefore low as compared with the muzzle. The zygomata are rather slender, and are not expanded. The side of the muzzle is concave just below the superior border of the maxillary bone and above the fundus of the canine alveolus. The inferior part of the maxillary is concave from below the anterior border of the orbit to the line of the canine alveolus. The region above and anterior to the lachrymal bone is convex, leaving the flat nasal bones a little depressed. The frontal has a convex swelling on the middle line just posterior to the frontal foramina, from which point the surface slopes gradually and evenly to the supraorbital borders, and not in two planes, as in *A. trifrons*. At the front of the orbit the section of the frontal bone is convex at the sides and a little so at the middle. The supraorbital border is short and concave, not long and straight as in *A. trifrons*, and the postfrontal process is moderately prominent, and is not decurved. The anterior temporal ridges do not reach them. The former converge in nearly straight lines at an acute angle to a long sagittal crest. This in turn bifurcates into two very prominent posterior temporal crests, which overhang the occipital condyles. The brain-case is an elongate-oval, and the olfactory portion is long and narrow, but not especially constricted at any one point. There is a prominent small tuberosity at the inferior part of the lachrymal bone ; above it the preorbital border is not defined as far as the beginning of the supraorbital. The postfrontal process originates below the anterior temporal surface which is continued along its posterior edge. The malar bone is concave on its external face. The zygoma is compressed, and has a long low superior convexity behind. Its crest continues into a fine, low, posttemporal crest, which turns posteriorly above to its prominent posterior expansion above mentioned. The latter turn outwards at the apices, and send a low ridge downwards towards the occipital condyle. Below, the latter form a low angle on each side, which separates a median from a lateral plane. Above, the occiput is deeply concave, and has a trace only of median keel.

The basicranial axis is flat and rather wide between the otic bullæ. The occipital condyles have distinct inferior boundaries which are separated by a flat interval. The posttympanic region is wide, and is bounded inferiorly by the deep styloid fossa. This is surrounded internally and posteriorly by the funnel-shaped base of the paroccipital process, which extends first posteriorly as a longitudinal lamina, and then outwardly. Its

edge terminates in a rough band which curves upwards and backwards to a point above the line of the occipital condyle. It is separated by a shallow groove from the corresponding posttympanic ridge. The tympanic bone is not so long as in the species of Oreodontinæ, and presents a tuberosity externally. Like the paroccipital its base unites with the otic bulla. The bulla is small. Its base is extended towards the postglenoid process, but it is well separated from it, and does not reach the line of its anterior border. It presents a face anteriorly, and one inwards. The postglenoid process is narrow transversely, the depth and width being equal, and is elongate downwards.

The coronoid process of the mandible is short, but has a base extended anteroposteriorly. The articular face of the condyle is convex anteroposteriorly, and is extended downwards on the inner side behind. The horizontal ramus is slender, and has a straight inferior border. (The angle is broken away from this specimen.) The symphysis is oblique and nearly straight in profile. It is moderately elongate, and has the suture persistent. There is a tuberosity looking downwards from its posterior extremity, where it is rounded-compressed.

The facial part of the lachrymal bone is longer than deep, and the lateral anterior part of the frontal is wide and obtuse, and extends anterior to the lachrymal. The nasals extend posteriorly to terminate in an acute angle which is above the anterior edge of the orbit. The frontoparietal suture extends across the space between the anterior temporal ridges at a point half way between the anterior border of the orbit and the anterior glenoid margin. The malomaxillary suture has no anteroinferior process. The mastoid forms a distinct mass between the exoccipital and squamosal. The sutures are largely coössified.

The infraorbital foramen is above the contact of the third and fourth premolars. The space between the frontal foramina is about one-sixth the interorbital width. There is a large postparietal foramen on the parietosquamosal suture, and there are two small postsquamosal foramina, in line above the posttympanic tuberosity. The mastoid foramen is small, and is not situated in a fossa of any extent, as is the case with the species of the Oreodontinæ. There is a large foramen intermediate in position between that of the anterior condyloid and the jugular. Anterior and a little external to it and slightly elevated between the confluent base of the paroccipital process and the otic bulla is another foramen, perhaps the jugular. Between the posterior base of the bulla and the basisphenoid, is a smaller foramen, probably the carotid. The other foramina are yet concealed by the matrix.

