PART SECOND.

THE WHITE RIVER AND JOHN DAY FAUNÆ.

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REPTILIA.

No vertebrata of a rank inferior to the reptiles have yet been found in the Lacustrine Tertiary formations of the central part of North America which lies between the Upper Eocene and Loup Fork horizons. Nevertheless, as fishes are known from the Bridger, Amyzon, and Loup Fork beds, and *Batrachia* have been obtained from the Green River and the Loup Fork, it is probable that they existed in the West during the intervening time.

The *Reptilia* are represented by a good many species and a moderate number of individuals, but were much less numerous than during the epochs of the Eocene. The order of *Crocodilia* apparently became extinct; a small remnant of the tortoises only continued, and the number of species of lizards greatly diminished. The *Ophidia* only, retained their position, if we can judge by the moderate number of species discovered so far in the two formations. As to their characteristics, the Reptilia of the Miocene beds resemble those of the recent period much more closely than do those of the Eocene. All of the peculiar types of that period had disappeared, and those which came upon the scene can nearly all be arranged in existing families, and in one instance (*Testudo*), in a recent genus. The numerical and horizontal relations of these forms may be represented as follows:

Number of species.

	White River.	John Day.
Crocodilia	0	0
Testudinata	4	1
Lacertilia	8	1
Ophidia	4	1

The species are none of them of remarkable size, but coincide with the average of the species now found in the same region of the continent.

TESTUDINATA.

The species of this order which have been found in the Miocene beds were of terrestrial habits. They belong to two genera, *Testudo* and *Stylemys*. That the lakes of this period were haunted by aquatic tortoises was to have been anticipated, but as yet they have not been found.

TESTUDO Linn.

As no jaws of the Miocene species have yet been found, it is not certain whether they belong to the genus above named, or to *Xerobates* Agass., with the Loup Fork species.

Five species which I refer here, left their remains in the White River beds of Colorado. As but one species had been previously identified from the White River formation, the discovery of these was unexpected. The numerous individuals found by Dr. Hayden in the Mauvaises Terres of Dakota and Nebraska were all referred by Dr. Leidy to the *Stylemys nebrascensis*. The same species is found in Colorado, but associated with the five species here described.

The differences between these Testudos are well marked, and are best appreciated by reference to the plastron, though not wanting in the carapace also. The principal characters are the following:

I. Each half of the lip of the plastron trihedral, as deep as wide.
Marginal bones short and thick, with simple dermal grooves ..... *T. cultratus.*
II. Halves of the lip of the plastron flat, thinner than wide.
a. Gular scuta square.
Lip prominent, with straight sides ..... *T. quadratus.*
aa. Gular scuta triangular.
Lip prominent, narrowed forwards, border with several teeth; posterior lobe dentate; marginals wide, mucronate ..... *T. laticuneus.*
Lip prominent, with parallel sides and entire margin; marginals wide, with notched border ..... *T. ligonius.*
Lip not prominent, truncate, entire; marginals wide, notched medially .. *T. amphithorax.*

None of the varieties of the *Stylemys nebrascensis* present the well-defined lip of the plastron seen in these species, nor do its marginal bones ever have

the projecting mucros or the step-like notches described above. In the *T. laticuneus* I have observed the tarsus and metatarsus. The latter is composed of much shorter bones than the corresponding ones in *Stylemys*, leading to the supposition that it has the short phalangeal series of the family *Testudinidæ*.[1] The positive determination of this point remains for future investigators.

TESTUDO CULTRATUS Cope.

Paleontological Bulletin No. 15, p. 6, August 20, 1873. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 511.

Plate LXIII; figs. 1–3.

Parts of two individuals of this species were obtained by my expedition of 1873.

This is the smallest of the five species of *Testudo*, having about the average size of the *Stylemys nebrascensis*. This is indicated by the costal and marginal bones which accompany the portions of plastron of both specimens. The width of the lip at the base is also less than that of any of the other species, but the length and thickness are remarkable as compared with the other dimensions. The width and thickness at the base of the lip are nearly equal; both dimensions diminish to the apex, which is obtusely acuminate. The superior face of the lip is gently convex in both dimensions. The inferior surface is plane anteroposteriorly; transversely it rises to the external edge, which is subacute. The suture of the gular scutum is directed posteriorly, giving the usual triangular form. The thickness of the lip is abruptly reduced above, where the surface descends to the mesosternal bone.

The lip of one of the specimens is fissured deeply, in an eccentric manner, on both sides of central core. Whether this or the unfissured condition is characteristic of the species or not, is uncertain. It appears to be homologous with the dentation in the lip of *T. laticuneus*.

The marginal bones are robust, and are much thickened below. The edges of those of the posterior margin are acute, while those of the anterior border are obtuse, thus differing from those of *T. laticuneus*, where they are acute. At the points where the dermal sutures reach the margin, both

[1] See page 109 of this work, where the families of *Testudinata* are characterized.

specimens are unfortunately broken in every instance, so that the question of notches or mucros cannot be decided. The costal bones are moderately thick, and alternate in width, narrower and wider. The dermal sutures do not display raised margins. The anal marginal bone is wedge-shaped, with the posterior margin representing a truncate apex. Its surface and margin are convex, and the anterior sutural margin is concave.

A fragment, which is in all probability the posterior lobe of the plastron, is characteristic. It is thick, and its inferior face is somewhat recurved posteriorly. The outline of the margin presents a pronounced obtuse angle, and the edge is several times abruptly notched.

Measurements of No. 1.

			M.
Diameters of half of lip	at base	vertical	.040
		transverse	.043
	length outer edge		.056
Diameters second marginal from anal	thickness		.019
	width		.030
Length free margin of anal			.026
Width of anal above			.050
Thickness of a vertebral bone			.011
Thickness of a costal at middle			.009

Found by myself near the head of Horse Tail Creek, in Northeastern Colorado.

TESTUDO QUADRATUS Cope.

Plate LXI; fig. 5.

This tortoise was, perhaps, the largest of those of the White River beds. It is, unfortunately, only represented so far in my collection by the lip of the plastron and by an imperfect marginal bone. The former fragment indicates clearly a species quite unlike the others here described.

The lip is thick at the base, and the superior surface descends gradually to both anterior and lateral edges. The middle of the former is notched, but there are no other indentations of importance. The lateral borders do not converge, as in *T. laticuneus*, but rather diverge, as in *Hadrianus octonarius*. Its form is more like that of *T. ligonius* than any other species, but it differs from it and from all other species known to me in the absolutely transverse posterior gular suture. The suture follows an angular groove, which cuts the lip off from the inferior surface of the plastron, which lies behind it. The latter swells prominently behind the suture, but less so at

the middle line than laterally. The marginal is probably the nuchal, and displays a part of the nuchal scute. The latter was at least not very narrow, and its free edge is concave. The borders of the dermal grooves are raised

Measurements.

	M.
Length of lip from gular groove	.070
Width at base	.120
Thickness at base	.029
Length of nuchal scute	.041

Head of Horse Tail Creek, Northeastern Colorado.

TESTUDO LATICUNEUS Cope.

Paleontological Bulletin No. 15, p. 6, August 20, 1873. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 511.

Plate LXI; fig. 1.

A number of fine chelonites which I obtained during my expedition of 1873 are, unfortunately, not accessible for description at present. Among these will probably be found some of the specimens of this tortoise, to which my original description refers. One individual, in a good state of preservation, must serve as the basis of the present description. It is, however, one of the best which I procured, although a little distorted in some places by pressure.

The general form is broad and depressed. The anterior and posterior outlines of the carapace are subtransverse, the former being nearly straight and the latter a little convex. The lip of the plastron projects much beyond the anterior border of the carapace, while the posterior lobe is included within that of the carapace. The free marginal bones are straight, but few of them being a little concave on their superior face. The anal bone is truncate wedge-shaped, with the free edge and the general surface gently convex. When the dermal scutal sutures reach the margin, there is a short acute mucro on both anterior and posterior marginal bones. There are no keels nor tuberosities on the carapace.

The plastron is rather flat, indicating a female animal. The anterior lip is large, and each half is rather longer than it is wide at the base of the external side. The exterior borders converge anteriorly, leaving a short margin, which presents six strong teeth, three on each half, of which the adjacent median ones are the widest. The posterior lobe is divided by a

deep notch into two rounded lobes, whose border is notched three times, leaving four teeth of smaller size than those of the lip.

The lateral suture of the nuchal marginal bone is much less oblique than in *T. amphithorax* and other species. The entosternal bone has eight sides. It is as wide as long, and narrows forwards. The dermal sutures are grooves with raised edges. This character is quite marked, and cannot be looked upon as indicating immaturity, as the animal is evidently adult. The nuchal scute is as wide as long, offering a strong contrast to that of *T. ligonius*, where it is long and narrow. Its lateral sutures terminate in mucros, which leave a concave margin between them. Vertebral scuta a little longer than wide. The anal scutum has a straight superior border, and is twice as wide as long. The gular scuta have a very oblique posterior border, and each one is about as long as the external free edge of the lip. The humero-pectoral suture retreats abruptly backwards from the free humeral border before becoming transverse. At its middle it is as far anterior to the pectoro-abdominal suture as the latter is from the abdomino-anal, thus leaving a much wider pectoral scutum than is found in *T. ligonius* and *T. amphithorax*.

Measurements.

	M.
Length of carapace (axial)	.408
Width of carapace (axial)	.356
Length of plastron (greatest)	.438
Width of base of anterior lobe	.200
Width of base of lip	.085
Length of lip on external edge	.045
Greatest length of posterior lobe (axial)	.111
Width of posterior lobe at base	.200
Width of anal marginal above	.070
Width of anal marginal on margin	.037
Length of nuchal scute	.027
Length of second vertebral scute	.082
Width of second vertebral scute	.080

From the head of Horse Tail Creek, Colorado.

TESTUDO LIGONIUS Cope.

Paleontological Bulletin No. 15, p. 6, August 20, 1873. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 511.

Plate LXI; figs. 2, 3.

Parts of carapace and plastron of one specimen represent this species in my collection. In the locality where I found this and most of the other specimens of tortoises from the White River beds here described, specimens

were very numerous. My means of transportation being limited, I could not collect a full series, but selected diagnostic bones from the best examples for purposes of future study. Of the present individual I have the clavicle ("episternal"), nuchal vertebral, several marginals, part of pectoral, and basal part of half of posterior lobe of plastron. This is a large species, with the marginal bones and edges of plastron thickened. The lip is produced, and has parallel sides and a truncate free edge without denticulations. The angle at which the borders would meet if produced, is obliquely cut off. The inferior surface is deeply, openly grooved along the oblique line of the gular dermal suture, and is excavated on the middle sutural line just anterior to the mesosternum. The superior face of the lip slopes outwards, and is swollen laterally behind. The free marginal bones of the carapace are not recurved at the margin. There is a projecting angle or point where the dermal suture reaches the margin, which is immediately followed by a step-like notch of little depth.

The lateral suture of the gular scute on the upper side of the lip is nearly parallel with the median suture, giving thus a paralellogramnic outline. The nuchal scutum is long and narrow, and is not bounded on the edge by mucros. The pectoral scutum is very narrow.

Measurements.

	M.
Length of lip on external edge	.035
Width of half of lip at base	.046
Thickness of lip at base	.023
Width of a free posterior marginal	.082
Length of a free posterior marginal	.072
Width of posterior lobe plastron at base	.188
Anteroposterior width of pectoral scute	.018
Length of nuchal scute	.040
Width of nuchal scute	.008

Head of Horse Tail Creek, Colorado.

TESTUDO AMPHITHORAX Cope.

Paleontological Bulletin No. 15, p. 6, August 20, 1873. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 511.

Plate LXI; fig. 4.

Of this large species I have before me two specimens which display the anterior lobe of the plastron, and probaby a third which does not include that diagnostic part.

The *T. amphithorax* agrees in many respects with the *T. ligonius*, but differs much in the characters of the anterior lobe of the plastron. There is scarcely any lip, but the margin is truncate, with a bounding angle on each side to represent the usual margin of the lip. In one specimen this angle is much rounded. The inferior surface differs from that of *T. ligonius* in being without impressed groove in the line of the gular suture and median fossa. In these respects it resembles *T. laticuneus*. One anterior lobe was found with the posterior lobes of two individuals, which are exactly alike. This lobe was deeply emarginate, and each sublobe is broadly rounded, wedge-shaped, with thin edge, with a notch in it at one point. The margin becomes very thick near the groin.

The relations of the inferior and superior bounding gular scuta are different in this species from what is seen in *T. ligonius*. The superior groove has the posterior position appropriate to a long lip, while the inferior leaves the margin much anterior to that point, and just posterior to the angle which bounds the very short lip which the species actually possesses. The two sutures nearly correspond in position in the *T. ligonius*. The pectoral scutum is quite narrow in the specimens, as in *T. ligonius*. The scutal sutures are impressed and do not have raised borders. The edges of the marginals are all injured in the specimens. The mesosternal bone is a little wider than long. It is more contracted anteriorly than posteriorly, but the lateral angles are about opposite the middle of the length.

The costal and vertebral bones are rather thin. A marginal bone, probably one of those in contact with the anal, has a peculiar form, such as does not exist in any other species, unless it be the *T. ligonius* and *T. quadratus*, where I have not seen it. It is recurved at the sutural edges, or is concave at the middle, so as to be openly trough-shaped. This indicates a very convex anal marginal bone, and a doubly sigmoid flexure of the free margin behind.

Measurements.

No. 1.

	M.
Width of truncate lip	.080
Width of humeral scute fore and aft	.024
Length of posterior lobe on axial line of a half	.151
Width of base of posterior marginal lobe of plastron	.092
Length of axial of trough-shaped marginal (anteroposteriorly)	.072

No. 2.

	M.
Width of lip	.089
Width of mesosternum	.103
Length of mesosternum	.096
Width of anterior lobe at base	.210
Length of anterior lobe (axial)	.125
Thickness of a costal bone	.080

Head of Horse Tail Creek, northeast Colorado.

STYLEMYS Leidy.

Cope diagnosis, Transactions Amer. Philos. Society, XIV, 1866, p. 123.

This genus probably belongs to the *Emydidæ*, in the neighborhood of *Manuria*, now existing in Eastern Asia. It is characteristic of the American lacustrine Miocene, but is represented by very few species.

STYLEMYS NEBRASCENSIS Leidy.

Report U. S. Geol. Surv. Terrs., I, p. 224, 1873. Proceed. Acad. Phila., 1851, p. 172. *Testudo hemispherica*, *T. oweni*, *T. culbersoni*, and *T. lata*, Ancient Fauna Nebraska, 1853, 105–110. Pl. XX–XXIV.

I obtained this species in Northeastern Colorado, in the White River formation, with the Tortoises already referred to the genus *Testudo*. Some of the specimens are of large size, others small. I have also numerous well-preserved chelonites from the John Day River beds of Oregon, which I refer to the same. Many of the Oregon specimens differ in some respects from the typical forms of the *S. nebrascensis*, but the characters are not constant. I observe three principal characters of the smaller and medium-sized specimens from Oregon. These are, first, the greater transverse length of the first marginal dermal scutum. This is caused by the more external position of its external bounding suture; instead of being nearly continuous with the lateral suture of the first vertebral, it is some distance external to it. This I find in all the Oregon specimens. Second, the less abrupt posterior flexure of the pectoro-humeral suture where it leaves the free margin of the anterior lobe on each side. A large Oregon specimen has the recurvature nearly as abrupt as in the Colorado and Nebraska specimens, and Leidy figures one of the latter (Ancient Fauna of Nebraska, Pl. XX), where the recurvature is as in some of the Oregon specimens. Thirdly, a convexity of the pygal and anal bones. This does

not appear in a very large and a very small specimen. It may be characteristic of the male sex.

One of the Oregon specimens is much larger than the others, and has the anterior lobe a little more produced, in this respect resembling the largest Colorado specimen. I add the measurements of these two specimens:

Measurements.

No. 1.—Colorado.

	M.
Length of plastron	.390
Width of plastron at middle	.310
Width of anterior lobe at base	.200
Length of anterior lobe	.145
Elevation of carapace	.210

No. 2.—Oregon.

Length of plastron	.420
Width of plastron at middle	.345
Width of anterior lobe at base	.215
Length of anterior lobe	.157
Elevation of carapace	.170

The Oregon form has been regarded by Leidy as a distinct species, with the name *Stylemys oregonensis*.* He adduces the thinness of the vertebral bones as its distinctive character. For the present I cannot admit it as more than a variety, although the skull and feet must be known before its position can be finally decided.

LACERTILIA.

Several species of this order were discovered by myself in the White River beds of Colorado in 1873, and a single species was found by one of my parties in the John Day beds of Oregon. With the exception of the *Peltosaurus granulosus* they rest upon fragmentary remains, which are in some instances not sufficient to furnish evidence of the position of the species in the system. The genera which are determinable display affinity to types now existing in the warmer parts of North America.

*Report U. S. Geol. Surv. Terrs., I, p. 225.

PELTOSAURUS Cope.

Paleontological Bulletin No. 15, p. 5, August 20, 1873. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 572.

Premaxillary undivided, with spine; a zygomatic, postorbital, and parieto-quadrate arches. Parietal bones united. Teeth pleurodont, with obtuse, compressed crowns, of similar form on all the jaw-bones. Body covered with osseous scuta, which are united laterally by suture. Vertebræ depressed, without zygosphenal articulation. Median hexagonal dermal scuta on the parietal bone.

There are sufficient remains of the typical species of this genus to furnish a basis for an estimation of its affinities, a point of some interest, as this has been seldom if ever done in the case of a terrestrial lizard of the Miocene epoch. The primary group to which it is to be referred is not difficult to determine.[1]

The frontal and parietal bones are each undivided, and there is no fontanelle in either, or in their common suture.[2] There is a large postfrontal, and the usual cranial arches are present, and the quadrato-jugal absent. The frontal possesses strong lateral inferior crests, but whether they underarch the olfactory tube completely, the specimen does not show. All the usual elements of the mandibular ramus are present, but the angular is very narrow. The dentary does not extend behind the coronoid on the external face of the jaw. The coronoid is little produced either forward or backward above, but sends a process forward on the inner face of the dentary. The splenial is well developed, but becomes very slender anteriorly; it covers the meckelian groove, except for a short space distally, where it furrows the inferior aspect of the jaw. The surangular is quite peculiar; it is massive, and lacks the usual deep fossa for the pterygoid muscle, and has a broadly truncate superior margin. It is in the same vertical plane as the dentary, and not oblique or subhorizontal as in most *Gecconidæ*. The dental foramen is small, and pierces its inner face. The posterior angle of the ramus is broken off.

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[1] See the author's Osteological Characters of the Scaled Reptiles, in Proceedings Academy Philadelphia, 1864, p. 224.

[2] What I originally thought was such is a foramen-like sinus in the posterior margin of the parietal.

The characters of the premaxillary bone, fontanelle, dentition, coronoid, dentary, splenial bones, and meckelian groove, place this genus out of the pale of the acrodont families. The parietals and vertebræ are distinct from anything known among the geccos. There is no resemblance in essentials to the *Amphisbænia*, so that we must look for its place among the numerous pleurodont families. Here the absence of the knowledge of the periotic bones and sternum somewhat embarrasses us; but other indications are clear. The coincidence of the want of parietal fontanelle with the lateral frontal plates refers us at once to the *Leptoglossa* or *Diploglossa;* a reference confirmed by the simple frontal, and strong cranial arches. The massive form of the surangular bone, and reduction of the angular, at once distinguishes *Peltosaurus* from any known family of the tribe *Leptoglossa*, and constitutes a point of near resemblance to the *Gerrhonotidæ*. This appears to be a real affinity, which is further confirmed by the presence of a symmetrical dermal scutellation on the top of the head.

Referring *Peltosaurus*, therefore, provisionally to the *Gerrhonotidæ*, it remains to consider the generic characters. The temporal fossa was not roofed over by true bone, though the border of the postfrontal encroaches on it; and it is rather small. The orbits, on the other hand, are large, and the malar bone forms a segment of a circle. The parietal thins out behind, and its posterior border has a subround excavation. The two median dermal scuta, which left their impressions on the parietal bone, represent the interparietal and postinterparietal plates respectively; the latter especially characteristic of the *Gerrhonotidæ*, and not found in leptogloss or diplogloss families generally; those possessing it being the *Lacertidæ* in the former, and *Anguidæ* in the latter. The most prominent character which distinguishes this genus from *Gerrhonotus* is the existence of the osseous scuta which covered the body. Even the form of these is similar to the corresponding dermal scuta of the existing genus. They are rectangular and are arranged in transverse bands on the body, those of one row overlapping the bases of those of the next row posteriorly, or imbricated. The scuta of each row are joined on their long sides, by minute suture.

PELTOSAURUS GRANULOSUS Cope.

Paleontological Bulletin No. 15, p. 5, August 20, 1873. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 513.

Plate LX, figs. 1–11.

I took numerous parts of the skeleton of an individual of this species from the White River chalk-bed on Cedar Creek, in Northeastern Colorado, during my expedition of 1873. The cranial fragments include the premaxillary and parts of both maxillary bones; the malar of one side; the coössified frontals and parietals separated from each other. Also the greater part of both mandibular rami. There are several vertebræ, and many dermal scuta.

The parietal is a wide element, and has a nearly plane superior surface. The granular sculpture vanishes posteriorly, leaving a wide, smooth band at the posterior border of the bone. The scutal areæ are rather narrow, each one longer than wide, and occupying just half of the length of the granular portion of the surface. The frontal suture is perfectly straight. The frontal bone is longer than wide, and is slightly convex in both directions. The greater part of it is preserved, and displays no dermal scuta, hence the frontal al scutum was large and undivided. The lateral olfactory ridges are massive and not very deep, being much thicker than in *Exostinus serratus*, and are strongly beveled on the external side; that is, to the supraorbital border. The malar and postorbital bones together form a rather slender arc of a circle, indicating a large orbit. The premaxillary bone has a wide, flat spine, which is so strongly inclined as to be nearly horizontal. No portion of it protrudes beyond the alveolar border, which supports seven teeth. There is a foramen at the base of the spine on each side. The external surface of the premaxillary is entirely smooth. On the external face of the maxillary the usual foramina occur at the usual intervals. In the mandible the postdentary parts are extended, about equaling the dentary (the angle is broken from both rami), and are robust. The anterior fourth of the meckelian groove is exposed. The external face of the dentary is convex, and is pierced by five foramina, all in the anterior half. The superior aspect of the surangular region is truncate or flattened, with angles separating it from the lateral faces, as in other *Gerrhonotidæ*.

There are ten teeth in .10^{m} of the maxillary bone, and there are twenty-four in the dentary bone. All are closely placed. Those of the superior series are a little more robust; their inner faces are convex, giving the shaft a slight curve in profile. The apices of the teeth are not expanded, but are wedge-shaped, with a cutting edge in the long axis of the jaw. A strong bevel of the crown to the external maxillary face gives their apices an especial robustness. Under the microscope their surface is delicately parallel-wrinkled to the cutting edge.

The scuta are parallelogrammic in form, and their proximal or concealed portions are from one-fourth to one-third the entire length. The granulation is like that of the cranium, fine and without distinct pattern.

The centra of the vertebræ are moderately depressed, those of the dorsal region the most so, and with the greater part of the face of the ball looking upwards. These centra are not ridged on the middle line below, but are slightly convex in transverse section. On either side, behind the inferior extremity of the parapophysis, is an open, shallow groove looking downwards, and defining the middle region as a wide band. Above, this groove is bounded by an obtuse longitudinal ridge, and above the ridge occupying the side of the centrum is a concavity. This is bounded above by the prominent ridge that connects the zygapophyses. The transverse process is vertical and narrow; it is nearly sessile and is not subdivided. A vertebra inclosed in matrix close to the skull is probably from the anterior part of the series. Its centrum is not so depressed as in those already described, and it has a strong hypapophysial keel. Its ventral spine is rather elevated, and is grooved posteriorly.

As compared with the so-called *Placosauridæ* of the Eocene formation, this species presents various points of resemblance, which the descriptions of the former do not yet permit us fully to estimate. The presence of regular cranial scuta will distinguish *Peltosaurus* from the known forms as a genus. The granulation of the cranium and osseous scuta, is finer than in any of the Eocene species I have met with.

Measurements.

	M.
Median width of parietals	0.0140
Median width of frontals	.0080

	M.
Length of mandibular ramus to cotylus	.0400
Diameter of vertebral centrum (transverse)	.0030
Length of vertebral centrum	.0055
Length of a dorsal scutum	.0075
Width of a dorsal scutum	.0042

About the size of the *Heloderma suspectum.*

EXOSTINUS Cope.

Synopsis of New Vertebrata Colorado, 1873, p. 16. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 511.

This form of lizard is represented principally by a nearly entire frontal bone. Close to it were found a zygomatic bone and a nearly complete dentary bone, with the teeth. The former is in all respects appropriate to the frontal bone, and the size of the dentary bears the usual relation of size to the same. Its dentition is appropriate to the affinities of this genus to *Peltosaurus* Cope.

The frontal bone is much narrowed between the orbits, as in recent leptogloss *Pleurodonta,* while the olfactory lobes were almost as completely underarched as in the thecagloss-type. The stout, well-developed zygomatic, with malar process, resembles the former group, and the teeth have a similar structure. These are closely placed, truly pleurodont and subcylindric. The crowns are simple, compressed, and with a convex edge. They are similar in form throughout the dentary bone. Cranial bones covered with symmetrical osseous prominences.

The sculpture of the superior surface of the frontal bone is more like that of the genus *Anolis* than any other known to me. The prominent inferior lateral olfactory crests, are, however, entirely inconsistent with any such affinity, excluding the genus from the Iguanian group altogether. It coincides with the evidence furnished by the forms of the teeth, that the genus *Exostinus* is one of the *Diploglossa,* and allied, but not very closely, to *Peltosaurus.* In the latter the frontal region is much wider, and is not covered with tubercles, and the olfactory ridges are much less prominent. In its narrow interorbital region *Exostinus* differs from any recent genus of the order known to me.

EXOSTINUS SERRATUS Cope.

Locis citatis.

Plate LX; figs. 12–14.

A series of tubercles along each supraorbital border, longitudinal at the front, and quadrate at the back part of the eyebrow. A single series of tubercles separates them. Five tubercles in a transverse row at the posterior margin of the frontal. Two series of flat tubercles on the zygomatic bone. Dentary quite convex on outer face; inner face slightly convex; 8 teeth in 0 .0050.

Measurements.

	M.
Length of frontal (nearly complete)	0.0070
Width of frontal posteriorly	.0034
Width of frontal at postorbital point	.0045
Width of frontal between orbits	.0018
Length of zygomatic	.0070
Depth of dentary at last tooth	.0030
Length of a mandibular tooth	.0018

About the size of the large males of the northern *Anolis principalis.*

ACIPRION Cope.

Synopsis New Vertebrata of Colorado, 1873, p. 17. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874) p. 514.

Represented by a dentary bone, with nearly all of the teeth remaining. A groove, apparently the Meckelian, extends along the inferior border of the distal half of the bone. The teeth are truly pleurodont, closely placed, and cylindric, with compressed crowns. The latter supports a large median and two small lateral cusps, three in all.

ACIPRION FORMOSUM Cope.

Locis citatis.

Plate LX; fig. 15.

The crowns project well above the alveolar border. External face of dentary smooth, with rather distant foramina. Ten and a half teeth in $0^m.0050$.

Measurements.

	M.
Depth of dentary at middle	0.0022
Length of a median tooth	.0018
Elevation of same above alveolus	.0010

This species is about the size of our *Cnemidophori*. From all the genera of this group, *Aciprion* differs in the uniform character of the teeth, there being no simple teeth in the front of the series so far as preserved. A jaw-fragment probably represents a second species of this genus. A well-preserved lower jaw of the *Aciprion formosum* was obtained in Dakota by the Princeton Expedition of 1882.

DIACIUM Cope.

Synopsis New Vertebrata Colorado, 1873, p. 17. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 514.

This genus was originally established on the sacral vertebra of a lizard which displayed the peculiarity of the absence of any trace of neural spine.

The diapophysis is subcylindric and elongate. Centrum concave below; neural arch flat above. Articulation without zygosphene or rudiment of it; zygapophyses oblique, the arch deeply excavated between the anterior ones. Obliquity of ball inferiorly.

DIACIUM QUINQUIPEDALE Cope.

Locis citatis.

Plate LX; fig. 20.

Two obscure hypapophysial tubercles below the ball. Centra slightly depressed, the cup excavated above and below. An angulation extends backwards from each anterior zygapophysis; the neural arch between them flat on the anterior half.

Measurements.

		M.
Length of centrum below		0.0100
Diameter of articular cup	transverse	.0086
	vertical	.0064
Diameter of base of diapophysis		.0044
Width between anterior zygapophyses		.0098
Width of upper plane of neural arch		.0078

This species is as large as any of the existing species of *Iguanidæ*.

PLATYRHACHIS Cope.

Synopsis New Vertebrata Colorado, 1873, p. 19. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), 516.

This genus is known only from vertebræ, which, though abundant in the White River beds, I have been as yet unable to connect with other

portions of the skeleton. The genus was founded on the supposition that the typical species, the *P. coloradoensis*, possesses the zygosphene articulation, a character which I have since been unable to verify, and do not now believe in. The subtraction of this character leaves little for the genus to stand on; but I retain the name with the following definition:

Vertebral centra with the articular faces much depressed, and without inferior or lateral carinæ. The ridge connecting the zygapophyses deeply incised. Neural spine a low keel.

The incised interzygapophysial ridge distinguishes these vertebræ from those of *Peltosaurus*.

The two best known species may be distinguished as follows:

Much smaller; neural spine not ending in a knob; costal articular face principally convex ..... *P. coloradoensis.*

Much larger; neural spine ending in an obtuse apex posteriorly; costal articulation, superior part concave ..... *P. rhambastes.*

A third species is only known from a sacral vertebra.

PLATYRHACHIS COLORADOENSIS Cope.

Locis citatis.

Plate LX; fig. 17.

The inferior face of the centrum in four dorsal vertebræ is plane, and is separated by an obtuse right angle from the nearly vertical lateral surfaces. Neural arch depressed, an angle connecting the zygapophyses. Neural spine a keel, projecting beyond the posterior margin in a mucro. Ball truncate below its convex face, looking slightly upward. Costal capitular surface semiglobular, directly below the anterior zygapophysis. Neural arch concave between zygapophyses.

Measurements.

	M.
Length of three dorsal vertebræ	0.0070
Length of one dorsal vertebra	.0028
Diameter of ball { transverse	.0014
Diameter of ball { vertical	.0006
Elevation of vertebra	.0019
Width between zygapophyses	.0025

This species is of small size, not exceeding the red salamander (*Spelerpes ruber*) in dimensions.

From Horse Tail Creek, Northeastern Colorado.

PLATYRHACHIS UNIPEDALIS Cope.

Diacium unipedale Cope. Synopsis of New Vertebrata of Colorado, 1873, p. 18. *Cremastosaurus unipedalis* Cope. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 516.

Plate LX; fig. 19.

Represented by a sacral vertebra of an individual much larger than any of those of the last-described species, and a little smaller than those of the species next following, characterized by the unusual protuberance of the articular ball and absence of flattening of the centrum below. Centrum depressed; plane longitudinally convex in transverse section. An annular groove round the ball. Diapophysis elongate, slightly depressed.

Measurements.

		M.
Length of centrum		0.0034
Diameter of cup	transverse	.0020
	vertical	.0018

Were this vertebra part of an individual of the *P. rhambastes*, its articular faces would have been more rather than less depressed than the dorsal vertebræ which represent it.

From Horse Tail Creek, Northeastern Colorado.

PLATYRHACHIS RHAMBASTES Cope.

Plate LX; fig. 18.

Established on seven dorsal vertebræ, which I formerly regarded as belonging to the *Cremastosaurus carinicollis*. (Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 515. They differ very much from the cervical vertebræ on which the latter genus is based; too much, I believe, to render it probable that they belong to lizards of the same genus. This also in spite of the fact that the difference is somewhat like that which prevails between cervical and dorsal vertebræ of many genera of Lacertilia. The inferior carina in the *Cremastosaurus* is not a hypapophysis of the usual kind found on only a few of the cervicals, but continues undiminished to the sixth and last I possess of the series. The articular ball at this point shows no indication of the depression characteristic of the dorsals, and which is usual at this point, even in species where the anterior cervicals have subround articular extremities.

The dorsal vertebræ have transversely-oval articular faces, and centra without inferior keel or ridge. The vertebræ are all dorsal, hence the diapophyses have the usual form in the order for costal articulation, and do not project as far inferiorly as the plane of the lower face of the centrum. It does not project beyond the anterior zygapophysis, and the lower half is especially developed as the costal condyle. The sides are separated from the wide, flat, inferior surface by an obtuse angle. Neural spine a keel extending from the front of the arch and rising into a short obtuse apex above the articular ball. There is a collar round the ball, which is faintly visible on the inferior side.

Measurements.

	M.
Length of centrum	0.0040
Width of cup	.0018
Depth of cup	.0010
Elevation of neural arch anteriorly	.0015
Elevation of neural spine and arch posteriorly	.0043
Total expanse in front	.0047

The dorsals represent several individuals.

Horse Tail Creek, Northeastern Colorado.

CREMASTOSAURUS Cope.

Synopsis New Vertebrata, Colorado, 1873, p. 18. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 515.

This genus was proposed for a lizard which presents some peculiar characters of the cervical vertebræ. There are five of these preserved in a continuous series. They are quite robust and short, resembling somewhat those of the *Phrynosoma cornutum* in proportions, but have remarkably small articular ball and socket as compared with that species. Another marked feature is the rib-like hypapophysis, which is equally developed on the fifth as on the second vertebra, being bounded by a fossa or groove on each side. It is probably continued, but less distinctly, on the dorsal vertebræ.

The neural arch is capacious in the cervical region, and each neurapophysis is excavated below the posterior zygapophysis, and sending a ridge downward and backward around the centrum, continuing as a low shoulder on the inferior face. Diapophysis with a single narrow capitular articulation, extending obliquely downward and forward; that of the third vertebra

smaller. Axis with an elevated neural arch, with obtuse, inferior carina Odontoid a crescentic element, with a transverse groove on its anterior face. All the centra with an obtuse but prominent hypapophysial keel.

CREMASTOSAURUS CARINICOLLIS Cope.

Locis citatis.

Plate LX; fig. 16.

Ball of sixth cervical vertebra round. Neural arches broad, each with a low, acute keel for spine, which is elevated on the third, and produced roof-shaped backward and forward on the axis. The costal articulations are not produced below the centrum.

Measurements.

	M.
Length of cervical vertebræ II to VI	0.0140
Length of axis	.0038
Elevation of axis behind	.0047
Diameter of odontoid (in front)	.0034
Length of c. VI	.0029
Diameter of ball of same	.0011
Total elevation of same	.0030

Size of the "horned-toad", *Phrynosoma cornutum.*

OPHIDIA.

Several species of snakes have been found in the beds of the White River and John Day epochs. The characters presented by the vertebræ, the only parts as yet discovered, do not differ much from those of existing types. None of them represent species of more than the average size of the colubrine snakes now existing in the same region

APHELOPHIS Cope.

Synopsis of New Species of Vertebrata obtained in Colorado in 1873 (Miscell. Pub. U. S. Geol. Surv. Terrs.), p. 16. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 518.

The vertebræ of this genus have various well-marked characters which distinguish them. The neural spine is short and robust, and does not extend along the entire length of the neural arch as exposed in the articulated column. There is no diapophysial process below the prezygapophysis. The zygosphene exceeds the articular cup in width, and the posterior border of the neural arch is not interrupted. There is no hypapophysis, nor

hypapophysial nor any other longitudinal ridges. The costal articular surface is single and uninterrupted.

These vertebræ resemble very much those of the Erycid genus *Charina*, which is found at the present time in the Pacific district of this continent. I can, in fact, detect no well-marked generic difference between them. The zygosphen of the recent species is somewhat narrower than that of the extinct one.

APHELOPHIS TALPIVORUS Cope.

Locis citatis.

Plate LX; fig. 21.

Vertebræ short and wide; the neural spine stouter and more obtuse than in any other species here described, occupying less than half the neural arch with its basis. Zygosphene wide, depressed, with nearly straight posterior margin, not sending any ridge backward from the posterior face. Articular faces of centrum depressed oval; ball looking upward, its axis making 45° with that of the centrum. Parapophysis not projecting below centrum.

Measurements.

	M.
Length of centrum	0.0026
Diameter of cup { transverse	.0018
Diameter of cup { vertical	.0012
Width between parapophyses	.0017
Depth of entire vertebra	.0034
Width of zygosphene	.0020

Represented by three vertebræ of an individual about the size of *Calamagras murivorus*.

The White River epoch of Northeastern Colorado.

OGMOPHIS Cope.

Neural spine of vertebra short and obtuse. No process below the prezygapophysis. Rib surface single, uninterrupted; rib extending posteriorly from its inferior extremity. Inferior face of centrum without hypapophysis on the dorsal region, but probably furnished with one on the cervical region.

This genus resembles *Aphelophis* in most respects, and probably has similar general affinities. It is distinguished by the ridge which extends from the parapophysis, and the groove which is included between this and the middle line of the centrum. Two species are known to me.

OGMOPHIS OREGONENSIS Cope.

Plate LVIII a; figs. 9–11.

This snake is represented by four dorsal vertebræ and probably by a fifth from the region near the skull. The last-named vertebra has a smaller centrum than the others, as is usual with those from the anterior part of the column, but the details of its structure are much as in the others. It has an acute hypapophysial ridge which extends posteriorly into a short, subacute process. In the other centra, the median inferior ridge bounded by the lateral grooves, is obtuse, and has different forms. It is wide at both extremities and the surface is equally convex; in two others it is much narrowed medially and widened posteriorly. In all of these the posterior part is slightly angulate medially. The articular faces are nearly round, and the obliquity of the ball is only moderate. The ridge from the inferior extremity of the rib surface terminates a short distance from the articular ball. The ridge connecting the zygapophyses is very prominent. The rib articular face is one-half deeper than wide; the superior half is convex, the remainder gently concave, the inferior border projecting slightly outwards.

The only specimen of this species preserved rather exceeds in size the others here described, excepting the *Neurodromicus dorsalis.*

Measurements.

	M.
Length of centrum with ball	0.0050
Transverse diameter of ball	.0026
Total elevation of vertebra	.0060
Elevation of neural spine	.0019
Width at interzgyapophysial ridge	.0044
Vertical diameter of rib surface	.0023
Width of ball of a "cervical" centrum	.0020

From the John Day beds near the John Day River, Oregon. J. L. Wortman.

OGMOPHIS ANGULATUS Cope.

Calamagras angulatus Cope. New Vertebrata Tertiary of Colorado, 1875, p. 16. Annual Report U. S Geol. Surv. Terrs., 1873 (1874), p. 518.

Plate LVIII a; fig. 12.

This species differs from the *C. oregonensis* in the following points. The interzygapophysial ridge is not nearly so prominent but is excavated behind the prezygapophysis. The neural spine is smaller and is not split poste-

riorly, as is the case with a dorsal of *C. oregonensis*. The hypapophysial ridge is narrower, and is subacute in a dorsal vertebra.

The zygapophses are well expanded, and the zygosphen is wider than the cup. The superior and prominent portion of the rib articulation is narrower than the inferior flat portion.

Measurements.

		M.
Length of centrum		0.0030
Diameter of ball	transverse	.0017
	vertical	.0016
Width between parapophyses		.0024
Depth of entire vertebra		.0045

CALAMAGRAS Cope.

Locis citatis, 1873, 1874.

Neural spine small and obtuse; no process below the prezygapophysis, nor longitudinal ridge of the centrum posterior to the rib articular surfaces. The latter is undivided. Inferior median line with a keel, which is probably produced into a hypapophysis on the anterior part of the columns.

This genus belongs most probably to the same natural division as *Ogmophis* and *Aphelophis*, which when fully known may prove to be the existing family of *Erycidæ* or *Lichanuridæ*. *Calamagras* shares the characters of the two genera named, so as to stand between them in the natural system.

CALAMAGRAS MURIVORUS Cope.

New vertebrata from Colorado, 1873, p. 15. Annual Report U. S. Geol. Survey Terrs., 1873 ('74), p. 517.
Calamagras truxalis Cope l. c.

Plate LVIII a; figs. 13–15.

Parts of three vertebral columns, including thirteen vertebræ, represent this serpent.

The zygosphene is a little wider than the articular cup. The ball, viewed directly in the line of the axis of the centrum, has a wide, transversely placed oval outline. The balls of a set of three vertebræ in which the hypapophyses are best developed, and which I therefore supposed to belong to the anterior part of the series, are more nearly round. The ridge connecting the zygapophyses is deeply emarginate. In the anterior ver-

tebræ the hypapophyses are acute keels supporting an angular prominence near the center; further posteriorly there is a slight prominence at the base of the ball. More posteriorly the hypapophysis forms a narrow but somewhat obtuse ridge, terminating posteriorly in an apical angle at the inferior side of the ball. The neural arches are separated by spaces equal to the lengths of their bases. The rib articulations present the peculiarity of other members of this group, of a single surface, of which the superior half is convex, and the inferior slightly concave.

Measurements.

No. 1.—More anterior.

	M.
Length of centrum	0.0027
Width of ball	.0016
Depth of ball	.0011
Width between parapophyses	.0020
Depth of entire vertebra	.0034

No. 2.—More posterior.

Length of centrum	0.0030
Width of ball	.0017
Depth of ball	.0013
Width between parapophyses	.0023
Depth of entire vertebra	.0040

From the beds of the White River Epoch in Northeast Colorado.

NEURODROMICUS Cope.

Synopsis of new vertebrata from the Tertiary of Colorado, 1873, p. 15. Annual Report U. S. Geological Survey Terrs., 1873 ('74), p. 516.

Centrum small, with a prominent truncate hypapophysis. Neural arch capacious, the zygantrum wider than the articular cup. Neurapophyses bounding the canal laterally below the zygosphene; its border not angulate behind. Parapophysis projecting acutely below centrum. An elevated neural spine. No process below the prezygapophysis. No prominent ridge connecting the zygapophyses.

This genus represents a different group of snakes from those included in the three genera above described. The vertebra resembles considerably those from the anterior part of the column of one of the *Crotalidæ*, but differs in the less robust hypapophysis and the absence of the process below the prezygapophysis.

NEURODROMICUS DORSALIS Cope.

Locis citatis, 1873, 1874.
Plate LVIII a; figs. 7, 8.

Articular surfaces of centrum round; the ball with a slightly upward-looking obliquity. Hypapophysis continued to cup as a prominent carina. Neural spine extending its base forward, so as to stand on the entire length of the neural arch. The rib articular process is of light form, and is separated by a considerable space from the prezygapophysis. The superior convex portion is quite small, while the inferior portion is narrow and is produced downwards. There is a trace of ridge connecting the zygapophyses, and a trace of a groove on each side of the anterior part of the base of the hypapophyses. Both the neural spine and the hypapophysis are thin edged, and all parts of the vertebra are delicate and light, in strong contrast to those of *Calamagras* and its allies.

Measurements.

	M.
Length of centrum	0.0045
Diameter of cup, vertical	.0020
Diameter of cup, transverse	.0021
Elevation of neural spine above centrum	.0055
Elevation of neural spine above neural arch	.0029
Length of hypapophysis below centrum	.0012
Width of hypapophysis	.0011

The zygantrum is capacious, and the whole neural arch open and light. The species was about the size of the black snake (*Bascanium constrictor*).

The White River Epoch of Northeast Colorado.

MAMMALIA.

The White River Epoch was very rich in *Mammalia*, but not more so than the preceding epochs of the Eocene proper, the Bridger and Wasatch. The composition of the fauna was very different, as a number of important groups of the earlier period were wanting, while several appear for the first time. Of the former kind may be included the Order *Amblypoda*, and the suborders *Tæniodonta*, *Tillodonta*, and the family of the *Lophiodontidæ*. The *Creodonta* and *Mesodonta* are represented by a very few remnants. The

divisions which actually appear for the first time are few, for nearly all the characteristic divisions had very few and insignificant representatives during the Eocene. The *Artiodactyla ruminantia* and the *carnivora* are not known from the Eocene, while the *Artiodactyla omnivora* had very few representatives. The *Menodontidæ* and *Palæotheriidæ* chiefly belong to this epoch, with several families of *Rodentia.* The *Chiroptera,* probably the *Marsupialia,* and the rodent family of the Squirrels held over from the Eocene, while the *Proboscidea* had not yet appeared.

No species of Mammal is common to this epoch and any of those of the Eocene, and only one or two genera of Marsupial or Marsupial-like families have continued from the one to the other, so far as present information extends.

The species of the White River Epoch attained a larger average size than those of the Eocene Epochs. This is especially evident on comparison of related or corresponding types of the two periods. The *Amblypoda,* which embraces the largest Mammalia of the Eocene, became extinct. The most notable increase of size is seen in the *Perissodactyla,* where the succession is most continuous. The same is generally true of the flesh-eating series.

The number of individual mammals of this epoch in Middle North America was evidently very great. Many of the species were represented by great droves, and their bones form beds of considerable extent. A locality in Colorado, examined by the writer, embraced about forty acres of naked, soft calcareous rock, carved by erosive action into areas of various sizes. Here the surface of the rock was found to be covered with the remains of the smaller and some of the larger species of the fauna. There were innumerable rodents, and small *Artiodactyla* and *Carnivora;* numerous *Marsupialia, Creodonta,* and *Poëbrotherium.* There was a great abundance of *Hyracodon,* and several other rhinoceroses, with quantities of three-toed horses. No traces of the huge *Menodontidæ* were there, but at a locality some miles distant, a similar deposit of these large animals was found, mingled with rhinoceroses. Evidently the causes which overwhelmed the smaller forms did not affect the giants, which only yielded to some other and more irresistible influence.

MARSUPIALIA.

Cuvier demonstrated the existence of species of this order in the gypsum of the upper Eocene of Paris, and additional species have been made known by Aymard, Filhol, and others. In 1873 I discovered in Colorado a number of species which agree very closely with the French forms, so far as can be ascertained from the dentition. These I referred to the *Insectivora*,[1] but subsequently identified[2] them as *Marsupialia*. They are nearly related to the European forms, and whether they can be placed in a distinct genus remains to be ascertained. A species of the same group, if not the same genus, is described in Part I of this volume, from the Wind River Eocene (page 269).

Along with these species were found several others, less evidently members of the Marsupial order. I refer to the genera *Mesodectes*, *Domnina*, and *Menotherium*. Close allies of the first of these had already been referred by Leidy to the *Insectivora*. I have in the first part of this book placed the group in the suborder *Creodonta* and the family of *Leptictidæ*, but with a feeling of uncertainty whether the family may be Marsupial or not. *Domnina* is, I suspect, chiropterous. *Menotherium* resembles the *Leptictidæ*, but still more the *Mesodonta*, where I originally placed it. I leave it there for the present in the immediate neighborhood of the genus *Apheliscus*. For purposes of determination from dental characters I compare these genera in a table, as follows. Some of them have been already defined in the analytical table of the genera of Creodonta, page 269.

I. Fourth inferior premolar constructed on the type of the true molars, with three anterior cusps.
Mental foramen anterior, below fourth premolar; inferior true molars subequal. *Peratherium.*
Mental foramen below first true molar; inferior molars diminishing in size posteriorly. *Domnina.*
II. Fourth premolar with three anterior cusps, as in I; but unlike true molars;
True inferior molars with only two cusps in front ..... *Mesodectes.*
III. Fourth premolar simple; unlike true molars;
True inferior molars with two anterior tubercles ..... *Menotherium.*

[1] Annual Report U. S. Geol. Surv. Terrs., 1873 ('74), p. 465.
[2] Bulletin U. S. Geol. Surv. Terrs., 1879, p. 45.

There are five species of *Peratherium* known to me, two of *Domnina*, and possibly of *Mesodectes*, and one of *Menotherium*.