The teeth do not differ in their form from those of other species of the genus. The second and third premolars have triangular bases, the second the narrower. The first has two roots. It is accidentally lost from one side, which circumstance led me to suppose at one time that this species has but three premolars above. The fourth premolar has its posterior external V well developed, though a little smaller than the anterior. In the

specimen now described, the posterior internal rudimental cusp is quite well developed; in the two other specimens now before me it is not so large. The superior canine is elongate, and not very robust, and its convex anterior border is directed partly posteriorly at the apex. The enameled portion of the crown is quite short. The premaxillary bones are narrow and weak, and are separated so as not to be in contact on the middle line. Its border displays two minute alveoli, from which teeth have been shed. I do not suppose that their presence is constant in the species. The external alveolus is twice the diameter of the internal. The inferior incisors are of normal number, but are very narrow, and much crowded. The canines are very narrow, but are longer than the incisors. The first inferior premolar is more caniniform than in any other species of Oreodontidæ known to me. The crown is a compressed oval in section, and is not expanded at its base. It is enameled to within 5 mm. of the alveolar border. A considerable diastema separates it from the second premolar. The description of the remaining teeth I take from a separate ramus of similar dimensions, as they are concealed in the type by their position in juxtaposition with the cranium. The cusps of the true molars are pyramidal and acute, and entirely separate from each other. The external faces of the external are convex, their internal faces flat. The external faces of the internal are convex, the internal faces concave at the base, and convex near the apex. The anterointernal angle of the posteroexternal cusp extends to the base of the anterointernal cusp. The only difference between the first true molar and the fourth premolar, is that the anterior crest of the anteroexternal cusp is continued round to the front of the anterointernal cusp, and to the internal side of the crown; and the apices of the two anterior crests are separated by a shallow notch. The second inferior premolar has two roots. The heel of the third true molar is well developed, and is convex posteriorly.

Measurements.	M.
Length from occipital condyles to postglenoid process	.038
" " " " " preglenoid border	.058
" " " " " postfrontal process	.104
" " " " " canine, inclusive	.226
" " orbit to canine inclusive	.085
" of mandibular ramus from condyle	.176
" "symphysis mandibuli below	.049
Width of occipital condyles inclusive	.046
" " occiput above	.045
" " between otic bullæ	.016
" " at postglenoid processes inclusive	.079
" " of skull above glenoid surfaces	.100
" " " below orbits	.099
" " " between orbits	.068
" " " at fundus of canine alveoli	.040

Measurements.	M.
Width of skull between last upper molars, inclusive...	.070
Depth of occiput to foramen magnum.....	.043
" " " " basioccipital bone.....	.058
" " skull at last superior molar, exclusive.....	.058
" " " " first premolar, exclusive	.055
" " ramus mandibuli at front of M. iii.....	.035
" " " " " " " P-m. iv.....	.027
" " zygomatic arch above glenoid facet.....	.027
Diameters of base of crown of superior canine { anteroposterior.....	.009
Diameters of base of crown of superior canine { transverse.	.0085
Length of superior diastema.....	.022
" " premolar series.....	.039
" " true molar series.....	.043
Width of premaxillary bones together.....	.043
Diameters of base crown inferior P-m. i; anteroposterior.....	.0085
Length inferior diastema.....	.015
" " last three premolars.....	.031
" " true molars.....	.046
" " last true molar.....	.021
" " third premolar.....	.009
" " fourth.....	.012
Horizontal diameters of otic bulla { anteroposterior. ..	.019
Horizontal diameters of otic bulla { transverse.....	.017

The specimens of this species which I have seen, are from the John Day river, and were obtained by Messrs. Sternberg, Wortman and Davis. The skull from which the above description was taken is the most perfect one of the genus Agriochœrus which has yet been found.

Agriochœrus ryderanus Cope.

Coloreodon ryderanus Cope, Bulletin U. S. Geological Survey Territories, vi, p. 173.

This species is represented in my collection by three nearly complete skulls without mandibular rami. While of the general size of the *A. guyotianus*, this species displays various well marked peculiarities. The most important of these are (1) the shape of the otic bulla, in which it differs from all other known Oreodontidæ; (2), the position of the infraorbital foramen, in which it resembles in this genus only the *A. trifrons;* (3), in the form of the nasal bones posteriorly, in which it differs from the species where this part is known; (4), in the form of the palatonareal border; (5), in the form of the postglenoid process; (6), in the outline of the section of the frontal bone.