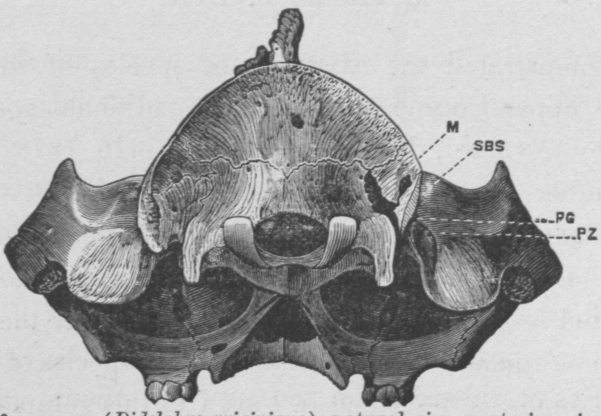

FIG. 32.—Skull of opossum (*Didelphys vriginiana*), natural size, posterior view, parts of the right mastoid and squamosal bones removed. M, mastoid foramen; SBS, subsquamosal; PG, postglenoid; PZ, postzygomatic foramen.

PERATHERIUM Aymard.

Herpetotherium Cope. Paleontological Bulletin, No. 16, August, 1873, p. 1. Synopsis of New Vertebrata from the Tertiary of Colorado (Misc. Pub. U. . Geol. Surv. Terrs.), October, 1873, p. 4. Annual Report U. S. Geol. Surv. Terrs., F. V. Hayden in charge, 1873 (1874), p. 465.

Dental formula: I. $\frac{?}{4}$; C. $\frac{1}{1}$; Pm. $\frac{3}{3}$; M. $\frac{4}{4}$. The superior canines are well developed. The premolars are compressed, with one apex, no inner lobes, and two roots. The superior molars, excepting the last, present two median **V**s, which would be termed external but for the fact that the external basal cingulum is so developed as to constitute an external crest. A single internal lobe, which is less elevated than the median. The last molar has but one median and one internal **V**. The superior incisors are unknown. The inferior incisors are subequal and closely placed; the first three are parallel, Inferior canine well developed, recurved. Inferior premolars compressed. simple unicuspid. Molars consisting of two **V**s, with apices external. The inner extremity of each branch of the anterior **V** is a pointed cusp, behind which stands, on the inner edge of the crown, a third cusp opposite to the middle of the posterior **V**. The last inferior molar is little shorter than the others, but the second **V** is narrowed so as to be only a heel. The molars do not materially enlarge anteriorly, and the posterior mental foramen is not posterior to the first true molar.

The general osteology of this genus is unknown, as the only portions of the skeleton yet discovered are mandibular rami and the cranium anterior to the middle of the orbits. From these it appears that the cranial sutures are distinct at maturity, and that the nasal bones are elongate and well developed. Either the maxillary bounds the orbit in front or there is a large lachrymal bone. A pit on the anterior rim of the orbit is probably the lachrymal canal. The *foramen infraorbitale* is well anterior to the orbit. The *symphysis mandibuli* is loose.

In determining the affinities of this and other questionable genera of this epoch it is first necessary to ascertain the homologies of the cusps of the molar teeth. The opossums are characterized by the presence of three longitudinal series of tubercles on the superior molars. The homologies of these cusps are rendered clear by the character presented by the fourth superior premolar, where the anterior intermediate cusp is wanting. The external cusps are really such, and are not developed from a cingulum external to the true external cusps, as appears at first sight to be the case with such animals as the *Talpidæ*. The intermediate cusps are really such, although the posterior looks like the apex of a **V**-shaped external cusp. In *Peratherium* the external cusps are smaller than in *Didelphys*, and the intermediate **V**s so much better developed, that the type is much like that of the *Talpidæ*, in whose neighborhood I originally referred it.

This leads to a consideration of the question of the homologies of the cusps in the genera of the old order of *Insectivora* proper, and of the *Creodonta*. Mr. St. George Mivart has briefly discussed the question so far as relates to the former group.[1] He commences with the primitive quadrituberculate type presented by *Gymnura* and *Erinaceus*, and believes that the external cusps occupy a successively more and more internal position, till they come to be represented by the apices of well-developed **V**s, as in the ungulate types. The **V**s are well developed in several families, and in *Chrysochloris* the two **V**s are supposed to be united and to constitute almost the entire apex of the crown, while in *Centetes* the same kind of a **V** forms a still larger part of the crown.

I believe that these conclusions must be modified, in the light of the characters of various extinct genera, and of the genus *Didelphys*. In the

[1] Journal of Anatomy and Physiology, II, 138 figures.

first place, there is an inherent improbability in the supposition that the external **V**s of the superior molars of the *Insectivora* have had the same origin as those of the *Ungulata*. The movements of the jaws in the two groups are different, the one being vertical, the other partially lateral. In the one, acute apices are demanded; in the other, grinding faces and edges. We have corresponding **V**s in the inferior dental series, and we regard those as produced by the connection of alternating cusps by oblique ridges. In homologizing the superior cusps, we have, as elements, two external, two intermediate, and two internal cusps. The first are opposite the external roots, and the anterior internal is opposite the internal root.

First, as regards *Centetes* and *Chrysochloris*. Besides the strained character of the hypothesis that supposes the **V**-shaped summit of the crown to represent two **V**-s fused together, there is good evidence obtainable in support of the belief that the triangle in question is the usual one presented by the *Creodonta*. This clearly consists of the two external and the anterior internal cusps united by angular ridges. The form is quite the same as in *Leptictis* and *Ictops*[1] (Plate XXIX *a*, fig. 3), and nearly that of *Deltatherium* (Plate XXIII *d*, fig. 8 *a*), where the external cusps are present. *Centetes* and *Chrysochloris* only differ from these in that the external cusps are wanting. In addition, the latter genus presents a rudiment of the posterior inner tubercle, as is seen in *Deltatherium* (Plate XXV *a*, fig. 10). An explanation similar to this is admitted by Mr. Mivart to apply to the cusps of the inferior molar of *Centetes*. It remains to ascertain whether the apex of the **V** in *Chrysochloris* represents the internal or intermediate cusp.

Secondly, as regards the *Talpidæ* and *Soricidæ*, where the external **V**s are well marked. If we examine the external cusps in the genus *Didelphys*, we find that the posterior one becomes gradually more anterior in its position, until on the second true molar it stands largely above the interspace between the roots, instead of over the posterior root. It will also be seen that the anterior intermediate tubercle is distinct and of insignificant proportions, while the posterior intermediate is large and is related to the posterior external, as is the apex of a **V** to its anterior base. In this arrangement I conceive that we have an explanation of the **V**s of the *Talpidæ*

* Leidy's Extinct Fauna of Dakota and Nebraska, 351, Pl. XXVI, fig. 29.

and *Soricidæ*. The first true molar of *Scalops* is a good deal like that of *Didelphys*, but the anterior cusp is larger, and there is no anterior intermediate cusp, while the posterior external is of reduced size. The posterior **V** is better developed than in *Didelphys*, but is composed in the same way, of a posterior intermediate cusp, and a posterior external with a posterior heel. These are united by stronger ridges in *Scalops*, *Condylura*, and *Blarina* than in *Didelphys*. On the second true molar in *Scalops* a **V** represents the anterior external cusps of the first true molar. Whether this **V** has a constitution like the posterior one, *i. e.*, is composed of external and intermediate cusps joined, is difficult to determine; but it is probably so constituted. It seems to be pretty clearly the case in *Blarina*, where the fourth premolar and first true molars may be compared, with a resulting demonstration of the correctness of this view. In *Condylura* the **V**s have become more developed and the external cusps reduced, so that the analysis is more difficult.

This interpretation applied to *Urotrichus* and *Galeopithecus* gives them quadrituberculate molars, not trituberculate, as determined by Mivart. *Mystomys* is trituberculate. The intermediate tubercles are present, but are imperfectly connected with the external, so that **V**s are not developed (*vide* figures of Mivart and Allman). This genus offers as much confirmation of the homology here proposed as do the opossums, but it differs from the latter in having the anterior intermediate tubercle the larger, instead of the posterior. *Mystomys* and *Solenodon* also confirm the determination the internal angle of the crown in *Centetes*[1] is the anterior internal cusp.

In conclusion I give the following synoptic view of the constitution of the superior molar teeth in various genera of the *Bunotheria:*

External cusp. Intermediate. Two internal.	External cusp. No intermediate. Two internal.	External cusp. Intermediate. One internal.	External cusp. No intermediate. One internal.	No external cusp. No intermediate. Two internal.	No external cusp. No intermediate. One internal.
Adapidæ. Tupæidæ. Galeopithecidæ Soricidæ (with Urotrichus).	Gymnura. Erinaceus. Macroscelididæ.	Mystomyidæ. Mioclænus. Miacis. Talpidæ. (Didelphys.) (Canis.)	Mesonyx. Leptictis. Ictops. Stypolophus. Oxyæna. Chriacus. Deltatherium. Esthonyx (posterior internal rudimental).	Chrysochloris (second internal rudimental). Solenodon (second internal rudimental).	Centetes.

[1]This view was first advanced by the writer in the Annual Report of the United States Geological Survey Territories, 1873 (1874), p. 472.

In criticism of the above table, it may be added that the external cusps stand within the border in *Stypolophus* and *Didelphodus*, and are nearly confluent in the false sectorials of *Oxyœna* and *Pterodon*. One is smaller than the other in *Mesonyx*. In *Solenodon* they are rudimental.

From the above considerations it appears that the external, often minute, cusps of the teeth of *Insectivora* are the homologues of those of true external series, and do not represent an additional cingulum. Comparisons of the molars of the extinct and recent forms are thus facilitated.

Peratherium is nearly allied to *Didelphys*, but has not the inflected angle of the mandible of that genus. The difference in dentition as above pointed out consists in the elevation of the median cusps of the superior true molars into Vs, and the obsolescence of the tubercles of the external series. It is quite possible that these characters may not be sustained in a comparison of the numerous extinct and recent species. The name *Peratherium* was proposed by Aymard for some similar species from France, but his characters were derived from the inferior dentition, and were of no great importance, as remarked by Filhol. Thus he states that the third inferior premolar is larger in the extinct than in the recent species, a character not generic, and which, as Filhol shows, is not common to all the French species, and which is not found in those of America.

Animals of this genus were abundant in North America during the White River epoch of the Miocene, but I have not seen any of their bones from later deposits. Those obtained by me in Colorado represent six species, some of which I have on former occasions referred to another genus (*Embassis*). Future discovery may justify this course, but at present I suppress the name.[1]

[1] In my account of the genus *Herpetotherium*, published in the Annual Report of the Hayden Survey for 1873 (p. 465), it is stated that this genus has a greater number of molar teeth than in *Talpa*, "thus $\frac{34}{34}$ in the extinct to $\frac{22}{22}$ in the recent genus." As these figures are absurdly erroneous, it becomes necessary to explain that the numbers originally given were $\frac{3-4}{3-4}$ and $\frac{3-4}{2-3}$. The paper was printed during my absence from the East, and the editor, not understanding my meaning, allowed them to go to press in the erroneous form in which they stand.

The species are distinguished as follows:

I. Anterior triangle of inferior molars with the two inner cusps subequal and deeply separated.

a. The anterior triangle not much more elevated than the posterior.

Larger; last two molars 4.5^{mm} long; ramus 4^{mm} deep at middle.....*P. fugax.*

Smaller; last two molars 4.5^{mm}; ramus 3^{mm} .....*P. tricuspis.*

Smallest; last two molars 2.7^{mm}; ramus 2^{mm} .....*P. huntii.*

aa. The anterior triangle twice as much or more elevated than the posterior.

Larger; last two molars 4.5^{mm} .....*P. scalare.*

II. The anterior cusp of the elevated anterior triangle insignificant, the posterior inner cusp much larger.

A groove extending to the base of the anterior cusp on the inner side; heels of molars supporting two cones .....*P. marginale.*

No groove separating anterior cusps; heels of molars very low .....*P. alternans.*

PERATHERIUM FUGAX Cope.

Herpetotherium fugax Cope. Paleontological Bulletin No. 15, August, 1873, p. 1. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 467.

Plate LXII; figs. 1–9.

This species is represented by the anterior half of the cranium with mandibular rami, with nearly complete dentition, of one individual; and by larger and smaller parts of mandibles of fourteen others.

The portion of cranium preserved is somewhat crushed by pressure, but it was evidently wider in proportion to its length at the frontal region than in the existing *Didelphidæ* of America. The muzzle is broken away, but the inferior incisor teeth show that it was not elongate. The skull begins to expand in front of the *foramen infraorbitale*, and at the lachrymal region overhangs, by a little, the maxillary border. The orbits do not appear to have been large. The malar bone, if it existed, is lost from the specimen. The nasal bones are narrowed by the elevated maxillaries for the distal two thirds of their length. They then rather abruptly expand to double the width, and terminate in a wide slightly convex posterior border. Either the maxillo-premaxillary suture is situated well in advance of the canine tooth, or else it has become obliterated by coössification. The *foramen infraorbitale exterius* is above the third premolar tooth.

The superior canine is compressed, but neither the anterior nor posterior edges are acute. The first premolar is smaller than the others, and its crown is rather obtuse. It is separated by a short interspace from the second. The latter has a trace of a posterior basal tubercle; its edges are not acute.

The third premolar is most prominent; its posterior edge is generally worn so as to be acute. There are no external cingula on the premolars. The elevation of the external cingula of the true molars is such as to produce, on wearing with the middle cusps, two triangular areas, of which the anterior is a little smaller than the posterior. The inner lobe of these teeth is more nearly opposite the anterior than the posterior triangle, giving a straight anterior and oblique posterior outline to the crown. There is no posterior basal cingulum on the true molars. The inner lobe of the fourth true molar is compressed and acute, and sends a sharp edge to the base of the small cusp which represents the posterior external triangle of this tooth.

The fourth inferior incisor is not larger than the others, and is directed a little more upwards than they. The inferior canine is large, but smaller than the superior, though similar in form. There is no interspace between the canine and first inferior premolar; but a short one between the first and second premolars, and a shorter one between the second and third premolars. The crowns of these teeth are a simple cusp, which is mainly over the anterior root. In all the true molars the anterior triangle is not much more elevated than the posterior, and the anterior and posterior cusps of the inner side of the former are well separated from the external cusp, which much exceeds them in size. The anterior triangle of the first true molar is a little narrowed. The cusp of the internal side of the posterior triangle is about as high as the anterior cusp. In many specimens there is a small cusp behind this one; in some specimens it is very small, while in others it is wanting. This peculiarity I at one time thought characteristic of another species, the *P. tricuspis*. This I do not now believe to be the case, but find that that species possesses other and more reliable characters. The heel of the last inferior molar of the *P. fugax* is somewhat narrowed, and always presents three cusps.

There are two mental foramina—one, the larger, below the first premolar; the other below the fourth molar, counting from either end of the series.

Measurements.

	M.
Length of superior molar series plus the superior canine	.013
Length of premolar series	.0052
Length of molar series	.0063

	M.
Length of second true molar	.0016
Width of second true molar	.0020
Length of inferior molar series of a second individual	.0128
Depth of ramus at first premolar	.0016
Depth of ramus at first true molar	.0035
Depth of ramus at last true molar	.0030

These measurements indicate an animal of about the size of the common mole of this country (*Scalops aquaticus*). The teeth are relatively smaller, and the mandibular rami deeper and less robust.

PERATHERIUM TRICUSPIS Cope.

Herpetotherium tricuspis Cope. Synopsis of New Vertebrata from the Tertiary of Colorado (Miscell. pub. U. S. Geol. Survey Terrs.), October, 1873, p. 5. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 466; partim.

Plate LXII; figs. 10–11.

This species as at present defined rests on a fragment of a lower jaw, which supports the second and third true molars. These teeth are similar to those of the *Peratherium tricuspis*, and possess, like some individuals of that species, a prominent posterior inner cusp of the posterior triangle. The character which distinguishes it from the typical species is the shallowness of the mandibular ramus. The depth of this bone is not over half that of some of the specimens of *P. fugax*, with teeth of equal size, and two-thirds the measurement of some others. This character is expressed in the following—

Measurements.

	M.
Length of second and third true molars	.0040
Width of third true molar	.0010
Depth of ramus at second true molar	.0025

From the same locality as the *H. fugax*.

PERATHERIUM HUNTII Cope.

Plate LXII; figs. 12–16.

Herpetotherium huntii Cope. Synopsis of New Vertebrata, Colorado, October, 1873, p. 5. Annual Rept. U. S. Geol. Surv. Terrs., 1873 (1874), p. 466. *H. stevensonii* Cope, Synopsis Vert., Colorado, p. 6. Ann. Report U. S. G. S., 1873 (1874), p. 467. *Miothen gracile*, Synopsis Vert., Col., 1873, p. 8. *Domnina gracilis* Cope, Ann. Report U. S. G. S., 1873 (1874), p. 470.

This is the smallest species of the genus known, and is readily distinguished from the *P. fugax* by other characters than its minute size. These are the uninterrupted series of premolars, which are without interspaces, and the greater acuteness and elevation of the cusp on the inner side of the posterior triangle.

The mental foramina are, as in *P. fugax*, below the first and fourth molars. The last inferior molar is as long or nearly as long as the penultimate, but has a rather narrower heel, always with three small cusps. The external anterior cusp is always much larger than the two internal, which are well apart, and not much elevated. In some specimens, as in *P. fugax*, there is a distinct third cusp on the posterior triangle, on its posterior inner border, but it is sometimes obsolete, and sometimes wanting. Hence the species, *P. stevensonii*, founded on this peculiarity, must be suppressed.

Measurements.

	M.
Length of dental series, omitting canine and Pm. 1 (No. 1)	.0072
Length of first true molar	.0013
Elevation of first true molar	.0010
Length of third true molar	.0013
Depth of ramus at third true molar	.0019
Length of last two molars	.0029
Length of third true molar	.0015
Elevation of third true molar	.0012
Depth of ramus at third true molar	.0020

I have portions of seven mandibular rami of this species, which were found at the same locality as the preceding species. It is dedicated to my friend Professor T. Sterry Hunt.

PERATHERIUM SCALARE Cope.

Herpetotherium scalare Cope. Synopsis New Vertebrata from Colorado, 1874, p. 7. Ann. Report U. S. G. Survey Terrs., 1873 (1874), p. 467.

Plate LXII; figs. 17–18.

This species is represented by portions of the mandibular rami of two individuals of the size of those of the *P. fugax*. These only support some of the posterior molar teeth.

The species is readily distinguished by the increased disparity in the elevations of the anterior and posterior portions of the molar teeth, resembling in this respect the *Peratherium alternans*. It is a considerably larger species than the latter, and exhibits a distinct anterior cusp, of moderate elevation, which is separated from the median external by a deep notch. It is entirely on the inner side, and sends a cingulum to the external base of the outer median. Fourth molar largest; heel narrowed, with three tubercles.

The masseteric fossa is well defined, and is bounded anteriorly by the strong external ridge of the base of the coronoid process. This ridge is

stronger, and the fossa extends further forwards than in any of the various specimens of *P. fugax* which display this region. There is no internal pterygoid fossa as in *P. alternans.*

Measurements.

	M.
Length of last three molars	.0060
Length of second true molar	.0020
Elevation of second true molar	.0022

From the same locality and horizon as the preceding species.

PERATHERIUM MARGINALE Cope.

Herpetotherium marginale Cope. Synopsis New Vertebrata, Colorado, 1873, p. 6. ***Embassis marginalis*** Cope, Ann. Report U. S. G. S. Terrs., 1873 (1874), p. 468.

Plate LXII, figs. 19–21.

This species has a more slender mandibular ramus than the *P. fugax*, but teeth of the same size, thus having the proportions of the *P. tricuspis.* The anterior triangle is more elevated than the posterior, and is not fissured on the inner side so as to distinguish the anterior and middle cusps, except at an elevated point. From the fissure between them a shallow groove descends inwards on the front of the tooth. The inner principal cusp is thus as large as the outer, and the triangle is transverse, or much broader than long. The species is also peculiar in the constitution of the posterior triangle or heel, which supports two elevated acute cones, which are sometimes curved forwards. The middle of the heel is concave. I at one time thought that the *P. marginale* was, with the *P. alternans*, worthy of generic separation, but so many intermediate conditions connect this form with that seen in *P. fugax*, that I no longer maintain this opinion.

There are four molars in the typical specimen, a part of the first being broken away. The last true molar is rather smaller than the others, and relatively smaller than in *P. fugax*, and is not narrowed posteriorly, supporting two opposite well-developed cusps instead of the three weak ones of the other species. It is crowded close to the base of the coronoid process, instead of standing well in front of it as in *P. huntii* and *P. fugax*, which gives the appearance of not being fully protruded, although its cusps have the same elevation as those of the other molars. The inferior border of the ramus rises strongly at this point, much more so than in the two species named, showing that the crowding of the fourth molar is not due to imma-

turity. It is broken off at the middle of the first molar, and does not display any mental foramen up to that point. A cingulum descends from the anterior and posterior cusps to the base of the median on the outer side. This species is about the size of *Domnina gradata*, and resembles it in the larger anterior teeth.

Measurements.

	M.
Length of last three molars	.0052
Length of third true molar	.0024
Elevation of third true molar	.0018
Depth of ramus at third true molar	.0023

Two other fragments of mandibular rami support teeth which have much the character of those of the present species as regards the form and proportions of the anterior triangle. The posterior triangle, however, is like that of some of the other species, with two low and little-developed cusps. One of the specimens includes the anterior base of the coronoid process, which does not rise abruptly as in the type. These specimens cannot be referred to the *P. marginale*, and they differ from the *P. alternans* in the anterior groove between the inner cusps of the anterior triangle.

PERATHERIUM ALTERNANS Cope.

Embassis alternans Cope. Synopsis New Vertebrata Colorado, 1873, p. 4. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 468.

Plate LXII, figs. 22–24.

Our knowledge of this marsupial rests on the posterior part of the right mandibular ramus supporting the last two molars of a single individual. All these parts present characters at variance with the species already described. The anterior triangle is much elevated above the heel, and appears at first sight to have but two cusps. The heel is low and concave, and has two low cusps, neither of which is crescentic. On these accounts I formerly referred this species to a genus distinct from the *P. fugax*, which I called *Embassis*. I believe, however, that the anterior cusp of the molars exists, although in a rudimental condition, and that present evidence does not warrant generic separation.

The last molar is distinctly smaller than the penultimate, and its heel is not narrowed, as in the typical species of this genus, but is truncate and supports two cusps. There is a cingulum on the outer side of the anterior triangle of both molars. The ridges at the base of the coronoid process are

stronger than in any other species. The masseteric fossa is deep, and is bounded in front by a prominent ridge which forms the external base of the coronoid process. The direction of this crest is nearly vertical, and its prominence throws the teeth to the inner side of the ramus. There is a strong horizontal ridge on the inner side of the base of the coronoid process, in line with the alveolar border, which rises posteriorly and incloses a shallow fossa with the prominent internal vertical edge of the base of the coronoid process. The last molar is situated more than half its length in front of the base of the coronoid process.

The teeth of this species are about the size of those of *P. fugax*. The depth of the mandibular ramus is unknown, as its inferior border is broken away. The *P. alternans* differs from all the species above described in the strong ridges of the coronoid region above described.

Measurements.

	M.
Length of two last molars	.0038
Width of third molar	.0020
Elevation of third molar	.0018

From the same locality and horizon as the other species of the genus.

BUNOTHERIA.

CREODONTA.

I refer provisionally to this order and suborder a few species which existed during the White River Epoch in North America. Two species of about the size of the Hedgehog were discovered in the bad lands of Southern Dakota by Dr. Hayden, and were described by Dr. Leidy as *Leptictis haydeni* and *Ictops dakotensis* in 1868.[1] A third species of about the same size, the *Mesodectes caniculus*, was discovered and described by myself in 1873, with several smaller species already referred to the genera *Peratherium* and *Domnina*. The three genera first named belong to a distinct division from those of the two genera last named, which is, perhaps, of ordinal value. But this remains uncertain on account of the incompleteness of the specimens on which they repose. The entire cranium, without mandible, of *Leptictis haydeni* is known, and part of the cranium with mandible, and part of the skeleton, of *Mesodectes caniculus* are in my possession.

[1] Extinct Mamm. Dakota and Nebraska, 1869, pp. 345–351.

MESODECTES Cope.

(Expl. Survs. W. of 100th Mer., Lt. G. M. Wheeler); April, 1875. Syst. Catal. Vert. Eocene, New Mexico, p. 30. *Isacis* Cope, Paleontological Bulletin (August, 1873) No. 16, p. 3. Bulletin U. S. Geol. Surv. Terrs., No. 1, 1874, p. 23. Ann. Rept. U. S. Geol. Surv., 1873 (1874), p. 470 (nom. præocc).

This genus embraces at present but a single species, which is known from numerous specimens discovered by the writer in the White River Miocene formation of Colorado. From these it appears that *Mesodectes* is closely allied to the *Leptictis* and *Ictops* of Leidy, occupying a position between these in the system. In *Leptictis* the last premolar is sectorial in form, consisting of a single compressed longitudinal crest, without internal tuberosity or cusp. In *Ictops* the last premolar exhibits a structure similar to that of the first true molar, viz, two exterior cusps and well-developed third on their inner side, thus giving a horizontal section of the tooth a subtriangular form. In *Mesodectes* the last premolar possesses a single acute cusp, as in *Leptictis*, with an internal cusp or heel homologous with that in *Ictops*. Such peculiarities are necessarily regarded as tangible definitions of generic groups, and are such in this case, although they separate species which have considerable resemblance in some other respects as far as known.

The *molars* of the superior series have two exterior compressed conic cusps and a stout subtriangular internal one. Behind the latter is a strong cingulum, supporting a rudimental cusp behind and within the principal one. Inferiorly there are three tubercular molars, of which the two anterior are composed of two elevated cross-crests, which form partial V's, opening to the inner side. The last premolar is larger than the true molars, and supports three anterior conic tubercles, the inner and outer equal, and a heel with a conic tubercle on the outer side. The number and character of the teeth in front of this one are unknown.

The posterior part of the *cranium* exhibits characters similar to those of *Leptictis*, but in the specimen the superior walls are wanting. The animal is not adult. The exoccipitals are distinct from the supraoccipital, displaying a wide, smooth sutural face. The mastoid is quite distinct, and is narrowed. Its superior portion enters into the posterior face of the skull, the union being formed by the posterior border of the squamosal. There are neither paroccipital nor mastoid processes, and the inferior extremity of the mas-

toid is grooved inwards and forwards to the inferior side of the skull. The *meatus auditorius* is wide, and has no inferior wall. There is an extensive petrous fossa inclosed between the exoccipital behind, the basisphenoid and basioccipital within, the alisphenoid in front, and the squamosal and mastoid externally. This is not overroofed on the inner side by a prolongation of the lateral border of the basisphenoid, as in *Erinaceus*. In the middle of the fossa is situated the petrous bone, which extends from the mastoid inwards and forwards to the adjacent parts of the basioccipital and basisphenoid. There is a well-marked postglenoid process, which is divided into two parts by a deep notch. The inner portion is directed obliquely somewhat forwards. Just inside of it a crest, probably the inferior border of the pterygoid process of the sphenoid, extends inwards and forwards, joining the longitudinal pterygoid. The latter terminates at the inner border of the large fossa above described. The squamosal bone has a remarkable extension behind the postglenoid process, and then rises into the oblique crest which forms the boundary of the inion. Longitudinal crests connect this with the superior extension of the postglenoid process, inclosing a fossa with a subsquamosal foramen, a postglenoid foramen between them. In this region this genus is identical with *Leptictis*, and resembles *Solenodon* more than any other living form. In that genus the mastoid is not larger, but is on the lateral instead of the posterior face of the skull. The inferior part of the squamosal in *Mystomys* also resembles considerably that of *Mesodectes*, but the mastoid is far larger, and the otic region is roofed by the basisphenoid wings. The squamosal is much shortened behind in *Erinaceus*, and there is no postglenoid process. The basioccipital and basisphenoid are continuous, as in *Solenodon*. The subsquamosal foramen is especially characteristic of the *Didelphidæ*.

The *cervical vertebræ* are short and transverse, and have well-developed lateral arterial foramina and diapophyses. The centra are depressed to a considerable degree, and are without hypapophyses. The neural arches are narrow, and without spines. The atlas is expanded, and has a very short diapophysis. The axis has a solid *processus odontoideus*. The dorsal vertebræ are smaller than the cervical in transverse diameter of the centrum, which somewhat exceeds the length; the articular faces are nearly plane.

The intervertebral foramina are quite large, and the narrow neurapophyses are almost entirely occupied by the bases of the diapophyses. These are well developed, obliquely truncate below at the end, and grooved on the under side of the shaft. The neural spines are elevated, narrow, and acute in front. The ribs are flat, and the capitular and articular faces are well developed.

The *præsternum* is shaped somewhat like the sternum of a bird. It has a prominent inferior longitudinal keel, which disappears posteriorly, leaving a vertically-oval face of articulation for the second sternal segment. The superior face is slightly concave, and the only lateral articular faces are those for the attachment of (?) first ribs, and are of considerable size, and are adjacent to the anterior extremity. The borders of the bone are but little contracted behind them. The scapula is elongate, and has an elevated crest, descending abruptly near the glenoid cavity. The latter is an elongate oval, the border at one end more produced than at the other, and terminating in a short hooked coracoid.

The *humerus* has a protuberant head and shaft, and condyles much flattened. The head is nearly 180° in arc, is posteriorly directed, and of compressed form. On the inner side is a depressed tuberosity for the pectoralis muscle, while opposite to it the greater tuberosity rises as high as the head, parallel to it. Distally, the condyles are continuous, nearly concave, and supplemented by huge inner and a smaller outer epicondyles. There is no supracondyloid foramen, but a strong arterial foramen.

The cast of almost the entire *brain* is preserved, and, as the parietal bones are wanting, the proportions are clearly traceable. The olfactory lobes are broken off. The superior face of the hemispheres and cerebellum together have a subquadrate outline, a little wider than long. The cerebellum is completely exposed behind the hemispheres, and is strongly angulate at its upper posterior border to fit the inion. The vermis is nearly as wide as each lateral lobe. The surface of the hemispheres is smooth, and the sylvian fissure distinctly indicated.

As compared with other forms, the following points may be observed: In *Chrysochloris* and *Centetes*, as above noted, the external cusps of the superior molars are wanting. In the genera in which they are present, as

Tupaia, *Talpa*, *Sorex*, &c., there are two of the middle series, as in *Peratherium*, and these add a strong internal lobe also. In *Erinaceus* and *Gymmora* they are quadrituberculate. The closest approximation is made by the genera *Mystomys* and *Solenodon*, the former African, the latter West Indian. In these the external cusps are present; there is but one well-developed median, and in the latter the internal is quite reduced. The molars of *Mesodectes* thus resemble most closely those of *Solenodon* (Brandt), but the external cusps are more developed than in that genus. Among the Eocene genera, the greatest resemblance is to be seen in the genus *Deltatherium*. The internal cusp of *Mesodectes* is connected with the external ones by oblique ridges, as in *Delthatherium;* and on one of these is a rudimental tubercle, representing an intermediate cusp. The dentition of the lower jaw is quite different in *Deltatherium* in the simple last premolar, and cutting last true molar.

In the lower series the form of the true molars is not unlike that of several diverse recent genera. It is quite unique in its large four or five cusped last premolar, which has some resemblance to a modified sectorial. The nearest approach to it which I can discover among recent genera is the Madagascar *Galeopithecus*.

In respect to the remainder of the skeleton, numerous characters distinguish it from the *Centetidæ* (which includes Solenodon) and the *Mystomyidæ*. Both of these lack the zygoma, which is present in *Septictidæ*, and have the nasals coössified, while they are distinct in these tertiary forms; *Mystomys*, further, lacks the clavicle. The presence of the zygoma without postorbital processes is a point of resemblance to *Erinaceus*, but the strongly keeled presternum and absence of cervical neural spines are found elsewhere in the *Talpidæ*. In the presence of the humeral arterial foramen, it again differs from *Erinaceus* and resembles other forms of the order.

Comparisons with the *Marsupialia* are chiefly to the *Didelphidæ*. The superior molars are much like those of *Didelphys*, the inner cusp of the third premolar being a point of difference not seen, however, in the allied *Leptictis*. The latter, according to Leidy, has only two superior incisors on each side, a wide divergence from the opossums. In the inferior molars the absence of the anterior inner cusp is a strong mark of distinction. The

presence of the subsquamosal foramen is on the other hand a marsupial character. The absence of any but rudimental neural spines of the cervical vertebræ is again an important difference from *Didelphys*.

The evidence is in favor of the *Leptictidæ*, as represented by *Mesodectes*, being a group of *Bunotheria*, and a member of the *Creodonta*, as defined by the form of the superior molar teeth.

MESODECTES CANICULUS Cope.

Isacis caniculus. Paleontological Bulletin No. 16, p. 3. Ann. Report U. S. Geol. Survey Terrs., 1873 (1874), p. 473.

Plate LXII; figs. 33-50.

This species is represented by portions of the skeletons of six individuals. All of these lack the anterior teeth of both jaws, while one includes mandibular teeth with vertebræ, ribs, humerus, scapula, presternum, a large part of the cranium, &c.

The basioccipital and sphenoid have straight lateral borders which are slightly decurved into a low ridge on each side. A low median ridge includes with these two a pair of longitudinal shallow fossæ, which fade out on the sphenoid bone. The occipital condyles are divergent, and with very small laterally-looking portion. The foramen magnum is largely transverse. The exoccipital does not extend far forwards, and the mastoid has a very short anteroposterior extent. A foramen issues from the base of the fossa inclosed by the longitudinal crests of the posterior part of the squamosal bone, and there are two other foramina above the superior of these crests. A small foramen pierces the same bone behind the inner extremity of the external half of the postglenoid process. A groove follows the free posterior edge of the squamosal, separating it from the mastoid. The petrous is somewhat rectangular in its sections, and its transverse diameter exceeds its anteroposterior. The inferior face is horizontal in the outer half, and looks forwards and inwards on its inner half.

The first rib is little compressed, and becomes very robust towards and at the distal extremity, where it is truncate for articulation with the præsternum. The extremity is oval in section.

The shaft of the humerus is somewhat curved, and the anterior com-

pressed crest does not project abruptly, but exhibits a muscular insertion some distance below the head.

The edges of the outer lobes of the first superior molar are acute; there is no external cingulum, but the diagonal crest from the median cusp passes to the posterior base of the posterior outer. There is a short but strong cingulum on the posterior base of the median lobe, which terminates in a small internal cusp. The rudimental anterior middle cusp is on the anterior diagonal ridge, which does not reach the base of the outer anterior cusp. The outer cusp of the last premolar is elongate and compressed; the inner cusp is small, acute, and opposite the posterior margin of the outer; enamel smooth. The anterior of the two prisms composing the inferior true molars is more elevated than the posterior. The crests of each form a V with the obtuse apex outward, and the anterior limb is shorter than the posterior. The last molar is a little smaller, and is produced behind by the addition of a small median lobe. In the last premolar, the conic cusps are well separated, and the inner one of the heel is insignificant. This tooth appears to have been the last one protruded; its temporary predecessor is distinguished by the obtuseness of the cusps, especially of the anterior one. Mandibular ramus deep, compressed, without inferior hook as far as opposite the basis of the coronoid process.

Measurements.

		M.
Length of sectorial and two tuberculars		0.0210
Length of sectorial alone		.0045
Width of sectorial		.0020
Width of first tubercular		.0030
Length of first tubercular		.0032
Depth of jaw at first tubercular		.0060
Width of skull behind		.026
Length from occipital condyle to postglenoid process		.013
Length of basioccipital		.006
Width of basioccipital medially		.005
Transverse extent of postglenoid process		.008
Length of two centra, third and fourth cervical vertebræ		.007
Transverse extent of fourth cervical between parapophyses		.012
Diameter of centrum behind	transverse	.006
	vertical	.003
Total elevation fourth cervical		.0066
Total length of axis		.007
Length of odontoid process		.0025
Diameter of atlas anteriorly	vertical	.0090
	transverse	.0140

		M.
Total transverse extent of atlas		.0165
Diameter centrum of anterior dorsal	longitudinal	.0040
	transverse	.0050
	vertical	.0028
Transverse extent with diapophyses		.0110
Total elevation (oblique)		.0130
Elevation of neural canal		.0028
Length of centra of four consecutive dorsal vertebræ, including spaces for intervertebral discs		.0190
Diameter of head of humerus	long	.0090
	short	.0075
Long diameter of shaft		.0045
Transverse diameter of distal extremity		.0110
Transverse diameter of distal condyles		.0070
Diameters of glenoid cavity of scapula	vertical	.0045
	transverse	.0065
Length of præsternum		.0150
Width of præsternum	anteriorly	.0110
	posteriorly	.0045
Greatest depth of præsternum		.0080

This species is about the size of the European hedge-hog. The remains representing it were found by myself at the same locality and horizon as the species of *Peratherium* above described.

GEOLABIS Cope.

This genus is established to receive a species which is represented by portions of two crania which are not accompanied by either superior or inferior molar teeth. It is very distinct from *Peratherium*, but whether identical with *Domnina* or not, it is not yet possible to state. The appearances are that the molar formula is 3–3, and the number of premolars is doubtless as stated, while that of the true molars remains uncertain. There is no canine tooth, and there are three incisors in each premaxillary. The formula will then be 3–0–3–3. The first superior incisor is larger than the others, and is strongly decurved. The first premolar follows a quite short diastema, is two-rooted, and has a simple compressed crown.

The absence of canine tooth and the enlarged first incisor distinguish this genus from *Talpa*, and constitute a resemblance to *Scalops*. In this genus there are four teeth instead of three, posterior to the incisors and anterior to the true molars, one of which may be fairly regarded as a canine.

GEOLABIS RHYNCHÆUS Cope.

Plate LXII; figs. 30–32.

The muzzle of this species is long and narrow, with vertical sides and convex superior surface, which is nearly straight in profile. The depth is a little greater than the width, and the extremity is rather abruptly truncated downwards and forwards. The nasal orifice is exclusively anterior. The nasal bones are narrow, but widen regularly posteriorly. The palate is moderately concave. The premaxillary bone presents a rather wide external face. The cranium expands just in front of the orbits, which are well defined in front and above by a rather flat wide frontal region.

The bases of the crowns of the incisors are subround. The second premolar is separated from the first by an interspace as wide as that between the first premolar and last incisor.

Measurements.

	M.
Length muzzle of No. 1 from front of orbit	0.0100
Depth at middle	.0030
Width at middle	.0028
Length external face of premaxillary bone	.0028
Width of No. 2 between anterior borders of orbits	.0070
Interorbital width of No. 2	.0060

The cranium of this species is rather smaller than that of the *Scalops aquaticus*. The species was first described, but not named, under the head of the genus *Domnina*, in the Annual Report of the U. S. Geol. Survey of the Terrs., 1873 (1874), p. 469.

INSECTIVORA.

MENOTHERIUM Cope.

Bulletin U. S. Geological Survey Terrs., I, January, 1874, p. 22. Annual Report U. S. Geolog. Surv. Terrs., 1873 (1874), p. 510.

This genus is possibly a remnant of the lemuroid group of the *Adapidæ*, so abundantly represented during the Eocene period; but as I only possess portions of two mandibular rami with dentition, a more exact determination will be looked for with interest. It is the first indication of the existence of lemurs in the Miocene formation of the United States.

There are at least two premolars and three molars in the inferior series;

those anterior being lost in the specimens. The last premolar is somewhat sectorial in form, having a compressed but stout median cusp, a broad heel behind, and a small tubercle in front. The last molar is rather smaller than the others, and with a slight posterior or fifth tubercle. The molars support four tubercles nearly opposite, in pairs, and connected by a diagonal crest, so that when the crown is worn an S-shaped figure results. The two alveoli in front of the last premolar may have contained each a separate tooth or a single tooth longer than any of the others. The form of the true molars is as in the Mesodont genera *Apheliscus*[1] and *Anaptomorphus*, and the simple fourth premolar is also that of the former genus.

MENOTHERIUM LEMURINUM Cope.

Locis citatis.

Plate LXVI; figs. 34–6.

The last premolar is longer than any of the molars. There are no cingula on the molars, but the transverse crest from one of the tubercles descends to the side of that opposite to it, along the end of the crown. Enamel smooth. Ramus of the jaw rather elongate.

Measurements.

	M.
Length of bases of six molars	0.0250
Length of bases of true molars	.0120
Length of basis of first true molar	.0040
Width of basis of first true molar	.0032
Length of basis of last premolar	.0052
Width of basis of last premolar	.0030
Depth of ramus at last premolar	.0090

The animal was about as large as the domestic cat.

CHIROPTERA.

The following genus is referred to this order with some hesitation. It is founded upon mandibular rami, which are identical, so far as they go, with the corresponding parts of certain bats, but the diagnostic parts are wanting. I originally referred the genus to the same group as *Peratherium*.

[1] Report Captain Wheeler IV, pt. ii.
[2] Hujus Operis., pt. i.

DOMNINA Cope

Paleontological Bulletin No. 16, p. 1, August, 1873. Ann. Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 469. ? *Miothen* Cope, Synopsis New Vert. Colorado, 1873, p. 5.

The evidence of the distinctness of this genus from *Peratherium* was originally seen in the position of the mental foramen, which is situated under the third inferior molar (counting from behind), instead of under the fourth. The deduction from this feature is that there is at least one molar tooth less in either the true or premolar series. Although a verification of this view has not yet been obtained from specimens which display the whole series, I confidently anticipate it. The true molars differ in their form from those of the species of *Peratherium*. Thus the posterior external cusp is a true crescent of the same form as the anterior one, but rather smaller. Both internal cusps are at the summits of strong subvertical ridges. The molars rapidly increase in size forwards, the third being little more than half as large as the first.

I associate with the typical species, *D. gradata*, a second one, which is represented by two mandibular rami in which the molar teeth are worn by use. They show that the posterior inner cusp had a crescentic base as in *D. gradata*, and that the last molar is even more reduced, being only half as large as the penultimate. The rami are both broken off posterior to the position of the mental foramen, so that its position cannot now be ascertained.

DOMNINA GRADATA Cope.

Paleontological Bulletin No. 16, p. 1, August, 1873. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 469.

Plate LXII; figs. 25–6.

Represented by the parts of the mandibular rami of two individuals which support the three last molars. These show that the anterior base of the coronoid process is wide and oblique, and that both its external and internal borders are prominent. The line of the inner alveolar border is continued as a ridge, which projects beyond the inner face of the ramus below it.

The inner cusps of the molars are much smaller than the external cusps, and the median is larger than the anterior or posterior. The anterior is little prominent, is well in advance of the median, and is separated to the base on the inner side. There is no fourth cusp or heel of the inner side of

the crown. The heel of the last molar is very small, and consists of only one obtuse cusp. The oblique anterior borders of the two triangles are sectorial in their character. There is a low cingulum on the external base of the crown, which bridges the interval between the lobes.

As compared with the *Peratherium fugax*, with which this species agrees in size, it differs, besides the generic characters, in the relatively larger anterior molar teeth and shallow ramus.

Measurements.

	M.
Length of last three true molars	.0060
Length of first true molar	.0024
Width of first true molar	.0013
Depth of ramus at first true molar	.0025
Length of last molar	.0016

From the same locality as the species above described.

DOMNINA CRASSIGENIS Cope.

Annual Report U. S. Geol. Survey Terrs., 1873 (1874), p. 470. *Miothen crassigenis* Cope, Synopsis New Vertebrata Colorado, 1873, p. 8.

Plate LXII; figs. 27–9.

This species is known from the posterior portion of a pair of mandibular rami of opposite sides, which look as though they might have belonged to the same individual. These show that the external border of the base of the coronoid process is prominent, but the inferior border is not, as in *Peratherium huntii*, well defined. The inner face of the rami is very flat, without the horizontal ridge behind the dental series seen in *Domnina gradata*, nor the internal pterygoid fossa of the *Peratherium alternans*. The inner face of the ramus towards the angle is gently concave. The external face of the ramus at the last two molars is convex. The last molar is only as large as the posterior triangle of the penultimate molar, and its anterior triangle is not larger than the heel. The two triangles of the penultimate are equal, and their section is strongly convex on the external side.

Measurements.

	M.
Length of last two molars	.0032
Width of penultimate molar	.0014
Length of last molar	.0012
Depth of ramus at penultimate molar	.0030

From the same locality and horizon as the preceding species.

RODENTIA.

Members of this order were very abundant during the White River and Truckee epochs in North America. They are referable to thirty-one species and eight genera. Of these genera three still exist in the regions where their fossil remains are found. These are *Sciurus*, *Hesperomys*, and *Lepus*. All of them occur in the Truckee beds, while the first named only has been found in the White River formation. All of the species belong to the three great divisions of the order which now inhabit North America, while the fourth, the *Hystricomorpha*, which is very sparingly represented on the continent, has not yet been detected in the formations in question. It appears in a single species of porcupine in the Loup Fork beds.

The four primary divisions of the order *Rodentia* are thus defined, principally after Brandt and Alston:

I. Incisor teeth $\frac{2}{2}$. Fibula not articulating with the superior condyle of the calcaneum. No intertrochlear crest of humerus.
   1. Mandible with the angular portion springing from the outer side of the bony covering of the lower incisor. Fibula distinct from tibia. "Malar bone not supported below by a continuation of the maxillary zygomatic process." An interpterygoid fissure ..... *Hystricomorpha.*
   2. Mandible with the angle in the plane of or springing from the inferior edge of the covering of the alveolus of the inferior incisor, more or less rounded; coronoid process high, falcate. Fibula distinct from tibia. No interpterygoid fissure ..... *Sciuromorpha.*
   3. Mandible with the angular portion springing from the inferior edge of the sheath of the inferior incisor (except *Bathyerginæ*). Fibula coössified with the tibia. Malar short, usually supported on a maxillary process. No interpterygoid fissure (except in *Bathyerginæ*) ..... *Myomorpha.*

II. Incisor teeth $\frac{4}{2}$. Fibula articulating with the condyle of the calcaneum.
   4. No true alisphenoid canal; fibula ankylosed to tibia below; angle of mandible in the plane of the incisive alveolus. An intertrochlear crest of humerus. *Lagomorpha.*

These groups, as is well known, include families and genera which display adaptations to various modes of life. Some are exclusively subterranean, others are arboreal, and some live on the surface of the ground. Of the latter, some are provided with formidable spines as a protection against enemies, while others depend for their safety on their speed. Of the latter character are the *Leporidæ* of the *Lagomorpha*, and I have noted how that they have superadded to the ordinary rodent structure certain points which

also characterize the most specialized *Perissodactyla* and *Artiodactyla* among ungulates. The fusion of the inferior part of the fibula with the tibia (found also in the *Myomorpha*) belongs to the higher types of these orders. The strong intertrochlear ridge of the humerus is an especial feature of the groups mentioned, distinguishing them from the lower types in all the orders. The articulation of the fibula with the calcaneum, mentioned by Mr. Alston, is a character of the *Artiodactyla*. Associated with these is the elongation of the bones of the limbs, especially the posterior one. The modification of the tarsus in *Dipus* (the jerboas) evidently has a direct relation to the projectile force transmitted through the hind legs in rapid progression by leaping. Here the metatarsals are coössified into a cannon bone, though, as there are three bones involved, the result is somewhat different from the cannon bone of the *Ruminantia*.*

The species of the American Miocenes, including Loup Fork formation, are distributed as follows:

	White River.	John Day.	Loup Fork.
HYSTRICOMORPHA.			
Hystricidæ.			
Hystricops, Leidy	.....	.....	1
SCIUROMORPHA.			
Mylagaulidæ.			
Mylagaulus, Cope	.....	.....	2
Fam.?			
Heliscomys, Cope	1	.....	.....
Castoridæ.			
Eucastor, Leidy	.....	.....	1
Castor, L	1	2	1
Ischyromyidæ.			
Ischyromys, Leidy	1	.....	.....
Sciuridæ.			
Meniscomys, Cope	.....	4	.....
Gymnoptychus, Cope	2	.....	.....
Sciurus, Linn	1	2	1

*On the significance of these characters, see Bulletin U. S. Geolog. Surv. Terrs., 1881, p. 361, and American Naturalist, 1883, pp. 44-380.