Agriochœrus ryderanus has the muzzle compressed laterally and flattened on top, as seen in the *A. guyotianus* and *A. trifrons*, and the side of the

muzzle has three distinct fossæ. The largest of these is above the position of the fundus of the superior canine alveolus; the second is below the fundus; and the third is behind the position of the infraorbital foramen, and above the third and fourth premolars, and the first true molar. The lachrymal region is plane, and the nasals are flat. The frontal bone is nearly flat in section between the posterior borders of the orbits, but each is decurved to the lachrymal opposite the anterior border of the orbit. There is no indication of the three planes of the infraorbital region characteristic of the *A. trifrons*, nor of the median convexity of the *A. guyotianus*. The anterior temporal ridges commence about the middle of the width of each frontal bone, and unite after a shorter independent course than they have in *A. guyotianus* into a long, narrow saggital crest. This bifurcates posteriorly into two prominent lateral crests, which are directed downwards and soon terminate, but which send forwards and downwards a delicate posttemporal crest. This passes without interruption into the superior edge of the zygomatic arch. This arch is not expanded either upwards or laterally, and is rather weak. The external face of the malar bone is gently concave, and the inferior edge is rather wide, is truncate, and grooved along the middle. The occiput is deeply concave between the crests, and below them is gently convex. The superior edge of the foramen is deeply notched at the middle, much as in *M. guyotianus*.

The occipital condyles are large, and their inferoanterior angles are produced horizontally for a short distance, forming short processes which are separated by a concavity of the basioccipital bone. The latter is plane below, but anteriorly develops a low meridian angle, which, widening on the sphenoid, causes its inferior face to be convex. The posttympanic element is distinguishable from the mastoid by a superficial groove, and a slightly free apex, and the mastoid from the paroccipital by a slight groove. The external base of the paroccipital extends but 5 mm. external to the line of the external border of the occipital condyles, and is therefore much less prominent than in the majority of species of Oreodontinæ. The base of the paroccipital has a posterior and an anterior face, nearly at right angles with each other. The latter is continued into the pinched posterior prominence of the auditory bulla, and encloses on its external side, with the apex of the posttympanic, the deep stylohyoid fossa. The tympanic bone is represented by a tuberosity below the meatus, and a laminar expansion on the posterior face of the postglenoid process. The otic bulla's long axis is inwards, and a little posterior from the internal side of the postglenoid process, from which it is separated by a narrow interval. The bulla is constricted at right angles to its long axis, in two parts. The external part is subglobular with the side next the postglenoid process flattened. The internal part is roughened, displays a flat side posterointernally, and has an apical keel which extends posteriorly and a little externally into the base of the paroccipital processes. This form is not known in any other species of the family. The postglenoid process is more robust than in either *M. guyotianus* or *M. trifrons*. Its width and thickness are equal,

and are a good deal longer than its height; in the species named the height equals the other measurements. The pterygoid ala rises opposite the middle of the end of the glenoid surface, and the angle of its junction with the pyramidal process of the palatine is considerably in front of the middle of the trough of the posterior nares. Its edge posterior to this angle is shallowly grooved. The palatonareal border differs from that of any other species of the family known to me. It is acute in front, forming a Gothic arch, its apex being opposite the middle of the superior third true molar. In a young *M. guyotianus*, the only specimen of that species in which it is perfectly preserved, it is rounded, and extends to the posterior part of the second true molar. In an adult specimen, where the middle portion of the margin is lost, it extended at least as far forwards; but its form is uncertain. The palate in the *A. ryderanus* is strongly concave throughout.

The lachrymal bone has a different form from that of a *A. guyotianus*, more resembling that of *A. latidens* figured by Leidy. Its anterior superior angle is not produced, and its outline is a little deeper than long. The anterior lateral prolongation of the frontal extends beyond it by nearly its width, and is wide, and terminates in an obtuse angle. The posterior edge of the nasals is broadly rounded, truncate at the middle, and is situated much in advance of the frontal foramina. The pariëtal is in contact with the alisphenoid. The squamosal does not extend beyond the vertical line from the base of the paroccipital process.

The infraorbital foramen is above the anterior edge of the third superior premolar, a position only seen elsewhere in the genus *A. trifrons*. The superior border of the orbit is concave and short as in *A. guyotianus*, and not straight and flat as in *A. trifrons*. The frontal foramina are above their middle, and their distance apart goes 4.5 times into the interorbital width. There is a large postpariëtal foramen on the pariëtosquamosal suture, and a large postsquamosal immediately below it. This arrangement differs from that seen in the other species here described, where there are two or three postsquamosals well posterior to the postpariëtal. Mastoid foramen small. There are two palatine foramina on each side of the mouth, one opposite the posterior edge of the second premolar, and one opposite the posterior part of the fourth premolar. The anterior condyloid foramen is large. On one side is a small posterior condyloid, the only occurrence I have met with in the family. The foramen lacerum posterius is not divided into three foramina as in the *A. guyotianus*, but remains open as in the species of *Eucrotaphus* and *Merycochœrus*. It shows its nearer affinity to the first named species, however, in its triradiate outline; and in the three grooves of the side of the bulla, which correspond to two of the three foramina. The *f. lacerum anterius* is not large, and is oblong in shape. The ovale is rather small, and is entirely bounded on the inner side by the pterygoid ala of the sphenoid. The *f. rotundum* is large and rather posterior. It is not bounded below by a transverse shoulder as is seen in the species of Merycochœrus, but is continued into a longitudinal groove, whose