	White River.	John Day.	Loup Fork.
MYOMORPHA.			
Muridæ.			
Eumys, Leidy	1		
Hesperomys, Waterh		1	1
Paciculus, Cope		2	
Geomyidæ.			
Pleurolicus, Cope		3	
Entoptychus, Cope		5	
LAGOMORPHA.			
Leporidæ.			
Palæolagus, Leidy	3	1	1
Panolax, Cope			1
Lepus, Linn		1	

The Rodentia, like other divisions of Mammalia, present a succession of changes of structure in time, in the feet and in the teeth. The earliest known forms, as I have pointed out, are the allies of the squirrels, members of the suborder Sciuromorpha. These have the most generalized foot structure because; first, the trochlear structures of the humerus and tibia are not at all or but little developed; second, because they have five digits on the feet, and are plantigrade; and third, because the fibula is not coössified with the tibia. They are similarly primitive in the forms of the teeth, because they are rarely prismatic, and nearly always have long roots and short crowns. The cavy division, or suborder Hystricomorpha, must claim the next place, but many of its members show a decided advance in having a limited number of toes, and prismatic dentition. In the third suborder, Myomorpha (the mice, etc.), we first meet with the coössification of the fibula with the tibia. A good many genera have prismatic teeth, and some of them a restricted number of digits; and a few of them (the jerboas) even metatarsal bones coösified into a cannon bone. The rabbits have the most specialized characters in all the points mentioned, but they add another character which is most primitive, viz, the presence of four superior incisor teeth. This is probably a remnant of the primitive group from which all the Rodentia have been derived. By the law of homologous groups it is not probable that the divisions of Rodentia were descended from each other, but from corresponding groups of the primary order from which they were

derived as a whole. This division may have been the suborder Tillodonta of the Eocenes, or the Rodentia may be the descendants of the Marsupialia with or without the intervention of that group.

The differentiation of the suborders of the Rodentia evidently dates from a period at least as early as the lowest Miocene. It is an important fact that the Lower Eocene (Wasatch epoch) has as yet produced nothing but the lowest type (Sciuromorpha). It is also true that the Puerco Eocene epoch has, in sixty species of Mammalia, disclosed no Rodentia at all, while Tillodonta and Tæniodonta are abundant.

The Myomorpha first appear in the White River beds (Oligocene), but none with prismatic teeth occur below the John Day epoch. The Lagomorpha, on the other hand, present us with almost all their special characters at once, in the White River. The Hystricomorpha, whose home is in South America, are unknown in North America below the Loup Fork or highest Miocene, where Leidy identified a true porcupine, *Hystricops venustus.**

Many of the above genera stand in evident genetic connection with existing forms. The Miocene Castors doubtless include the ancestor of the modern beaver. The *Ischyromys* is a primitive type of the *Sciuridæ*, and *Gymnoptychus* connects it directly with the existing forms by the character of its molar teeth. *Eumys* is the primitive form of *Hesperomys*, as *Paciculus* is of *Sigmodon*. *Entoptychus* and *Pleurolicus* are the near ancestors of the *Geomyidæ* of the Pliocene and present periods. *Palæolagus*, *Panolax*, and *Lepus* form a direct genetic line. The ancient genera all differ from their modern representatives in the same way; that is, in the greater constriction of the skull just posterior to the orbits, and accompanying absence of postorbital processes. This relation may be displayed in tabular form as follows:

Skull wider behind orbits.		Skull narrower behind orbits.	
Postorbital processes.	No postorbital processes.	Postorbital processes.	No postorbital processes.
.....	Castor fiber	.....	Castor peninsulatus
Sciurus	.....	.....	Ischyromys
.....	Hesperomys	.....	Eumys
Lepus	.....	.....	Palæolagus

* See American Naturalist 1883, p. 380, where these conclusions are presented.

None of this species of this fauna are of larger size than their modern representatives. In the cases of the beaver, squirrels, and rabbits, the ancient species are the smaller.

SCIUROMORPHA.

SCIURUS Linn.

In this genus the molars are $\frac{5}{4}$ or $\frac{4}{4}$, the first superior small when present. The grinding surfaces of the crowns when unworn present in the superior series a single internal cusp, which is low and anteroposterior. From this there extend to the external border of the crown two low transverse ridges, whose exterior terminations are somewhat enlarged. In the lower jaw the transverse ridges are not visible, and there is a low tubercle at each angle of the crown, between which there may be others on the border of the crown. Attrition gives the grinding surface of the latter a basin-like character. The *foramen infraorbitale* is a short, narrow fissure, situated in the inferior part of the maxillary bone in front of its tooth-bearing portion, but descending nearly to the level of the alveolar border.

The well-known characters of this genus are found in the mandibles of species which I obtained from the White River Miocene beds of Colorado and Oregon. The teeth display the subquadrate form of this genus, without any tendency to the transverse enlargement seen in *Arctomys*, *Cynomys*, and *Spermophilus*. Two of the species, *S. vortmani* and *S. relictus*, are as large as our gray and red squirrels, respectively, and the third, *S. ballovianus*, is about the size of the *Tamias quadrivittatus*.

SCIURUS VORTMANI Cope.

Paleontological Bulletin No. 31, p. 1, December 24, 1879. Proceed. Amer. Philos. Soc., 1879, p. 370. Plate LXIII; fig. 4.

Like the *S. relictus* of the Colorado White River beds, this is a rare species, being only represented by a mandibular ramus in my collection. This part is remarkable for its depth as compared with its length, and the base of the coronoid process has an anterior position. It rises opposite the posterior part of the third molar, and its anterior border descends to a point just below the posterior part of the first molar. The inferior border of the

masseteric fossa is a prominent edge, which descends below the inner inferior margin of the ramus. The molars diminish regularly in size forwards. Their crowns are basin-shaped, with the anterior angle of the external border elevated, and the inner border notched medially. Incisor compressed.

Length of inferior molar series, .010; anteroposterior diameter of first molar, .0024; length of fourth molar, .003; depth of ramus at diastema, .0055; depth at third molar, .0095.

This species is considerably larger than the *S. relictus*. It is dedicated to Jacob L. Wortman, of Eugene, Oregon, who found the typical specimen in the John Day Miocene deposit of that State.

SCIURUS RELICTUS.

Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 475. *Paramys relictus* Cope; Synopsis New Vertebrata Colorado, October, 1875, p. 3.

Plate LXV; fig. 35.

This species was established on two mandibular rami, with all the teeth complete. It was referred to the genus *Paramys*, because I found no difference between the corresponding parts of the respective species; but as the characters of the latter are chiefly observable in the maxillary teeth, the reference was not final.

The ramus is quite robust, and has the general proportions of that of *S. hudsonius*. The diastema is much shorter than the tooth-line, and the foramen mentale is situated below its middle, a little above half way between the inferior and superior borders of the ramus. The masseteric fossa has an angular termination below the posterior border of the second molar. The ascending ramus begins opposite the posterior border of the third molar. The symphysis is not abruptly recurved, but commences in a gentle ascent of the inferior border to the incisive alveolus. The latter issues lower down than in the species of *Eumys* and *Heliscomys* described in this volume.

The inferior incisor tooth is less curved than in the species of the genera above named, and is not so much compressed. Its section is subtriangular, with the anteroposterior diameter a little greater than the transverse in front. The anterior face is gently and equally convex in trans-

verse section, and the enamel is perfectly smooth. The inner angle is sharp, and the enamel does not pass it, but the external angle is rounded, and the enamel covers it, narrowly overlapping the side of the tooth.

The molars exhibit the basin-shaped character, with the tubercles marginal, as usual in *Sciurus*. They increase regularly in size from the front backward. The transverse crests are marginal, and terminate in cusps at the inner extremity, which are separated by a lower acute median cusp.

A longitudinal crest connects the crests just within their outer extremities; it exhibits a loop directed outward. A low ridge passes from the posterior outer butress, just in front of the posterior margin, in the last two molars. Anterior cusps of first molar contiguous.

Measurements.

	M.
Length of ramus to end of M. 4	.0120
Length of molars	.0088
Length of third molar	.0015
Width of third molar	.0018
Depth of ramus at third molar	.0050
Width of incisor	.0015

As compared with the corresponding part of the *Sciurus hudsonius*, the best preserved ramus of this species differs in the more robust incisor teeth, in the less anterior extension of the masseteric fossa, and in the rather smaller size.

SCIURUS BALLOVIANUS Cope.

Bulletin U. S. Gelog. Surv. Terrs., VI, 177, February 11, 1881.
Plate LXIII; figs. 5–6.

This squirrel is the second species of its genus supposed to occur in the John Day beds of Oregon, and the third *Sciurus* obtained thus far from the Lower Miocene or Oligocene of the West. The typical specimen fortunately includes the cranium, with both rami of the mandible, so that its reference to the genus *Sciurus* rather than to *Gymnoptychus* is assured. Like the latter genus, the infraorbital foramen is reduced to a slit, but, unlike it, there is but one internal tubercle of the crowns of the superior molars instead of two.

The skull is flat above, and the interorbital space is also flat, and is remarkably wide. Temporal ridges none. Muzzle short and narrow. Palate wide, its posterior notch extending as far forwards as the last supe-

rior molar. The ascending ramus of the mandible originates opposite the anterior part of the last inferior molar. The masseteric fossa extends to opposite the anterior border of the second inferior molar. The mental foramen is near the superior border of the posterior part of the diastema. The second and third superior molars, the only ones preserved, have two cross-crests and a strong anterior cingulum. The external extremities of the cross-crests are little elevated, and there are no other cingula. The inferior molars have basin-shaped grinding faces, with a lobe at each angle. There is a small tubercle between the lobes of the inner and outer pairs. The incisors of both jaws are much compressed, strongly convex in front, and, in the lower jaw at least, without sculpture.

Measurements.

	M.
Length of skull to orbit	.0090
Width between orbits	.0090
Width of muzzle	.0047
Width between last molars	.0040
Length of superior dental series	.0054
Diameters of second molar { anteroposterior	.0015
Diameters of second molar { transverse	.0016
Width of superior incisor	.0013
Length of mandibular ramus	.0150
Elevation of ramus at coronoid	.0080
Length of diastema	.0030
Length of inferior dental series	.0070
Depth of ramus at second molar	.0045

This species is much smaller than the *Sciurus vortmani*, from the same horizon of Oregon. The type specimen was discovered by Mr. L. S. Davis, of Mr. Wortman's party. The name is given in honor of Mr. M. H. Ballou, of Chicago, a naturalist and journalist.

GYMNOPTYCHUS Cope.

Paleontological Bulletin No. 16, p. 5 (August 20, 1873). Ann. Report U. S. Geolog. Surv. Terrs., 1873 (1874), p. 476.

Dental formula: I. $\frac{1}{1}$; C. $\frac{0}{0}$; M. $\frac{4}{4}$. Crowns of the superior molars supporting two crescents on the inner side, and two cusps on the external side opposite to them. Each cusp sends a transverse crest to the concavity of the corresponding crescent. The adjacent horns of the crescents are united,

and the connecting portion sends a transverse crest into the interval between the cusps. The opposed horns of the two crescents each send a crest round the anterior and posterior sides of the crown, of which they form the borders. Incisors simple. The walls of the alveolus of the inferior incisor produced into a tuberosity on the external side of the base of the ascending ramus.

The above characters define a genus which, when fully known, will in all probability be referred to near the existing genus *Sciurus*. In confirmation of this opinion, I add that the alveolar sheath of the interior incisor is in the vertical plane of the ramus; the incisive foramen does not invade the maxillary bones, and the *foramen infraorbitale exterius* is a small fissure situated in the inferior portion of the maxillary bone, well in advance of both the orbit and first molar tooth.

As compared with the existing genera, it differs in the structure of the molar teeth. The arrangement of the tubercles and crests is more complex than in any of them, excepting *Pteromys*. Thus in all of them there is but one internal crescent of the superior molars, and but two or three cross-crests; while in the inferior molars the arrangement is unlike that of the superior teeth, the cross-crests being marginal only. In *Pteromys* (F. Cuv.) the transverse valleys of the inferior series of *Gymnoptychus* are represented by numerous isolated fossettes. The structure of the molars in the fossil genus is exactly like that which I have described as found in *Eumys*, extending even to the details. This is curious, as that genus is a Myomorph.

The protrusion of the posterior extremity of the alveolar sheath of the inferior incisor on the outer side of the ascending ramus is not exhibited by the North American *Sciuridæ*, which I have examined, nor by any of the extinct genera herein described, excepting *Castor* and the *Geomyidæ*. It is seen in a lesser degree in *Mus musculus*, *Hesperomys leucopus*, *Meriones hudsonius*, and *Arvicola riparia*—all *Muridæ*.

Whether this genus possesses a postfrontal process I have been unable to ascertain. Its absence would not in my opinion isolate it from the *Sciuridæ*, as I accord with Dr. Coues in his estimate of the value to be attached to this character.

Of other portions of the skeleton I possess incomplete humerus, ischium,

femur, and tibia. Most of these are appropriate in size to the *G. minutus*, which is also the most abundant species. A fragment of a larger femur belongs perhaps to the *G. trilophus*.

The *humerus* is rather slender, and the deltoid crest does not exhibit the prominence so usual in the *Muridæ*. It is most prominent on the antero-external aspect of the shaft near its middle; an external as well as an anterior ridge diverges from it upwards. The condyles have no intertrochlear ridge, and the external trochlea is not more extended transversely than the internal, measuring from the fundus of the groove. There is a moderate internal epicondyle, and the arterial foramen is distal, and opens anteriorly below and on the external face above. The bridge is slender and moderately oblique. The external border is acute and twisted.

The *ischium* is characterized, like that of other *Sciuridæ*, by the presence of a spine or process which is wanting in North American *Muridæ*, but is present in *Perognathus*. The bone is rather short, the tuberosity is but little enlarged, and the pubic process not very wide. The proximal end of a *femur* may belong to *Eumys elegans*, but is too small according to usual data. The great trochanter is elevated as high as the head, from which a deep notch separates it; its posterior fossa is pronounced. The little trochanter is very prominent, projecting at right angles to the shaft. The shaft is broken, so that the presence of a third trochanter cannot be ascertained. The distal end of the femur is characterized by a patellar groove of moderate width, with fairly elevated ridges which are continued well posteriorly on the shaft, but not further than in existing *Sciuridæ*, and not so far as in *Palæolagus*. The distal extremity of the *tibia* displays characters of the *Sciuridæ* as distinguished from those of *Muridæ* and *Leporidæ*. The fibula is of course distinct, and the external trochlear groove opens from its fundus outwards. The internal groove is narrower, and is bounded internally by a vertical malleolus, which has no distal articular facets, and which does not project, but is flat on the inner side. The greater part of the posterior face is occupied by the bones of the wide groove for the tendon of the *flexor longus pollicis* muscle. Its inferior edge is produced downwards as far as the malleolus, from which it is separated by the deep groove for the *tibialis posticus* and *flexor longus digitorum* muscles. This

groove is marked on the inner side of the distal portion of the shaft, its anterior border being especially well defined.

Two species of this genus are certainly known. They belong to the White River horizon of Colorado. They differ, so far as known, chiefly in size, and in the proportions of the inferior premolar tooth.

GYMNOPTYCHUS MINUTUS Cope.

Paleontological Bulletin No. 16, p. 6 (August 20, 1873). Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 476.

Plate LXV; figs. 19–30.

This species is about the size of the *Dipodomys philipsi*, and was abundant during the White River epoch in Western North America. The specimens which I obtained in Colorado represent twenty or more individuals. Among them are portions of four crania. One of these presents characters somewhat different from those seen in the best preserved of the others, and may belong to another species of the genus. To this supposed species I formerly gave the name of *Gymnoptychus nasutus*.

The *Gymnoptychus minutus* was originally described from mandibular rami. The cranial fragment which agrees with these in the size of its teeth is the portion anterior to the middle of the orbit, and lacks the greater part of the nasal bones. The maxillo-premaxillary suture is quite sinuous in its inferior portions, and passes in front of the infraorbital foramen, measuring one-fourth the distance from the latter to the inferior border of the incisive alveolus, or about two-fifths the distance from the last-named point to the first molar tooth. The incisive foramina extend chiefly in advance of this suture, notching the maxillary bone a little. A shallow groove entends posteriorly from each incisive foramen along the palate as far as the palatine foramina, becoming shallower posteriorly. The tuberosity behind the inferior extremity of the infraorbital foramen, usual in the *Sciuridæ*, is here represented by a scar, with an inferior angular border. A shallow and wide fossa occupies the entire side of the maxillary bone above the infraorbital foramen and behind the premaxillary suture. The side of the premaxillary anterior to the suture is also shallowly concave. The maxillary is also slightly concave in front of the inferior base of the zyomatic arch The base of the latter has considerable vertical extent, but the arch is not

preserved in any of my specimens. The premaxillary bone is continued upwards and backwards to the frontal, ceasing with the posterior extremity of the nasal. Of the superior maxillary teeth the first and third are equal, while the second is a little larger. The fourth has about three-fourths the linear dimensions of the third. The outlines of all are, in horizontal section, quadrate with rounded angles. The incisors are much compressed, and the anterior face of each is strongly and equally convex. The inner angle is pronounced, while the external is rounded. The enamel is smooth, without groove or keel, and does not lap over on the inner side. It extends a short distance on the inner side, forming a narrow band.

The mandibular ramus is of rather slender proportions, much as in *Hesperomys leucopus*. The symphyseal portion leaves the inferior border at an angle of 135°, not being continuous as in *Sciurus relictus*, nor so steep as in *Eumys elegans*. The inferior border is nearly straight, with a slight contraction below the last molar. The grinding surfaces of the molars form a plane which rises a little forwards. The pterygoid fossa is deep, and is bounded below by a thickened continuation of the inferior border. The ascending ramus commences opposite to the posterior end of the third molar, and its anterior border is quite oblique. The coronoid process is a rounded laminar projection, and is quite low. A groove separates its base and that of the condylar portion from the tuberosity which contains the papilla of the inferior incisor tooth. The masseteric fossa is well defined by borders, which are not prominent, and which unite in an acute angle below the middle of the first molar, above the middle of the side of the ramus. The *foramen mentale* is opposite the middle of the diastema and close to the superior plane.

The inferior incisor is compressed like the corresponding superior tooth. The front is symmetrically convex, but rounds into the outer side, while it is separated from the inner by an angle. The enamel does not fold on to the inner side, but covers about one-third of the outer side, as seen in profile view. A feature of this tooth, where it differs from the corresponding one of the upper jaw, is seen along the line where the anterior passes into the external surface. Here is a delicate groove, which is bounded on the outer side by an equally delicate thread-like ridge. In some specimens a

still more delicate groove extends along at the front of the inner angle. The second and third molars are subequal; the last molar is a little smaller, while the first is a little smaller than the fourth. All are subquadrate in horizontal outline, but the first is narrowed in front. The composition of the molars has already been described. It remains to add that the posterior cross-crest is absent from the fourth molar, and the anterior one from the first molar. There are no basal cingula on the internal or external sides of the crowns. The direction of the dental series is moderately oblique to that of the axis of the ramus, and the posterior alveolar walls do not project very far either posteriorly nor inwards. The interior face of the ramus below the last molar is quite concave. The surface of the bone of the inferior surface is sparsely punctate.

The head of the *femur*, ascribed to this species with doubt, is perfectly round in vertical section, and is not prolonged transversely. The *fossa ligamenti teris* is submedian and isolated. The neck is constricted. There is a faint rectangular connection between the posterior ridges of the great and little trochanters. The femoral condyles are well separated, and the shaft is flat above them on the posterior face. The ridge forming one of the borders of the patellar groove is continued on the shaft as a rounded angle.

The distal portion of the shaft of the *tibia* has three sides, viz, a posterior flat side, an antero-external flat side, and a rounded antero-internal side. The fibular face forms another rather elongate facet. The process which carries the tendon of the *flexor longus pollicis* is acute below, and carries an anteriorly-directed crest on the inner edge of the groove, which sinks into an angle of the shaft. The posterior border of the astragaline face of the tibia is truncate. The two trochlear grooves are separated by a wide ridge.

Measurements.

		M.
Length of mandibular ramus from incisive alveolus to dental foramen		.0110
Length from same to end of last molar		.0090
Length from same to first molar		.0040
Depth of inner face of ramus at diastema		.0030
Depth of inner face of ramus at first molar		.0036
Depth of inner face of ramus at last molar		.0032
Depth of inner face of ramus at coronoid process		.0052
Diameter of incisor	anteroposterior	.0012
	transverse	.0009
Diameter second molar	anteroposterior	.0012
	transverse	.0012
Length of superior molar series		.0043

	M.
Length of superior diastema	.0070
Length from premolar to infraorbital foramen	.0029
Depth of cranium at front of orbit	.0065
Width of cranium at front of orbit	.0084
Width of palate between premolars	.0030
Width of palate between infraorbital foramina	.0040
Width of top of muzzle above the same	.0042
Length of incisive foramina	.0028

The cranial fragment on which the *G. nasutus* was founded differs from that above described in a somewhat greater compression of the muzzle and greater prominence of the tuberosity behind the inferior part of the *foramen infraorbitale exterius.* This tuberosity is well marked, while in the muzzle of the *G. minutus* it is merely indicated. The enamel of the incisors is of a bright bay color; it is pale waxen in all those of *G. minutus.* The nasal bones are preserved; they are distinct, and were continued beyond the line of the anterior border of the incisors. They are convex anteriorly and very shallowly concave behind. They extend a little further posteriorly than the extremities of the premaxillary bones

Measurements.

	M.
Length of superior diastema	.0078
Length from premolar to infraorbital foramen	.0035
Depth of cranium at front of orbit	.0065
Depth of palate between premolars	.0030
Depth of palate between infraorbital foramina	.0032
Width of top of muzzle above same	.0041
Length of incisive foramina	.0028

Measurements of bones.

		M.
Length of humerus below deltoid angle		.0110
Diameter of shaft above the same	anteroposterior	.0024
	transverse	.0020
Diameter of distal extremity	anteroposterior	.0020
	transverse	.0045
Length of ischium from acetabulum		.0070
Width of distal extremity		.0025
Anteroposterior diameter of acetabulum		.0025
Width of proximal end of femur at head		.0050
Width at little trochanter		.0040
Diameters of shaft from below middle	fore and aft	.0018
	transverse	.0020
Diameters of distal end femur	anteroposterior	.0038
	transverse	.0035
Diameters of distal end of tibia	anteroposterior*	.0035
	transverse	.0030

* This includes the crest of the *sulcus tendinis flexor is longi pollicis.*

GYMNOPTYCHUS TRILOPHUS Cope.

Paleontological Bulletin No. 16, p. 6 (August 20, 1873). Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 476.

Plate LXV; figs. 31–34.

This squirrel is represented by mandibles only of a small number of individuals, although very similar to the species last described in most details it is constantly of larger size, and I have seen no individual proportioned so as to be intermediate between them.

Three of the inferior molars of this species have the same longitudinal extent as the four, or entire series of the *G. minutus*. The detailed structure of the molars is the same as in that species. Attrition very soon causes the union of the exterior cross-crests with those which proceed from the cusps, producing as a result only three transverse yokes, and a figure something like the Greek ω. The delicate groove of the inferior incisor, and the posterior protuberance of its sheath, are as in *G. minutus;* so also the form of the masseteric fossa, the position of the mental foramen, etc. The premolar is relatively a little more elongate than in the *G. minutus*, but its details are the same. The diastema is relatively shorter.

Measurements.

		M.
Length of inferior molar series		.0065
Length of inferior diastema		.0045
Depth of inner face of ramus at diastema		.0035
Depth of inner face of ramus at first molar		.0040
Depth of inner face of ramus at last molar		.0035
Depth of inner face of ramus at coronoid process		.0052
Diameter of inferior incisor	anteroposterior	.0015
	transverse	.0010
Diameter of second molar	anteroposterior	.0014
	transverse	.0015

I discovered this species in the same locality as the *G. minutus*.

MENISCOMYS Cope.

Paleontological Bulletin No. 30, p. 5, December 3, 1878. Proceed. Amer. Philos. Soc., 1878 (1879), p. 67.

The characters of this genus are derived from the dentition of both jaws, and from portions of the cranium which are preserved. The molars are rooted, and number $\frac{5}{4}$ or $\frac{2}{1}$ $\frac{3}{3}$. Those of the superior series are without enamel inflections, and the triturating surface exhibits two external

and one internal crescentic sections of the investing enamel. On the second superior molar there are three external crescents, and the first molar is simply conic. Between the inner and external crescents there are the curved edges of enamel plates directed obliquely and transversely. The grinding surfaces of the inferior molars display, in the unworn condition, curved transverse crests, connected longitudinally on the median line; on wearing, the lateral emarginations of the enamel become shallower, disappearing from the inner side, but remaining on the outer. Incisor teeth not grooved. *Foramen infraorbitale anterius* small, inferior, and near the orbit. Postorbital processes; no sagittal crest.