external wall is longer than in any of the other genera of the family, extending to a point half-way between the inferior edge of the foramen and the middle of the last superior true molar tooth. It is curved both inwards and downwards just posterior to the foramen.

The superior molar teeth do not differ from those of *M. guyotianus*, *M. antiquus* and *M. latifrons*. The canines are very robust, and are separated from the first true molar by a considerable diastema.

Measurements.	M.
Length from occipital condyles to line of postglenoid processes	.046
Length from occipital condyles to line of preglenoid border	.060
Length from occipital condyles to line of postfrontal process	.110
Length from occipital condyles to line of canines, inclusive	.220
Length from orbit to canine inclusive	.076
Width of occipital condyles inclusive	.050
" " occiput at paroccipitals	.031
" between otic bullæ	.015
" at postglenoid processes inclusive	.093
" of skull above glenoid surfaces	.110
" " " below orbits	.094
" " " between orbits	.064
" " " at fundus of canine alveoli; about	.029
" " " between last upper molars, inclusive	.080
" " palate at second true molars	.033
" " " " third premolars	.031
" between superior canine	.021
Depth of occiput to foramen magnum	.038
" " " " basioccipital	.057
" " skull at last superior molar exclusive	.050
" " " " first premolar, exclusive	.046
" " zygomatic arch above glenoid facet	.021
Diameters base crown superior canine { anteroposterior	.014
Diameters base crown superior canine { transverse	.012
Length diastema to first premolar	.0185
" premolar series	.0365
" true molar series	.045
Diameters P-m. iv { anteroposterior	.011
Diameters P-m. iv { transverse	.014
Diameters M. i { anteroposterior	.014
Diameters M. i { transverse	.015
Diameters M. iii { anteroposterior	.018
Diameters M. iii { transverse	.021

The skulls of this species came from the John Day bed of the John Day river, Oregon, and were found by Mr. J. L. Wortman. The species was established on an immature individual. The adults show that it belongs to this genus.

COLOREODON Cope.

Proceedings American Philosophical Society, 1879, p. 375.

Superior premolars three, the fourth with two external Vs, no facial vacuities.

The mandibles of the species of this genus are unknown, so that the character of the inferior dentition is unknown. The otic bullæ are also destroyed in all the specimens, so that their character is unknown.

In its reduced dental formula this genus represents one stage of that specialization which Owen has shown, has overtaken all the modern types of Mammalia. In this series this process seems to have stopped at this point, and not to have gone further, as the entire line has come to an end.

The first superior premolar probably exists in a rudimental condition for a short time, and is early shed. The same state of things has been found to exist as an abnormality on one side in the *Agriochœrus guyotianus*, and may be found again, but not so as to invalidate the characters of the genus Coloreodon.

Two well-marked species of this genus have been described, which differ as follows:

Smaller; palatonareal border opposite posterior cusps of second true molar; sagittal crest anterior, commencing opposite optic foramina..... *C. ferox.*

Larger; palatonareal border opposite posterior cusps of third true molar; sagittal crest posterior, commencing opposite preglenoid border..... *C. macrocephalus.*

Coloreodon ferox Cope. Fig. 1, p. 505.

Proceedings American Philosophical Society, 1879, p. 375.

The size of *Oreodon culbertsoni*. Known from one skull from the North Fork of the John Day river, Oregon. C. H. Sternberg.

Coloreodon macrocephalus Cope.

Proceedings American Philosophical Society, 1879, p. 376.

Size of the *Eucrotaphus major*. The typical skull is from the North Fork of the John Day river. A second skull, lacking all the parts posterior to the anterior origin of the sagittal crest, is undistinguishable from the first. It was found at the "Cove" of the John Day river, Oregon. Both were obtained by Mr. J. L. Wortman.

GENERAL CONCLUSIONS.