The characters of the dentition of this genus resemble those of the genus *Pteromys*, which is now confined to Asia and the Malaysian Archipelago. The superior molars differ from those of *Pteromys* in wanting all reëntrant enamel inflection.

The general characters of the skeleton are unknown. A femur is rather slender, and a tibia rather elongate, showing that the limbs are not short.

Four species of this genus are known to me, all from the Truckee Miocene of Oregon. They differ considerably in the details of the structure of the molar teeth. Their more prominent characters may be set forth as follows:

I. Superior molars short-rooted, with the external face plane; inferior molars with a prominent median transverse crest.

Smaller; dental crests fewer, simple, not crenate..... *M. hippodus.*

II. Superior molars long-rooted; external face of crowns inflected, forming two V's; no median transverse crest on inferior molars.

***a.* Crests of superior molars fewer, simple, not crenate.**

Larger; crowns short..... *M. liolophus.*

***aa.* Crests of superior molars more numerous and much crenate.**

Smaller; plications of inferior molars shallow; borders raised..... *M. cavatus.*

Larger; plications of inferior molars profound..... ..... *M. nitens.*

There is a suggestive resemblance between the forms of the molar teeth of the *Meniscomys hippodus* and those of the *Haplodontia rufa* now living in Oregon. The two genera have doubtless had a common origin, but the present differences are considerable. Thus, the *Haplodontia* has an extended osseous cavum tympani which does not exist in *Meniscomys*.

This genus appears to be referable to the *Sciuridæ*.

MENISCOMYS HIPPODUS Cope.

Paleontological Bulletin, No. 30, p. 5, December 3, 1878. Proceedings Amer. Philos. Soc. 1878 ('79), p. 67, Plate LXIII; figs. 7-10.

Superior molars with a vertical ridge from the points of junction of the crescents on the external side; there are thus two on the second molar, and one each on the third and fourth. Within each of the external crescents is another crescentic edge of a pair of vertical enamel plates, and the inner marginal crescent sends off a short transverse branch towards them. With attrition, all these crests unite by their extremities, inclosing four distinct lakes, which, after still further wear, disappear. The crowns of the inferior molars, in the unworn condition, terminate in two crescents; that is, in elevated anterior, external, and posterior borders, with a transverse ridge equally dividing the space thus marked out and joining the notch in the external crest. This pattern resembles somewhat that of *Anchitherium*. The first inferior molar differs from the others in its superior size, and in its having the crescents more widely separated by a deeper external emargination. On attrition, the spaces bounded by the enamel crests are inclosed by the junction of the extremities of these crests on the inner side of the crown. Further attrition results in three lakes within the crown, and one notch of the external border and two notches of the internal border. The anterior molar has two lakes in its posterior area, and one large one in its anterior area. In old teeth there are, successively, one and no lakes left to interrupt the dentine. The first temporary molar (Pm. 2) has much the form of the permanent tooth, but is smaller. The inferior incisor has a wide, shallow groove or concavity on its external face. Superior incisors regularly convex.

The skull of one specimen shows that the otic bullæ are large and moderately compressed. They have no recurved lip at the meatus, and their internal surface is covered with fine inosculating septa, forming a reticulate pattern (fig. 7). On another skull I observe that the fronto-nasal and fronto-maxillary sutures are in one transverse line, crossing the skull just anterior to the anterior border of the orbit.

The maxillary bone, anterior to the molar teeth, is shorter than the premaxillary. The incisive foramina are entirely in the latter. The sides

and superior aspect of the muzzle are regularly convex in transverse section. The inferior incisive alveolus is inclosed entirely in the plane of the ramus, and extends posteriorly to below the last molar tooth. The masseteric ridge is very oblique, and rises to a median point below the second molar. The coronoid process rises from the front of the last molar.

Measurements.

		M.
Length of superior molar series		.008
Diameter of second superior molar	anteroposterior	.004
	transverse	.0035
Diameter of third superior molar	anteroposterior	.0020
	transverse	.0025
Width of superior incisor		.0020
Length from base of first superior molar to base of incisor		.0065
Width between bases of first molars		.0020
Length of first inferior molar		.0033
Depth of ramus at second molar		.0050
Width of ramus below second molar		.0035

This species was evidently abundant during the early Miocene period in Oregon. I have received numerous specimens from the John Day region from Messrs. Sternberg and Wortman.

MENISCOMYS LIOLOPHUS Cope.

Bulletin U. S. Geol. Survey Terrs., VI, p. 366.

Plate LXIII; fig. 11.

This species is known from a crushed skull, which displays the second, third, and fourth superior molars and the superior incisor in good preservation.

The superior molar teeth indicate that this is the largest species of the genus. Their characters place it between the extremes of form represented by the *M. hippodus* and the *M. nitens*. The crowns of the teeth are short, and the roots are long. The external **V**'s are distinctly inflected, and are separated by a deep notch. The external dividing ridge is not prominent, and the posterior **V** is smaller than the anterior. The internal lobe is a simple raised border, which would be crescentic in section. It sends a ridge inwards to the anterior intermediate tubercle. The intermediate tubercles are low cones, and the posterior is connected with the apex of the posterior **V** by a low, simple ridge.

The entire absence of crenations and plications of the crests and lobes of the superior molars distinguishes this species from the *M. cavatus* and *M.*

nitens, but the details differ from those of *M. hippodus* in quite as great a degree. Thus, the intermediate tubercles are lower and more conic, and the external enamel border is not produced so as to inclose lakes, as in that species.

Other portions of the dentition are not determinable, except the superior incisor. This is moderately compressed, and has a regularly convex anterior face, without grooves.

Measurements.

		M.
Length of three large anterior molar teeth		.0095
Diameters of Pm. 2	anteroposterior	.0036
	transverse	.0032
Diameters of M. 2	anteroposterior	.0030
	transverse	.0040
Width of anterior face of superior incisor		.0020

MENISCOMYS CAVATUS Cope.

Bulletin U. S. Geol. Surv. Terrs., VI, p. 366.

Plate LXIII; figs. 12–15.

A concretion contains a number of limb bones and a mutilated skull of this rodent. The latter displays the entire dentition of one side, in both jaws.

Besides the characters of dentition which distinguish this species, the ear-bullæ differ from those of the *M. hippodus*. They are, as in that species, very large and somewhat compressed, but they differ in being transversely divided by bony laminæ of no great depth, which give a sacculate appearance like that of a colon, with the difference that the external surface is not grooved at the bases of the partitions. The superior surface of the skull is flat; there is no sagittal crest, and there is a well-marked postorbital angle. The interorbital surface is plane. The occipital condyle is narrow, and is separated from the otic bulla by a space as wide as itself. The basioccipital is not excavated, but has a low median keel-angle. The superior molar teeth are all posterior to the anterior border of the orbit, excepting the anterior lobe of the second premolar.

The anterior **V** of the second premolar is the largest; while on the last molar the anterior **V** only is present, the place of the posterior one being occupied by a flat space. There is a short external rib separating the two external **V**-faces. On the grinding surface of the molars it is evident that the posterior intermediate tubercle is represented by two crenate

ridges, which are connected with each other and with the posterior external V by a zigzag ridge. The anterior intermediate tubercle is an enlargement of a crenate ridge which connects the internal edge with the external anterior V. In the inferior series the molars have those lobes on the edge of the inner side, of which the middle one is the least prominent. There are two better defined lobes on the external margin. The crowns are basin-shaped, and although the enamel is wrinkled in a complicated manner, the wrinkles are not elevated, as in the other species of the genus. Thus the inferior molars more nearly resemble those of ordinary *Sciuridæ* than do those of the other species of *Meniscomys*. The inferior incisor is much compressed.

The inferior border of the masseteric fossa is well marked and terminates forwards below the middle of the second molar. The base of the coronoid rises opposite the posterior part of the third molar. A femur has a cylindrical shaft. The distal portion is not elevated, and the rotular groove is rather wide and with equal lateral ridges. The condyles are narrow anteroposteriorly, and are spread well apart. A broken tibia is quite elongate, and the distal part of the shaft is subcylindric. The proximal part is triangular in section. The inner side above is a little concave, the posterior side is a little more concave, while the external side is rather strongly convex. The crest is not prominent.

Measurements.

		M.
Width of skull just behind postorbital angles		.0066
Length of otic bulla		.0115
Width between otic bullæ		.0038
Length of superior molar series		.0088
Diameters second molar	anteroposterior	.0028
	transverse	.0028
Diameters last molar	anteroposterior	.0023
	transverse	.0020
Length of inferior molar series		.0090
Diameter third molar	transverse	.0018
	anteroposterior	.0025
Width of inferior incisor		.0010
Depth of ramus at front of Pm. iv		.0040
Depth of ramus at front of M. iii		.0060
Width of condyles of femur		.0060
Depth of condyles of femur		.0050
Depth of fragment of tibia		.0320
Diameters head of tibia	anteroposterior	.0060
	transverse	.0060

From the John Day River region, Oregon.

MENISCOMYS NITENS Marsh.

Allomys nitens Marsh, Amer. Journ. Sci. Arts, 1877, September, p. 253. *Mesniscomys multiplicatus* Cope. Proceedings Amer. Philosoph. Society, 1878, p. 68.

Plate LXIII; figs. 16–17.

Represented in my collections by fragmentary jaws of eight individuals, two of which contain superior molar teeth. These indicate a species which has some range of size, and which may be nearly as large as the *M. liolophus.*

The characteristic peculiarity of this species is, that there are two much crenate intermediate tubercles on the posterior side of the superior molar tooth, which are connected by a ridge with the posterior V; and that the anterior intermediate tubercle is part of a crenate ridge which connects the inner crescent with the anterior V. The external face of the crown is prominent at the notches between the Vs.

The inferior molars are bilobate on the external side, and while the inner sides of the crowns are flat, their superior edge is trilobate. The grinding-face is much complicated by enamel ridges. Four crescentic areas are discernible on the worn surfaces of the crown, of which the posterior is reduced in size on the middle two molars. The two inclosed lakes have very plicate borders which form many small loops, and sometimes they are fused into a single irregular area. The last molar is extended a little posteriorly, and all present an entrant angle between the inner columns. The coronoid process originates opposite the third molar, and the masseteric ridge ceases below the middle of the jaw below the second molar.

Measurements.

		M.
Length of Pm. iv and M. i		.0060
Diameters of Pm. iv	anteroposterior	.0040
	transverse	.0040
Diameters of Pm. I.	anteroposterior	.0020
	transverse	.0040
Probable length of inferior molar series		.0120
Length of posterior three molars		.0095
Diameter of second molar	anteroposterior	.0030
	transverse	.0025
Length of fourth molar		.0040
Depth of ramus below second molar		.0070
Width of ramus below second molar		.0050

The above measurements are taken from the largest specimens. In some of the smaller ones the length of the anterior three inferior molars is .0085, and in one instance .0080. I think that it was on a specimen of this species with the last-named measurement that Professor O. C. Marsh established his *Allomys nitens*. The species was very briefly described, but may be recognized by an accompanying figure. A new generic name was proposed, but no characters were given, and it was even made the type of a new family, but no reasons for this course were adduced.

ISCHYROMYS Leidy.

Proceed. Acad. Nat. Sci. Philad., 1856, p. 89; Extinct Fauna Dakota and Nebraska, 335.—*Colotaxis* Cope, Paleontological Bulletin, No. 15, p. 1.

Char. gen.—The essential features are, dentition, I., $\frac{1}{1}$; C., $\frac{0}{0}$; M., $\frac{5}{4}$; the molars with two crescents on the inner side above, each of which gives rise to a cross-ridge to the outer margin. In the mandibular series the crests and crescents are identical, but in a reversed relation. No cementum.

To the above characters given by Dr. Leidy, I have added the absence of postfrontal processes, and the superior position of the infraorbital foramen; also that the pterygoid fossa is large, and that its inner and outer plates are well developed, and subequal. The palate is excavated posteriorly. The acuminate anterior part of the malar bone extends as far forwards as the front of the orbit. There is no tuberosity on the side of the superior diastema near the premolar teeth. In the mandible the posterior extremity of the incisive alveolus is not distinct from the ascending ramus.

In Hayden's Bulletin, vol. vi, I described some of the characters of the remaining portions of the skeleton. Those which I possess are the distal extremities of humeri, and a tibia, astragali, and portions of the pelvis. The condyles of the humerus are narrow anteroposteriorly. The internal flange descends at once to the fundus, leaving a long external cylindrical roller without intertrochlear ridge. Anteriorly this portion is cut into for half its length by the ligamentous fossæ. There is a large internal epicondyle, which is constricted by a neck at the base, and presents a compressed edge inwards and upwards. The arterial canal opens above on the interior side of the humerus. There is no external epicondyle.

The section of the *ilium* at its base and at its middle, is triangular. There is an angle along the middle of its external face which supports a moderately prominent tuberosity, a little above the acetabulum. On the anterior margin a little higher up, is a short, compressed, rather prominent process, which probably represents the anterior inferior spine. From this point posteriorly the internal face of the ilium is deeply concave, producing an attenuation of the inner wall of the acetabulum. The ischium is rather narrow at the base.

The distal portion of the tibia is much like that of *Arctomys*, *Gymnoptychus*, and other *Sciuridæ*. The posterior median process is very large and is shallowly grooved; the usual deep tendinous groove separates it from the internal malleolus. The trochlear grooves are deep and well separated; the fibular surface is short. The head of the astragalus is horizontally oval, and is separated from the trochlear portion by a neck of moderate length. It extends obliquely inwards, so that the internal margin of the head is interior to the line of the inner margin of the trochlea. The sides of the latter are vertical. It is considerably wider than long; the trochlear carinæ are marginal, and the external is considerably more elevated than the inner. The separating groove is profound but open. The posterior inferior fossa is small and foramen-like.

Besides the very different form and position of the infraorbital foramen, this genus differs from *Gymnoptychus* in the excavation of the posterior edge of the palate.

Dr. Leidy remarks that this genus belongs to the family of the *Sciuridæ*. This is indicated by the dental characters; but in some other respects there is a greater divergence from the squirrels and marmots than is the case with the preceding genus, *Gymnoptychus*. Thus, the large *foramen infraorbitale anterius* occupies the elevated position at the origin of the zygomatic arch seen in the porcupines and cavies. There is no superciliary ridge nor post-orbital process as in most *Sciuridæ*, but the front is contracted between the orbits in the same manner as, but to a less degree than, in *Fiber*, and the Eocene *Plesiarctomys*, Brav. Both the last named and *Ischyromys* present many points of resemblance to Pomel's tribe of *Protomyidæ*, but differ from any of the genera he has included in it.

This family is thus defined by Pomel:* "infraorbital foramen large as in the *Hystricidæ*, and by the position of the angular apophysis of the mandible almost in the general plane of the horizontal ramus. The jugal bone, at least in those species where we have observed it, is very much enlarged at its anterior portion, and the orbit is almost superior."

These characters apply to *Ischyromys*, excepting as regards the malar bone, which is principally unknown in the latter.

Another family, the *Ischyromyidæ*, has been proposed by E. R. Alston for the reception of this genus, to which he thinks with me† *Plesiarctomys* (=*Pseudotomus*) should be referred. He thus defines the family:‡ "Dentition as in *Sciuridæ;* skull resembling *Castoridæ*, but with the infraorbital opening large, a sagittal crest; no postorbital processes; palate broad; basioccipital keeled."

Doubtless *Ischromys* belongs to an extinct family, but which of the above names is available for it I do not yet know. I would characterize it as follows:

Dentition as in *Sciuridæ;* infraorbital foramen large, superior; pterygoid fossa large, with well-developed exterior as well as interior walls; a sagittal crest.

The superior position of the infraorbital foramen and the well-developed pterygoid laminæ are characters found in the *Muridæ*.

But one species of this genus is known.

ISCHYROMYS TYPUS Leidy.

Proceedings Academy Philada. 1856, p. 89. Extinct Fauna of Dakota and Nebraska, 1869, p. 335. Cope Annual Report U. S. Geol. Surv. Terrs. 1873 (1874), p. 477. *Colotaxis cristatus* Cope Paleontological Bulletin No. 15, p. 1. *Gymnoptychus chrysodon* Cope, Paleontological Bulletin No. 16, p. 5.

Plate LXVII; figs. 1–12.

The principal characters of this species have been given by Dr. Leidy as above cited. I repeat the most important of these, and several which have not been previously noticed.

In the molar teeth of both jaws there is no transverse crest arising from the connection between the adjacent horns of the crescents. The

* Catalogue Method. et Descr. de Vertebrés Foss. de le Bass. de la Loire, 1853, p. 32.

† Annual Report U. S. Geol. Survey Terrs. 1873 (1874,) p. 477.

‡ Proceed. Zool. Society London, 1876, p. 78.

transverse crest from the anterior horn of the anterior crescent is largely developed in both jaws, while that proceeding from the posterior horn of the posterior crescent is united at both ends with the adjacent one. On the last superior molar, the posterior of the two principal cross-crests is shortened, and the posterior marginal crest is cut off from the inner crescent by a notch. In the premolar of the inferior series, the two anterior cross-crests are wanting and are replaced by two adjacent cusps, an internal and an external.

The incisive foramina are short and rather wide. There is no tuberosity on the side of the superior diastema as in most *Sciuridæ*. There is a well-marked fossa above the first premolar, and below the *foramen infraorbitale exterius*. The anterior part of the zygomatic arch is convex above and flat below, and at right angles to the long axis of the skull. An osseous bar extends outwards and backwards from the external base of the external pterygoid ala; whether it spans an alisphenoid canal I cannot determine. The palate is excavated as far as the posterior border of the last superior molar tooth. The ascending portion of the premaxillary bone is wide.

The area of insertion of the masseter muscle on the mandible, is feebly defined, extending only to the posterior border of the second molar. The pterygoid fossa of the ramus is on the other hand, deeply excavated. The ascending ramus commences opposite the third molar. The dental foramen enters some distance behind the last molar on a level with its summit, and above the angular superior border of the pterygoid fossa. The mental foramen issues behind the middle of the length of the diastema and above the middle of the vertical diameter of the ramus at that point.

The section of the superior incisor teeth is a nearly regular oval, a little flattened on the inner side near the front. The anterior face presents a very shallow median longitudinal concavity. The enamel is nearly smooth, and is wrapped on the inner side for a moderate width. The inferior incisors are more oblique on the exterior side anteriorly, and are therefore narrower in front than the superior. The enamel is smooth, presents no sulcus, is wrapped in a narrow band on the inner side, and on half the entire width on the outer side.

There are differences in the form of the inferior premolar, some being

a little wider anteriorly than others. On a specimen presenting the narrowed form the name *cristatus* was proposed. In some specimens the inferior incisors are more compressed than in others. In some of the specimens the original bright-bay color of the enamel of the superior and inferior incisors is beautifully preserved.

Measurements.

	M.
Length of inferior molars	0.0140
Length of penultimate molar	.0033
Width of penultimate molar	.0035
Width of first molar	.0030
Length of first molar	.0035
Depth of jaw at penultimate molar	.0090
Depth of incisor-tooth	.0040
Width of incisor-tooth	.0020

The olecranar fossa of the *humerus* has a small perforation. There are two small rather deep fossæ on the posterior aspect of the humerus distally; the larger is at the base of the epicondyle, the other is within and a little above it. The marginal crest from the external epicondylar region is acute and rather elongate. The shaft of the humerus above it is quite slender. In a second specimen, the inner of these two fossæ is wanting. At the middle of the shaft of the tibia, the anterior and external faces meet at a right angle; the inner and posterior faces form a nearly continuous curve. The inner crest of the posterior distal process, which bounds the *sulcus tendinis flexoris longi pollicis* is not so produced as in *Gymnoptychus minutus*, or *Arctomys monax*. The humerus bears considerable resemblance to that of both these species, but differs from both in the presence of the posterior fossæ. In *Arctomys monax* the arterial foramen is wanting.

Measurements.

		M.
Diameter distal end of humerus	anteroposterior	.0050
	transverse	.0190
Length of internal epicondyle		.0060
Diameter distal extremity tibia	anteroposterior	.0060
	transverse	.0080
Diameter of base of ilium	exterointernal	.0060
	anteroposterior	.0065
Anteroposterior diameter of acetabulum		.0065
Length of astragalus (axial to foot)		.0100
Length of astragalus obliquely		.0115
Width of trochlea of astragalus		.0060
Width of head of astragalus		.0045
Elevation of external arc of astragalus		.0045

This squirrel was about as large as the existing *Sciurus niger*. It was common during the White River epoch, specimens having been obtained in Dakota, Nebraska, Wyoming, and most abundantly in Colorado.

CASTOR Linn.

Syst. Nat. I, p. 78, 1766.—Cope, Bulletin U. S. Geol. Surv. Terrs., VI, p. 368. *Steneofiber*, E. Geoffr., Revue Encyclopédique, 1833.—"*Chalicomys* Meyer, Neues Jahrbuch, 1838, p. 404, et 1846, p. 474."—*Palæocastor* Leidy, Extinct Mammalia Dakota and Nebraska, 1869, p. 338.

The family of the *Castoridæ* differs from the *Sciuridæ* in the absence of postorbital angles or processes, and the presence of a prolonged tube of the meatus auditorius externus. In both of these points it agrees with the *Haplodontiidæ*, a family which Mr. Alston has distinguished from the *Castoridæ* on various grounds. I do not think any of his characters are tenable, excepting that drawn from the form of the mandible, which is expressed thus in Mr. Alston's diagnosis: "Angular portion of mandible much twisted" I have described this character better as follows: Angle of mandible with a transverse edge due to inflection on the one hand, and production into an apex externally; the inflection bounding a large internoposterior fossa.

Mr. Alston enumerates four genera of *Castoridæ*—*Castor*, *Diobroticus*, *Steneofiber*, and *Castoroides*. J. A. Allen has shown that the last-named genus cannot be referred to this family. The characters of *Diobroticus*, as given by Alston, are as follows: "Skull much as in *Castor*. Third upper molar and lower premolar elongate, with four enamel folds, the rest with only two; all the folds soon isolated." This diagnosis appears to separate the genus satisfactorily. The definition of *Steneofiber* is as follows: "Parietals not parallelogrammic; interparietal subhexagonal; basioccipital not concave; grinding teeth as in *Castor*, the subsidiary folds sooner isolated." The distinction from *Castor* here rests exclusively on the forms of the parietal, interparietal, and basioccipital bones. This kind of definition is always of questionable validity, as the terms "parallelogrammic," "hexagonal," &c., are not intended to be exactly used and cannot be exactly applied. The *Castor* (*Steneofiber*) *peninsulatus* illustrates this fact, for there is no striking difference in the forms of the two bones to which these terms are applied, as compared with the *Castor fiber*. The basioccipital bone differs from

that of the beaver, but not so as to conform to J. W. Alston's diagnosis of the genus *Steneofiber*. Its inferior surface is concave, but doubly so, as a keel occupies the median line. In the *S. viciacensis* according to Filhol, this region is shallowly concave, without median keel. Although important as specific characters, these variations do not appear to me to require the recognition of as many genera. The possession of the epitrochlear foramen in the *S. viciacensis* is at first sight an important character. Mr. Filhol, however, informs us that of thirty-four humeri which he has studied, sixteen possess the foramen, and in eighteen it is wanting.

The *Castor tortus* was described by Leidy from the Loup Fork formation. He coined the subgeneric name *Eucastor* for it without corresponding definition. In his monograph of the *Castoridæ*, J. A. Allen referred this species[1] to a genus distinct from *Castor*, and defined it, using for it Leidy's name *Eucastor*. This genus appears to me to be valid. The three genera of *Castoridæ* will then be defined as follows:

Molars and premolars with one inner and two or three outer folds ..... *Castor.*
"Inferior premolar and third superior molar elongate, with four enamel folds; the rest with only two" ..... *Diobroticus.*
Superior premolar enlarged, with one inner fold; inferior molars small, with two lakes ..... *Eucastor.*

Some affinity probably exists between this family and the *Mylagaulidæ*, which followed in the Loup Fork epoch.

The species of *Castor* may be distinguished as follows. I do not know the *C. nebrascensis*[2] from the White River, nor the occipital bone of the *C. pansus*[3] from the Loup Fork formation.

I. Basioccipital bone deeply concave below, simple;
  Angle of lower jaw not deflected ..... *C. fiber.*
II. Basioccipital shallowly concave below:
  Angle of lower jaw deflected ..... *C. viciacensis.*
III. Basioccipital concave below with a median keel; angle of lower jaw not deflected.
  Palate wider; size medium ..... *C. peninsulatus.*
  Palate narrower; size small ..... *C. gradatus.*

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[1] Monographs of North American Rodentia, Coues and Allen, U. S. Geol. Surv. Terrs., 1877, xi, p. 450.

[2] *Steneofiber nebrascensis* Leidy, Proceed. Academy Phila., 1856, 89; 1857, 89; *Chalicomys nebrascensis* Leidy, l. c., 1857, 176; *Palæocastor nebrascensis* Leidy, Ext. Mammalia Dakota and Nebraska, 1869, p. 338, xxvi, Figs. 7–11.

Steneofiber pansus Cope, Report Capt. G. M. Wheeler, iv, pt. ii, 1877, p. 297.

CASTOR PENINSULATUS Cope.

Bulletin U. S. Geol. Survey Terrs., 1881, VI, p. 370. American Naturalist, 1883, p. 53, figs. 9, 10.
Steneofiber ? nebrascensis Cope, loc. cit., 1879, p. 55.

Plate LXIII; figs. 18–21.

This species is about the size of a large prairie marmot—*Cynomys ludovicianus.* It was abundant in Oregon during the period of the John Day Miocene. Leidy originally described the closely allied *C. nebrascensis* from the WhiteRiver beds of Nebraska, but I have never obtained it from that formation. Another and similar species, *C. pansus* Cope, is common in the Loup Fork beds of Nebraska and New Mexico.

Several well-preserved skulls from Oregon display characters not visible in specimens heretofore collected, and which enable me to make fuller comparisons with the European *C. viciacensis,* so fully described by M. Filhol.[1]

The postorbital constriction is much greater in this species than in the *C. viciacensis,* and greater than in the *C. nebrascensis* from the White River beds. The straight anterior temporal ridges are in line with the superciliary borders, and unite into a sagittal crest at the constriction. In the *S. viciacensis* they continue separate beyond this point one-fourth the distance to the supraoccipital crest. The zygomata are wide, and the malar ridge is very prominent anteriorly, overhanging the face, and curving rather abruptly to the base of the muzzle. The latter is rather wide, with parallel sides, and is flat above. The brain-case expands rather abruptly from the interorbital constriction, and is rather flat above. The infraorbital foramen is a narrow vertical oval and is situated low down in the vertical line with the anterior extremity of the malar angular edge. It is a little nearer the line of the first molar than the posterior border of the superior incisor. The incisive foramina are relatively larger than in the beaver, and are chiefly in the premaxillary bone. The palate between the anterior molars is as wide as the transverse diameter of the first molar. There is no distinct fossa of the maxillary bone in front of the orbit as represented by Filhol in the *C. viciacensis.* The pterygoid fossa is wide, with the inner process the longer,

[1] Étude des Mammifères Fossiles de Saint-Grand-le-Puy Allier. Bibl. de l'École des Hautes Études, XIX, Art. I, p. 44, 1879.

and reaching the otic bulla. The latter are large and obliquely placed; the meatal borders are produced into a short tube, which is not so long as that of the *C. fiber*. Its superior border is quite prominent, overhanging the inferior, and projecting more than represented by Mr. Filhol in the *C. viciacensis*. There is a strong ridge of the squamosal bone extending posteriorly from the base of the zygomatic process, which overhangs a fossa. This fossa is further defined posteriorly by the tympanic tube. This fossa is larger and deeper than in either *C. fiber* or *C. viciacensis*. Below its superior bounding ridge is a large subsquamosal foramen. The mastoid bone is distinctly exposed between the squamosal and occipital, and its surface is separated from that of the former by a groove which is not so well marked in the *C. fiber*. Its inferior angle is in contact with the bulla, and is shorter than the paroccipital process. The latter is short, not extending below the line of the condyles, and is directed downwards, not posteriorly as in *C. fiber*. The occiput is nearly vertical and flat, excepting laterally, where there are two fossæ, a superior and inferior, the latter the longer, and extending to the inferior surface.

The premaxillo-maxillary suture is just half way between the anterior molar and the superior incisor, and is vertical to opposite the middle of the incisive foramen, and then turns backwards. The frontomaxillary and frontonasal sutures are in one transverse line across the front. The malar-maxillary suture is behind the anterior border of the zygoma, thus confining the malar bone to the zygoma. The latter is much expanded in a vertical direction, but has no postorbital angle, resembling in this respect the *C. viciacensis* rather than the *C. fiber*. Its posterior portion extends well posteriorly and below almost all of the squamosal part of the zygoma. The parietal is of a parallelogrammic form; the anterior inner border cut obliquely by the frontal, and the posterior inner border cut out for the supraoccipital. The latter bone has an oval form, narrowed anteriorly and truncate posteriorly.

I describe a mandibular ramus of a second individual. It unfortunately has the coronoid and the angle broken off. The base of the latter is concave on the inner side. The external face of the ramus is everywhere convex. The base of the coronoid is separated from the molar line

by a wide groove. The anterior base is opposite the second molar. The incisive alveolus is continued upwards and backwards, and ceases in a protuberance which is external to the plate which connects the condyle with the coronoid process, and is separated from it by a fossa. The condyle is subglobular, and has considerably more external than internal articular surface. The series of inferior molar teeth is quite oblique, descending posteriorly.

Dentition.—The grinding surfaces of the superior molars are none of them longer than wide, and in all but the first, the transverse diameter exceeds the anteroposterior. The dimensions diminish posteriorly in all the measurements. There is one inflection of the sheathing enamel on each side of the crown in all the molars in their present state of wear. The positions of the lakes indicate that in an earlier stage there were two external inflections. At present all the molars display a fossette external to the fundus of the internal inflection. Besides this there are two others in the first molar, and one other in the fourth. Posterior to the external inflection there is one fossette in the first and third molars, two on the fourth, and none on the second, where it is probably worn out. According to Leidy there are three in this position in all the molars in the *C. nebrascensis*, and two in the position first described. According to Filhol, there is but one in each position, in about the same stage of wear, in the *C. viciacensis*.

The inferior molars display a deep external inflection, and three transverse lakes on the inner side. These probably represent inflections at an earlier stage of wear; the median one is still continuous with the sheathing enamel on the first molar (Pm. IV). The sizes of the inferior molars increase anteriorly regularly, excepting that the first is relatively a little longer than the others.

Measurements of skull.

	M.
Length from inion to edge of nasals	.067
Length from edge of nasals to interorbital constriction	.034
Length of muzzle to preorbital angle of maxillary	.018
Width of skull at paroccipitals	.025
Width of skull at posterior edge of squamosal	.034
Width at zygomata posteriorly	.056
Width at interorbital constriction	.006

	M.
Width between anterior parts of orbits	.0275
Width at base of muzzle	.018
Length from occipital condyle to front of otic bulla, inclusive	.018
Length from bulla to last molar tooth	.008
Length from first molar to base of incisor	.023
Length of superior molar series	.0195
Diameters of first molar { anteroposterior	.0045
Diameters of first molar { transverse	.0045
Diameters of fourth molar { anteroposterior	.0030
Diameters of fourth molar { transverse	.0035

Measurements of mandible.

Length from condyle to incisor tooth	.0390
Length from incisor to Pm. iv	.0105
Length of inferior molar series	.0145
Diameters of Pm. iv { anteroposterior	.0047
Diameters of Pm. iv { transverse	.0040
Diameters of M. i { anteroposterior	.0030
Diameters of M. i { transverse	.0040
Diameters of M. ii { anteroposterior	.0030
Diameters of M. ii { transverse	.0035
Depth of ramus at diastema	.0100
Depth of ramus at Pm. iv	.0130
Depth of ramus at M. iii	.0100

A few bones accompany the mandible, all having been cut from the same fragment of matrix. The head of the femur is perfectly round, and is bounded by a well-defined neck. The great trochanter incloses a large fossa. The lesser trochanter is large; the third trochanter is not prominent as it is in *C. viciacensis*. The shaft is generally flattened, with its long diameter transverse. The condylar extremity is flattened, and the rotular groove is wide, and the condyles well separated. The epicondylar angles are distinct, but not so prominent as in *S. viciacensis* (see Filhol, *l. c.*, Pl. VI, Figs. 13, 14). The general form of the femur is robust, as in that species.

The distal extremity of the tibia resembles that of *Sciuridæ* generally, especially in the large size of the external posterior angle. Its diameters are small, and the distal part of the shaft is slender and subcylindrical. The crest extends well down from the proximal end, being much stronger than in the true squirrels, and bounds a longitudinal fossa. The fibular facet of the tibia overhangs extensively, and bounds a rather narrow proximal fossa. This continues into a narrow shallow groove on the posterior face of the shaft, which disappears near the middle of its length. The proximal half of the shaft is much compressed. The inner face is smooth

and gently convex. The crest sinks rapidly into the head, and the femoral facets are well separated. The tibia resembles that of *C. viciacensis*, but is more compressed in its proximal half.

Measurements of hind leg.

		M.
Length of femur		.057
Width of femur at head		.019
Width of femur shaft below third trochanter		.009
Width of femur at epicondyles		.015
Width of condyles of femur		.013
Anteroposterior diameter at condyles		.011
Anteroposterior diameter of head		.009
Diameters of head of tibia	anteroposterior	.012
	transverse	.014
Diameters of distal end of tibia	anteroposterior	.0080
	transverse	.0085
Anteroposterior diameter	above middle	.010
	below middle	.005

I have referred to this species in former catalogues of the vertebrate fauna of Oregon as the *Castor nebrascensis* of Leidy. It is very nearly allied to that species, but I find the following differences: First, the post-orbital constriction is narrower; second, there are fewer fossettes on the posterior half of the molar teeth, but one or two. Leidy figures two or three in the species described by him.

CASTOR GRADATUS Cope.

Steneofiber gradatus Cope. Paleontological Bulletin No. 30, p. 1, December 3, 1878. Proceedings American Philosophical Society, 1878 (1879), p. 63.

Plate LXIII; fig. 22.

This species is represented in my collection by parts of several individuals. One of these is a palate with both series of molars; a second is a mandibular ramus with all the molars. The best specimen is a cranium, which is nearly perfect, the principal deficiency being the absence of the mandibular rami. It is of smaller size than the *S. nebrascensis* and *S. pansus*, and differs from both these species in the relative sizes of the superior molar teeth. The first of these is the largest, and the others diminish regularly in size to the last, whose grinding face does not present more than one-third the extent of that of the first. The triturating surfaces of the second and third have their long axes transverse. In all the crowns, besides the internal and external enamel inflections, there is but one fossette, which is

anterior to the external inflection. The latter has become isolated from the superficial enamel on the last three molars, by attrition. The superior incisors are flat anteriorly with the external angle rounded, and its dentine presents the transverse undulation seen in *S. pansus*.

The palate is distinctly narrower in this species than in the *C. peninsulatus*. The width between the bases of the first molars (Pm. iv) is less than the transverse diameter of each of those teeth; in *C. peninsulatus* its width is equal to that of those teeth. The temporal ridges do not unite so early in this species as in *C. peninsulatus*, but continue parallel for a considerable distance. The parietal bone is injured posteriorly from the middle, so that the union into a sagittal crest, if it takes place, cannot be seen. The middle line of the basioccipital bone is keeled, with a fossa on each side. The tympanic meatus is prolonged, and the posttympanic process is short. The space between the incisor and superior molar teeth is about two-thirds the same space in the *C. peninsulatus*, and is relatively shorter than in that species.

Measurements.

		M.
Length of skull from incisive alveolus		.0500
Width between bases of first molars		.0030
Width between bases of fourth molars		.0070
Length of molar series		.0115
Diameter of the first molar	anteroposterior	.0040
	transverse	.0045
Diameter of third molar	anteroposterior	.0028
	transverse	.0032
Diameter of fourth molar	anteroposterior	.0020
	transverse	.0024

From the above measurements it is apparent that the molar series in this species is equal in length to the anterior three molars of the *S. nebrascensis* and *S. pansus*. The posterior fossettes of the crowns seen in those species are wanting in the *S. gradatus*.

From the John Day River, Oregon.

HELISCOMYS Cope.

Synopsisof New Vertebrata from Colorado (Miss. Pub., U. S. Geol. Survey Terrs.), 1873 (October), p. 3; Annual Report U. S. Geol. Survey Terrs., 1873 (1874), p. 475.

Inferior molars four, rooted, the crowns supporting four cusps in transverse pairs. A broad ledge or cingulum projecting on the external side

from base of the cusps. The inferior incisor compressed, not grooved, and with the enamel without sculpture.

This genus is only represented by a small number of specimens, which are mandibular rami exclusively. Its special affinities, therefore, cannot be ascertained, and even its general position remains somewhat doubtful. There is some probability, however, that it belongs to the *Myomorpha*, as the type of dentition is much more like that of the genera of that group than those of the *Sciuromorpha*. To the *Hystricomorpha* it does not belong.

As compared with known genera of *Myomorpha*, it is at once separated from many of them by the presence of a premolar tooth. Among recent genera of this suborder, *Sminthus* possesses this tooth in both jaws, and *Meriones* in the upper jaw only. It is present in both jaws in the *Sciuromorpha* generally. The tubercles of the teeth resemble those of the *Muridæ*, but their disposition is unlike that of any existing North American genus. A remote approximation to it is seen in the genus *Syllophodus* of the Bridger Eocene formation, where there are four subquadrate molars with tubercles; but the latter form two transverse crests, with an additional small intermediate tubercle, and the wide cingulum is absent.

But one species of *Heliscomys* is known, the *H. vetus*.

HELISCOMYS VETUS Cope.

Synopsis of New Vertebrata Colorado, 1873 (October), p. 3. Annual Report U. S. Geol. Survey Terrs., 1873 (1874), p. 475.

Plate LXV; figs. 14–18.

The mandibular ramus is rather robust in its proportions. Neither the alveolar sheaths of the molars nor that of the incisor project beyond the general surface. The anterior base of the ascending ramus commences opposite the anterior part of the last molar tooth. The masseteric fossa extends remarkably far anteriorly, its inferior border terminating close to the mental foramen. This border is moderately raised, and extends downwards and backwards, not reaching the inferior border anterior to a point below the anterior base of the ascending ramus. The symphysis rises at an angle of about 45°, and the inferior border is very little convex to below

the last molar. The *foramen mentale* is situated near the superior plane of the diastema, half way between the alveolar borders of the incisor and premolar teeth.

The grinding face of the molar series rises slightly anteriorly. The sections of the middle two molars are subquadrate and are of equal size. That of the fourth is smaller by one-third; having the same longitudinal extent, but less width, thus forming a longitudinal oval. The section of the premolar is round, and its diameter is half that of the long diameter of the other molars. The premolar has two contiguous roots, and three conic cusps, one anterior and two opposite and posterior. The cusps of the other molars are separated transversely by a deep notch, and longitudinally by a fissure, which does not invade the surface of the cingulum. The latter extends a short distance round the anterior base of the crowns of the second and third molars. The crown of the fourth molar is worn or injured in my specimens, so as not to be described. The incisor is strongly compressed, as in many *Muridæ*, and the anterior face is slightly convex in section. The enamel is smooth, and is abruptly recurved in narrow borders of about equal width on both the inner and outer sides. On the inner side the surface makes a sharp right angle; on the outer side the angle is right, but is obtusely rounded. The surface of attrition is elongate, and displays a small pulp cavity.

Measurements.

	M.
Length of incisive alveolus to end of molar series	.0050
Length from incisive alveolus to base of ascending ramus	.0044
Length of diastema	.0020
Length of third molar	.0008
Width of third molar	.0008
Long diameter of incisor	.0008
Short diameter of incisor	.0004
Depth of ramus at diastema	.0018
Depth of ramus at third molar	.0021
Thickness of ramus below the same	.0014

The *Heliscomys vetus* is the least mammal of the fauna of the White River epoch. The mandibular ramus is the size of that of the *Mus musculus*, and its four teeth occupy the same length as the three of the latter species. One of the specimens indicates an individual a little larger than the one above measured.

MYOMORPHA.

EUMYS (Leidy nom.) Cope.

Annual Report of the U. S. Geological Survey of the Territories, F. V. Hayden in charge, 1873 (1874), p. 474.—*Eumys* Leidy (name only), Proceedings Academy, Philada., 1856, p. 90; loc. cit. 1857, p. 89; Extinct Mamm., Dakota and Nebraska, p. 342.

Dental formula: I. $\frac{1}{1}$; C. $\frac{0}{0}$; M. $\frac{3}{3}$. Crowns of the superior molars supporting two external cones, and two internal tubercles of crescentic section which communicate with the former by transverse ridges. Inferior molars of similar constitution, but reversed, the conic tubercles being interior and the crescentic exterior. The posterior tubercles of the posterior molars reduced, and an additional one on the anterior extremity of the first molar. Superciliary ridges none, but the supraorbital borders converging towards the middle line, and meeting above the postorbital region. No indication of postfrontal processes. Infraorbital foramen rather large above, terminating below in a vertical fissure. Incisive foramen entering the maxillary bone extensively. Incisor teeth not grooved.

I only know this genus from the cranium anterior to the pterygoid region, the mandibles, and the dentition. These parts display the characters of *Muridæ*, and in particular of the existing genus *Hesperomys*. The only character which I can find which has enabled me to distinguish *Eumys* from the latter genus is the extension upwards of the orbital fossæ so as to form an interorbital crest. In none of the Sigmodont genera of North America are the supraorbital borders contracted in this way, but the crest is seen in *Fiber* and in various degrees in the genus *Arvicola*, being as distinct in *Eumys* as in *A. xanthognathus*.[1]

A single species is certainly referable to this genus, the *E. elegans*, which was abundant during the White River Miocene epoch.

The typical species was originally described by Leidy, who gave it the generic name which I have adopted; but he at no time characterized the genus, or showed how it differed from others already known. This was first done by myself, as above cited.

[1] Report of Lieut. G. W. Wheeler, IV, p. 300, Pl. LXIX, fig. 15.

EUMYS ELEGANS Leidy.

Proceedings Academy, Philada., 1856, p. 90; loc. cit. 1857, p. 89. Extinct Mammalia of Dakota and Nebraska, p. 342, Pl. XXVI; figs. 12, 13, 1869. Cope Ann. Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 474.

Plate LXV; figs. 1–14.

I found remains of this rat exceedingly abundant in the shallow washes of the White River rocks in Eastern Colorado. It had previously been known from a single imperfect jaw-fragment from Dakota, found by Dr. Hayden.

The sutures of the cranium anterior to the brain-case are distinct, including those that separate the frontal and nasal bones on the median line. The suture separating the maxillary and premaxillary bones crosses the palate a little behind the line connecting the bases of the zygomata, passes upwards a little in front of the latter and then turns posteriorly, joining the nasal suture at its posterior extremity. The apices of the premaxillary and nasal bones form an acute angle above the middle of the orbit, and the frontals enter an acute notch between them. The palatomaxillary suture crosses the palate opposite the middle of the second molar tooth.

The nasal bones are strongly convex at the extremity, and extend a short distance beyond the base of the superior incisor teeth. They narrow posteriorly, become plane, and then concave on the median line. The carina of the frontals incloses a median groove. The superior portion of the maxillary bone presents a subround fossa at the entrance of the *foramen infraorbitale.* The latter is overarched by a slender bridge, which is as wide as thick. The malar bone does not appear in the base of the zygoma, whose inferior expansion presents a shallow, wide fossa, downwards and forwards. The anterior border of the base is free, inclosing a fissure which descends from the superior portion of the foramen. The posterior margin of the base is opposite to the anterior part of the first molar tooth, a point which is nearly attained by the incisive foramina. The latter are separated by a narrow septum on the median line. The free border of the palate is slightly concave, but does not advance beyond the posterior part of the third superior molar. The palatine foramen is large, and is opposite the posterior half of the second molar.

The mandible is robust, and the symphysis is very steep in profile. Its sutural face descends at an angle of 45°, and then exhibits a rugose point of union below the first molar on the inferior border of the ramus. The inferior border is subparallel with the tooth line, but presents an upward concavity below the third molar. The coronoid process originates opposite the anterior part of the third molar, is vertical and compressed. The anterior border extends obliquely backwards. The masseteric fossa has a prominent inferior border which extends upwards and forwards to below the middle of the first molar. Its surface is gently concave below, convex above. The pterygoid fossa of the ramus is deep and large. Its inferior border is a spur-like continuation of the inferior part of the ramus, from which the thin outer wall of the fossa rises. The latter is somewhat convex on the external side. The tooth basis and the incisive alveolar sheath do not project much on the inner side of the ramus. The diastema is as long as the tooth line, and the foramen mentale is below a point a little behind its middle. The foramen dentale enters a little above the base of the vertical ramus and three times the length of the last molar behind that tooth.

The superior incisor teeth are convex in front, the convexity slightly oblique to the external side. The enamel is smooth and does not overlap the sides. The crescents and cones of the molar teeth are well separated from those of the same side by vertical fissures. A narrow crest connects the base of each cone with the concave side of each crescent. The adjacent horns of the two internal crescents join, and the connecting portion sends a short crest into the interval between the external cones. The anterior and posterior horns of the two crescents are produced transversely, forming the anterior and posterior borders of the crown in the middle molar, the anterior border of the third, and posterior border of the first molars. The anterior or fifth lobe of the first molar is simple. The inner and outer lobes of the third molar are reduced in size, and close together. The last superior molar is only half as large as the first, and the middle molar is intermediate in size.

The molars of the inferior series do not differ in size so widely as those of the superior series. They are subequal, but the anterior and posterior are

somewhat narrowed at their extremities. The tubercles of the first and last differ slightly from those of the superior series. The anterior odd one of the first is smaller; while the posterior outer crescent of the third is well developed, with all the transverse crests. The posterior inner cone is, however, wanting. The details of the inferior molars repeat those of the superior series, but in reversed relation, the external portions of the one being the internal of the other, and vice versa. The inferior incisors are nearly as much curved as the superior ones; they are robust and subtriangular in section. The enamel is smooth, and has a convex surface presented more obliquely outwards than the superior incisors.

Measurements.

	M.
Depth of skull at middle of orbit, without molar teeth	0.0080
Width between orbits	.0050
Length from middle of orbits	.0150
Length from front of zygoma	.0100
Length of superior diastema	.0075
Length of nasal bones	.0120
Length of superior molar series	.0060
Length of first superior molar	.0025
Length of third superior molar	.0015
Width of first superior molar	.0020
Width of third superior molar	.0018
Width of nasal bones at middle	.0020
Width of nasal bones distally	.0030
Width between bases of zygomata	.0070
Width of superior incisor tooth	.0015
Length of mandible of another individual to dental foramen	.0160
Length to end of dental series	.0115
Length to front of dental series	.0055
Length from base of vertical symphysis to front of pterygoid fossa	.0095
Depth at diastema	.0050
Depth at middle molar	.0055
Length to base of coronoid	.0090
Thickness of ramus on front border of masseteric fossa	.0040
Anteroposterior diameter of inferior incisor tooth	.0020
Anteroposterior diameter of last molar	.0020
Width of last molar	.0018

The hundred and more individuals represented by my specimens, evidently differed in various minor respects, as in size and robustness. Some, perhaps males, have the muzzle stouter in proportion to the length than others; some are more decurved than others.

With molar teeth as large as those of the Norway rat the muzzle of the *Eumys elegans* is not more than two-thirds as long; so that the species was in general proportions smaller and more robust.

HESPEROMYS Waterhouse.

This recent genus had a representative in the John Day Miocene in North America, so far as the characters of the skull and dentition may be considered to be conclusive in evidence. It is not very probable that the indications thus obtained will be invalidated by other portions of the skeleton.

The molars are $\frac{3}{3}$, and the crowns support alternating tubercles separated by shallow open transverse valleys. These are, one on the inner and two on the outer sides of the superior series, and one on the outer and two on the inner side of the inferior. In the recent species, (*H. leucopus*) there are two inflections on the inner side of the first molar, but in the species here described that tooth is constricted at the position of the anterior internal loop, and does not regain its width, but continues narrowed to the anterior extremity. The infraorbital foramen is rather large.