From what is now known of the history of the Oreodontidæ, the following conclusions may be drawn. These are especially instructive as far as they go, since they involve the causes of the rise, great development, decadence and extinction of one of the best-marked types of Mammalia the world has seen. The history of this type involves more or less the history of the life of the North American continent during the Miocene epoch of Tertiary time. It moreover involves the laws which regulate the vital success of all types of life, and which express the causes of multiplication, of energy, of weakness, and of sterility.

Two lines of the family, the *Oreodontinæ* and the *Agriochœrinæ*, come to light simultaneously in geological time, the White River epoch, or the Oligocene. The latter is a higher type than the former in its more complex fourth premolars, while it is inferior in the non-closure of the orbits posteriorly. It may then be regarded as a parallel line. It has but two generic types, while the Oreodontinæ present us with seven. So far as yet known, the Agriochœrinæ did not continue as long as the Oreodontinæ, as will be shown in tabular form below.

In the progressive modifications of the Oreodontinæ series, the first step was the inflation of the otic bulla (genus Eucrotaphus). This was succeeded by the coössification of the premaxillary bones (genus Merycochœrus). These changes were accompanied by a regular increase in dimensions. The species of Merycochœrus are all of the largest size, and there are no small ones. The smallest species of Eucrotaphus are equal to the largest ones of Oreodon. The fourth genus Merychyus, while it loses none of the points already gained, shows a deficiency in its facial walls where vacuities appear. There is the greatest range of size here: with one species (*M. major*), as large as any of the Merycochœri, we have another as large as the usual Eucrotaphi (*M. zygomaticus*), and several one degree smaller, or as large as the largest Oreodons. In the next genus the facial vacuities have attained to an enormous size. The premolar teeth become smaller, and the weakness of the narrow symphysis of the lower jaw is made up for by its coössification. The size is reduced from equal to the smallest Merychyi, to that of the smallest Oreodons (genus Leptauchenia). In the next stage (genus Cyclopidius) the superior incisors disappear. Finally, the lower jaw is so reduced in front that it loses both incisors and premolars, in spite of its symphyseal coössification (genus Pithecistes).

The species may be thus arranged in accordance with their distribution in time.

White River Epoch. Oreodon gracilis; O. affinis; O. culbertsoni. Eucrotaphus jacksoni; E. major. Agriochœrus antiquus; A. major; A. latifrons.

John Day Epoch. Eucrotaphus jacksoni; E. major. Merycochœrus superbus; M. leidyi; M. chelydra, sp. nov.; M. macrostegus, sp. nov

Agriochœrus guyotianus; A. trifrons, sp. nov.; A. ryderanus. Coloreodon macrocephalus.

North Fork of John Day River Epoch. Eucrotaphus trigonocephalus, sp. nov.; E major. Coloreodon ferox; C. macrocephalus.

Ticholeptus Beds. Merycochœrus montanus, sp. nov.; M. rusticus; M. proprius. Merychyus arenarum, sp. nov.; M. pariogonus, sp. nov.; M. zygomaticus. Cyclopidius simus; C. emydinus, sp. nov. Leptauchenia major; L. decora; L. nitida. Pithecistes brevifacies; P. heterodon; P. decedens, sp. nov.

Loup Fork Beds. ? Merychyus elegans; M. medius; ? M. major.*

The stratigraphic relations of these species may be represented under their generic heads in the following table:

	No. of species.	White River Epoch.	John Day Epoch.	? North Fork Epoch.	Ticholeptus Epoch.	Loup Fork Epoch.
Oreodontinæ.						
Oreodon Leidy.....	3					
Eucrotaphus Leidy....	3					
Merycochœrus Leidy ..	7					
Merychyus Leidy.....	6					
Leptauchenia Leidy ...	3					
Cyclopidius Cope.....	2					
Pithecistes Cope.....	3					
Agriochœrinæ.						
Agriochœrus Leidy....	6					
Coloreodon Cope.....	2					
	35					

On the Structure of the Skull in the Elasmobranch genus Didymodus.

By E. D. Cope.

(*Read before the American Philosophical Society, March 7, 1884.*)

The genus *Diplodus* was described by Agassiz from specimens of teeth from the European Coal Measures. In America, Newberry and Worthen† have described four species from the Carboniferous of Illinois and Ohio; and I have reported two species from the Permian beds of Illinois and Texas. Recently Mr. Samuel Garman has described a shark, said to have been taken in the Japanese seas, under the name of *Chlamydoselachus*

* The questions refer to the geological age.

† Geology of Illinois, vol. ii.