It is probable that there is a second species of this genus in the Loup Fork beds besides the *H. loxodon* Cope.

HESPEROMYS NEMATODON Cope.

Paleontological Bulletin No. 31, p. 1, Dec. 24, 1879. Proceedings American Philosoph. Soc., 1879–'80, p. 370.

Plate LXVI; fig. 33.

This rat is represented by a beautiful skull, discovered by Prof. Thomas Condon, of Eugene City, and by several jaws and other fragments subsequently found by Mr. Wortman.

The frontal region is not contracted as in *Eumys elegans* and *Fiber zibethicus*, but the superciliary ridges are well separated from each other, as in *Hesperomys americanus*. The frontal and posterior nasal regions are slightly concave in transverse section. The molars display tubercles on one side and crescents on the other, the former being external in the superior series. The first superior molar has an additional tubercle at its anterior extremity. The incisors have a transverse anterior face, which is divided by several delicate ridges.

Length of superior molar series, .0065; length of first superior molar, .0028; interorbital width, .0042 Length of inferior molar series (specimen

No. 2), .0064; length of first molar, .002; width of incisor, .001; depth of ramus at second molar, .004.

The *Hesperomys nematodon* is about as large as the red squirrel, *Sciurus hudsonius*, and considerably larger than the *H. loxodon*.

PACICULUS Cope.

Paleontological Bulletin No. 31, p. 2, Dec. 24, 1879. Proceedings American Philosoph. Society, 1879 (1880), p. 371.

Superior molars three, rooted. Enamel forming three entrant loops on the external face of the crown, and one on the internal face.

While the number of the superior molars of *Paciculus* is as in the *Muridæ*, the details of their structure is much as in *Dasyprocta* and *Fiber*. Two species are known.

In the *P. lockingtonianus* the cranial characters are as follows: The infraorbital foramen is very large, with a general triangular outline. The superciliary borders and temporal ridges are well separated, and there is no sagittal crest. There are no postorbital processes. The otic bullæ are large, and furnished with a very large meatus auditorius externus. The malar is a narrow bone extending to the glenoid cavity posteriorly, and resting anteriorly on a prominent peduncle composed of a maxillary bone. It probably reaches the lachrymal.

This genus is probably one of the *Muridæ*, and a near ally of *Sigmodon* and *Neotoma*. It differs from these genera in having three external inflections of the enamel in the superior molars, instead of two. It differs from *Hesperomys* as these two genera do, viz, in having deep enamel inflections instead of tubercles and valleys. It is true that the deepening and narrowing of the valleys of the molars of *Hesperomys* would result after wear in a pattern like that of *Neotoma*. The same process in *Eumys* would produce a pattern much the same as that of *Paciculus*, but that genus is further characterized by the contraction of the postorbital region and the production of a sagittal crest.

Two species of this genus are known to me, *P. insolitus*, a smaller, and *P. lockingtonianus*, a larger one. Both are from the John Day beds of Oregon. They demonstrate an early origin for the American type of *Neotoma*, as contemporaries of the first of the *Hesperomys*.

PACICULUS INSOLITUS Cope.

Locis citatis.

Plate LXVI; figs. 31, 32.

Size small. Molars regularly and rapidly diminishing in size posteriorly. Inner enamel loop turned forwards; the external straight and transverse, excepting in the first molar, where the anterior column of the tooth is extended forwards, and the anterior loop is turned backwards. No fossettes. The first molar is longer than wide, and is contracted forwards; the second and third are subquadrate in form, with the inner angles rounded. The palate is wide, considerably exceeding the long diameter of the first molar.

Measurements.

		M.
Length of superior molar series		.0060
Diameters of first molar	anteroposterior	.0021
	transverse	.0018
Length of third molar		.0010
Width of palate at first molar		.0040

The *Paciculus insolitus* is about the size of the Chipmunk, *Tamias striatus*.

PACICULUS LOCKINGTONIANUS Cope.

Eumys lockingtonianus Cope, Bulletin U. S. Geological Survey, Terrs., VI, 1881, p. 176.

Plate LXIV; fig. 10.

This rodent is represented by a nearly perfect skull, which is without lower jaw. Its specific characters separate it widely from the *Eumys elegans* Leidy and *Hesperomys nematodon* Cope. It is considerably larger than either, and the temporal ridges are very obsolete and do not unite posterior to the orbits, as in *E. elegans*, resembling in this respect the *H. nematodon*. The parietal region is wide and flat above. The interorbital region is only moderately contracted. The muzzle is rather short as compared with the total length of the skull. The interorbital region is gently convex above, and the top of the muzzle is flat. The zygoma is quite slender, and the otic bullæ are large and prominent. The notch of the palate extends as far forwards as the posterior part of the last superior molar. The infraorbital foramen is very large and round.

The anterior face of the superior incisor is nearly plane, and it is marked by a weak groove near the inner and a strong groove near the external border In *E. elegans* this face is convex and without grooves. The molars are rather small for the size of the skull; their crowns are worn by use. The third is subround in section, and its diameter is about half that of the first; the latter has the anterior odd lobe quite small.

Measurements.

	M.
Total length of skull	.0380
Length (axial) to front of orbits	.0140
Length (axial) to palatal notch	.0190
Length (axial) to first molar	.0120
Width at otic bullæ	.0205
Width at middle of zygomata	.0220
Width of interorbital space	.0060
Width between first molars	.0055
Length of molar series	.0070
Length of first molar	.0030
Width of superior incisor	.0015

This species is dedicated to my friend, W. N. Lockington, the well-known naturalist of San Francisco.

ENTOPTYCHUS Cope.

Paleontological Bulletin No. 30, p. 2, Dec. 3, 1878; Proceeds. Am. Phil. Soc., 1878–'79, p. 64.

Family *Saccomyidæ*.[1] The cranium is elongate, and presents inflated periotic bones, and slender zygoma. The foramen infraorbitale is small and anterior in position, entering the maxillary bone near its suture with the premaxillary.

Generic characters.—Molars $\frac{4}{4}$-$\frac{4}{4}$, rootless, and identical in structure. The crowns are prismatic, and in the young stage present a deep inflection of enamel from one side, the external in the superior teeth, the internal in the inferior. After a little attrition, the connection with the external enamel layer disappears, and there remains a median transverse fossette, entirely inclosed by enamel. The tooth then consists of two dentinal columns in one cylinder of enamel, separated by a transverse enamel-bordered tube. Incisors not sulcate.

[1] *Geomyidæ* Alston.

The teeth of this genus differ from those of *Perognathus* in being without distinct roots, and in having the enamel loop cut off and inclosed. In *Dipodomys*, the molars are undivided simple prisms.

The skull is compact, and does not display the vacuities or large foramina seen in some genera of *Rodentia*. The incisive foramina are rather small and posterior in position. There is a foramen on the side of the alisphenoid, which is nearly in the position of the anterior alisphenoid canal of the *Thomomys bulbivorus*. The foramen rotundum is immediately below and within the anterior part of the glenoid cavity. The foramen ovale is not distinct from the foramen lacerum anterius, and is on the external side of the apex of the petrous bone. The other *foramina lacera* are closed, so that the carotid foramen pierces the inner side of the otic bullæ. The condyloid foramen is close to the occipital condyle. The meatus auditorius externus is at the extremity of a tubular elongation of the bulla, and is separated by a space from the zygomatic process of the squamosal bone. Between the bases of these is a fossa which is bounded above by a ridge as in the genus *Castor*. Below this ridge is a subsquamosal foramen, and above it a postsquamosal. There are no postparietals nor mastoid foramina.

There are deep pterygoid fossæ, whose inner bounding laminæ unite on the middle of the palatine border, and whose external laminæ are continuous with the posterior extremity of the maxillary bone. The otic bullæ are not separated very distinctly from the mastoid. The latter looks like a continuation of the former, as in *Thomomys*, and occupies considerable space between the exoccipital and the squamosal. The latter sends downwards a process just posterior to the auricular meatus, which forms the handle to a hammer-shaped laminar bone. This is, no doubt, a dismemberment of the squamosal, as a similar process is continuous with that bone in *Thomomys*, and one somewhat different is seen in *Neotoma*, *Hesperomys*, &c. Supraoccipital distinct on superior face of skull Paroccipital process small or none. Mastoid elongate, adherent to otic tube. No postfrontal process.

A well-marked character which distinguishes the skull of this genus from *Thomomys*, *Dipodomys*, &c., is the separation of the meatal tube of the otic bulla from the zygomatic process of the squamosal bone by an inter-

space. There is no postsquamosal foramen in the recent genera. In *Dipodomys* the otic bulla is more largely developed, but it has the anterior bottle-neck prolongation seen in *Entoptychus.*

In the mandible the coronoid process is developed, but is not large. It is well anterior to the condyle, which it somewhat exceeds in height. The incisive alveolus forms a convexity on the outer side below the coronoid process. The angle is prominent, and is at first incurved below, and then turned outwards at the apex. The degree of obliquity of the grinding surfaces of the molar teeth vary with the species.

Parts of several skeletons are in my collection, but I cannot attach them to any cranium. They present the general characters of the genus *Thomomys* so far as they go. I describe some bones which apparently belong to one individual. The sacral vertebræ carry neural spines. There was evidently a well-developed tail. The scapula has a narrow glenoid cavity ending in a tuberosity adjacent to the coracoid hook. The spine is robust, terminating in a stout acromion. The tuberosities of the humerus are situated below the head, and are so rounded off as to be little prominent. One side of the greater is continued into a very prominent deltoid crest, which terminates abruptly below. The ilium has a narrow trilateral neck, and a projecting anterior inferior spine. The pubis is directed posteriorly at the base. The femur is not elongate. Its trochanters are well-marked, including a third. This is wanting in *Thomomys bulbivorus.* The neck rises obliquely to the rather large head. The condyles are short and spreading, and the rotular groove is short and rather wide, and with well-marked ridges. The tibia is much curved backwards at the proximal part. The crest is acute and is directed outwards, but does not project much at the head.

Individuals of this genus were very abundant in Oregon during the middle Miocene epoch. They represent several species, but how many it is difficult to determine. The most noteworthy variations are found in the development of superciliary ridges; then there are modifications in the forms of the premolar teeth, differences in the length and width of the muzzle, and some range in dimensions.

The following table represents the characters of the species so far as I can determine them at present:

A. Thickened superciliary ridges wanting; front wide.
  Superciliary borders obtuse, not continued into temporal ridges; front flat, or little concave; premolars narrow.
    Length of skull .046 ..... *E. planifrons.*
    Length of skull .038 ..... *E. minor.*
  Superciliary borders sharp, vertical, continued into two straight temporal angles, which form a V.
    Premolars narrow; size of *E. planifrons* ..... *E. lambdoideus.*
AA. Thickened ridge on the superior side of each supercilium; front narrower.
  Superciliary ridges soon discontinued; size of *E. planifrons*..... *E. cavifrons.*
AAA. Superciliary ridges much thickened, soon uniting, and closing the frontal groove behind. Front narrowest.
  Premolar widened at the base; size of *E. planifrons*..... E. *crassiramis.*

Some differences in the form of the mastoid bone may be observed in species of this genus. Thus it is flat behind, and bears a well-marked "lateral occipital" angle in *E. planifrons* and *E. lambdoideus*, while in the remaining species it is convex, and with the angle little apparent. In some specimens the loss of the hammer-shaped squamosal dismemberment, which I will call the posttympanic bone, gives a deceptive extension forwards to the mastoid.

Parts of more than a hundred individuals of *Entoptychus* are in my collection.

ENTOPTYCHUS PLANIFRONS Cope.

Paleontological Bulletin No. 30, p. 3, December 3, 1878. Proceedings Amer. Philos. Soc., 1878 (1879), p. 65. American Naturalist, 1883, p. 170, fig. 18.

Plate LXIV; fig. 1.

A nearly perfect skull, with a portion of a second, are the only specimens that I can certainly refer to this species. They represent the largest size found in the genus.

The muzzle is long, and gently decurved anteroposteriorly, and slightly convex transversely The length from the side of the orbit at its anterior border to the extremity of the nasal bones is exactly equal to the length from the same point to the inion at one side of the middle line. The front in the more perfect skull is slightly concave, but is without lateral ridges; in the less perfect specimen it is more nearly flat. There is no trace of

temporal ridges, and a delicate raised line represents the sagittal crest. The muzzle is wider above than below, and the superior and lateral faces are separated by a distinct angle, which is acute on the posterior half. In front of the superior part of the orbit is a fossa, which is directed obliquely upwards and forwards. The fundus of the orbit is not as large as in some species, giving a greater depth to the maxillary bone, which is an indication of length of the prisms of the superior molars. The palatal surface has two grooves, each of which is continued into a pterygoid fossa. The otic bullæ are rather small for the genus, and are flattened behind. Anteriorly they are continued into a neck on each side, which meets its mate of the opposite side on the middle line, resting on the basisphenoid bone. Each neck is pinched off backwards, so that the two inclose an angle between them. The tympanic or meatal tube in this species is very long, exceeding that of any other species, and equaling the long diameter of the bulla without the anterior neck. The mastoid adheres closely to the posterior side of the tube, extending to its extremity, and separated from it on the inferior side by a groove. The posterior side of the mastoid is triangular in form, and is nearly flat. Inferiorly there is no groove marking its point of separation from the bulla; superiorly it carries a strong angle from the inion to its external extremity. The superior face of the brain-case is nearly flat. The occiput is vertical, slightly concave between the points of junction with the mastoid, and with a slight median keel above. The foramen magnum is large, subquadrate, and a little wider than high. The basioccipital supports a median keel, and is concave on each side in front of the condyles.

The supraoccipital bone has a rather wide triangular exposure. The parietals diverge from the middle line anteriorly, and the suture reaches the squamosal near the posterior border of the orbit. The posterior extremity of the nasal bones reaches that of the premaxillaries, and both terminate in line with the deepest part of the preorbital fossa.

The superior molar teeth display the typical characters of the genus. Each has an external groove for part of its length, and the anterior column of the last premolar has no anterior production, but has the form of the other teeth. The sizes are, commencing with the largest, 2–1–3–4.

The inferior edge of the angular portion of the mandible is strongly inflected, and the interior face below the molars is concave. The inferior

boundary of the masseteric fossa is well marked, and terminates below the anterior border of the first molar. The grinding face of the molars is very oblique anteroposteriorly, and that of the first molar is rather smaller than that of the second and third. It has no anterior expansion at the alveolus. The tuberosity of the incisive alveolus is not very prominent.

Measurements.

No. 1.

	M.
Length of skull from end of nasal bones to occipital condyles, inclusive	.046
Length from front of premaxillary bone to base of Pm. iv	.021
Length of molar series on base	.009
Length from occipital condyles to junction of otic bullæ, inclusive	.011
Length of nasal bones	.020
Length of supraoccipital bone	.008
Width of otic bulla at middle	.006
Length of tympanic tube	.005
Width of muzzle at middle	.009
Width of interorbital space	.007
Width of skull at anterior extremity of glenoid cavity	.0165
Width of skull at meatus	.0205
Width of occipital bone posteriorly	.013
Width of foramen magnum	.006
Length of inferior molars on alveoli	.0080
Elevation of first molar above alveolus	.0036
Width of crown of second molar	.0025
Depth of ramus at third molar	.0070
Width of ramus below at third molar	.0050

No. 2.

Width of interorbital space	.007
Width of muzzle at middle	.0086
Elevation of skull from second molar	.0130
Length of inferior molar series	.0072
Depth of ramus at M. 2	.0072
Width of inferior face at M. 2	.0043
Width of inferior incisor	.0018
Distance between infraorbital foramen and M. 1	.0050

Besides the characters already mentioned, the somewhat greater interorbital width distinguishes this rodent from the *E. cavifrons*.

ENTOPTYCHUS LAMBDOIDEUS Cope.

Bulletin U. S. Geol. Survey Terrs., IV, 380.

Plate LXIV; fig. 2.

This species is represented by two parts of crania, which include the interorbital and adjacent regions, with the molar teeth. A nearly entire skull presents some of the characters of this species and some of those of

E. cavifrons, so that its validity may be thought to be as yet not entirely beyond question.

In this species, the interorbital region is concave, but there is no ridge-like thickening of the supraorbital border. It presents, on the contrary, a subacute superior edge, flush with the inferior part of the same border. These edges leave the orbital border posteriorly, and converge in straight lines to an acute angle, forming two temporal ridges. The nasal bones do not extend as far posteriorly as the premaxillaries, which reach to the inner line of the anterior border of the orbit. The anterior molar tooth is like the others, and has no anterior basal extension.

The size is about equal to that of *E. planifrons*.

Measurements.

	M.
Interorbital width	.0064
Anteroposterior length of orbit	.0100
Depth of skull to alveolar edge	.0140
Length of series of superior molars	.0070
Width between bases of Pm. iv	.0030

The skull above referred to presents the temporal ridges of the typical specimens. It has also lateral occipital angle of the mastoid, as in *E. planifrons*, and a meatal tube nearly as long as in that species, differing in both points from the *E. cavifrons*. But it has a ridge-like thickening of the supraorbital border, as in that species, and the interorbital space has the same relative width.

Its size is that of *E. cavifrons*.

ENTOPTYCHUS MINOR Cope.

Bulletin U. S. Geol. Surv. Terrs., IV, 379.

Plate LXIV; fig. 3.

This was an abundant species. Eight more or less complete crania are in my collection, and many fragments present the characteristic measurements. It is the smallest species, and is characterized also by the perfectly flat interorbital region and the absence of temporal ridges.

The muzzle of the skull is shorter than in *E. planifrons*, as may be seen by the measurements, and it is also narrower above, as compared with the interorbital width. The preorbital fossa is not well defined in front. The otic

bulla is angulate along the inferior middle line, and has a narrower form than that of any of the other species of the genus. The bottle-neck processes send out prolongations, which meet on the middle line below. The mastoid is convex posteriorly, but carries a lateral occipital angle above.

The molars of the superior series are fissured on the external side for a distance, and the anterior is like the others in both jaws. The superior incisors are slightly convex anteriorly, and are perfectly smooth, except a delicate groove close to the inner border, a character found in most of the other species.

The masseteric ridge of the mandible extends as far forward as the line of the front of the first inferior molar, and is well defined posteriorly to near the angle.

Measurements.

	M.
Length of skull from front of premaxillary bone to posterior face of mastoid	.038
Length from front of premaxillary to base of Pm. iv	.018
Length of molar series on base	.0066
Width of otic bulla at middle	.0040
Length of bulla and mastoid	.0110
Width of muzzle at middle	.0080
Width of interorbital space	.0055
Depth of mandible at M. i	.0060

John Day River, Oregon.

ENTOPTYCHUS CAVIFRONS Cope.

Paleontological Bulletin No. 30, p. 2. Proceedings American Philosophical Society, 1878 (1879), p. 64.

Plate LXIV; fig. 4.

I refer portions of six crania to individuals of this species, and seven others probably belong to it. It differs from the *E. minor* in its superior size, and in the presence of superciliary ridges. These ridges are rarely as thick and prominent as in the *Pleurolicus sulcifrons*, and do not approach the development seen in the *Entoptychus crassiramis*.

The postorbital part of the skull is subquadrate in outline and depressed in form. The interorbital region is narrowed, but the superciliary margins do not meet nor converge to form a sagittal crest. They are thickened, forming two subparallel ridges which are separated by a shallow concavity of the frontal bone. The nasal bones are very narrow, and their posterior apices just attain the line of the supero-anterior angle of the orbit. The

base of the malar bone is much elevated and very oblique. The otic bulla is flattened on the inner face, as in *E. planifrons*, and is not so compressed as in the described specimen of *E minor*. The mastoid bone is convex posteriorly, and supports an obtuse keel continuously with the inion. The meatal tubes are broken off, but they were evidently not so long as in *E. planifrons*. The postsquamosal foramen is large, and is near the posterior lateral ridge of the squamosal bone. The frontal width of this species is less than that of the *E. planifrons* and *E. lambdoideus*, being just half of that of the muzzle at its middle. In most of the crania the nasal bones do not extend so far posteriorly as the premaxillaries. In one of them the sagittal crest is quite prominent; in others more or less distinct traces of it are visible.

The molar teeth are directed obliquely backwards, the alveolus of the first issuing below the anterior part of the orbit. The first superior molar is the largest, but does not differ in form from the others; and the proportions of the others diminish regularly posteriorly. The first inferior molar is a little smaller than the second and third, and is about equal to the fourth; its anterior column is contracted; while the last molar is like the second and third. The face of the inferior incisor is flat, and its enamel is smooth. The external face of the jaw is bounded below by a strong angle as far anteriorly as below the first molar.

Measurements.

	M.
Length of skull to incisive alveoli	.041
Width of skull at mastoids	.020
Width of skull between orbits	.005
Width of skull at middle of muzzle	.010
Elevation of skull from second molar	.011
Length of molar series	.007
Length of first molar	.002
Width of first molar	.002
Length of crown of last molar	.0015
Width of crown of last molar	.0015
Length from M. 1 to infraorbital foramen	.007
Depth of mandibular ramus at M. 2	.006
Width of face of inferior incisor	.0016

John Day River region of Oregon.

ENTOPTYCHUS CRASSIRAMIS Cope.

Paleontological Bulletin No. 30, p. 3. Proceeds. Am. Philo. Soc., 1878 (1879), p. 65. American Nauralist, 1883, p. 169, fig. 17.

Plate LXIV; fig. 5.

This species was originally established on mandibular rami. I find, in my later collections, rami of this character attached to crania, which enable me to fix the definition of the species with greater precision than heretofore.

The skull is about the size of that of *E. planifrons*, and has a relatively shorter muzzle. The internal orbital walls are rolled inwards at the supraorbital region so as to meet at a point opposite the posterior border of the orbital space. Opposite the anterior part of the orbit, the ridges are more widely separated, so that the interspace is a narrow wedge-shaped fossa, opening forwards. There are no temporal ridges, and only a weak sagittal crest. There is no preorbital fossa, but the preorbital ala of the maxillary bone is very prominent. The orbital fossa is small and profound, leaving a full depth to the maxillary alveoli. The otic bulla is ovate, and not keeled or flattened. Its size is medium, and its anterior bottleneck is continuous with the external pterygoid lamina. The meatal tube is elongate, but not so much so as in *E. planifrons*. The mastoid bone is not distinguished from the bulla by a groove, and it is convex both vertically and transversely. It is injured in the specimen superiorly. The superior molars display an external fissure for part of their length. The premolar has the base extended anteroposteriorly more than in any species of the genus. The premaxillo-maxillary suture is exactly half way between the bases of the incisor and first molar. It is much nearer the first molar in *E. planifrons*.

Measurements.

	M.
Length of cranium from premaxillary to mastoid, inclusive of both	.048
Length from front of premaxillary to Pm. iv	.022
Length of molar series on base	.008
Length of otic and mastoid bullæ	.015
Width of otic bulla at middle	.007
Interorbital width	.006
Width at anterior border of glenoid cavity	.017
Depth of skull at M. i	.0155

In the mandibular rami the inferior masseteric ridge extends to below the anterior border of the first molar, and is very prominent and acute. It results that both the exterior and inferior aspects of the ramus are concave to the anterior extremity of the crest, which slopes upwards. The incisive alveolus, though not prominent, as in *Hystricomorpha*, is on the inner side of the base of the ramus in front. Above the alveolar prominence the inner face of the ramus is gently concave. The anterior origin of the coronoid process is opposite the posterior border of the second molar.

In the mandible the condyle projects as far backwards as the angle, and is hence quite a distance posterior to the coronoid process. The latter is small, and is a little higher than the condyle. The angle has an acuminate apex, which is turned out. The posterior extremity of the incisive alveolus forms a prominent tuberosity, bounding a fossa of the ascending ramus on its external side. The inferior outline of the mandible follows the curve of the incisor tooth anteriorly to the middle of its length, when it reaches the line of the inferior border of the masseteric fossa. Here it commences another convexity, which is most prominent directly below the incisive tuberosity, and ascends again to the angle.

The triturating surface of the molars is not oblique, as in *E. planifrons*, but is nearly horizontal. The enamel of the incisor is smooth, and has a well-marked bounding angle at the inner edge, and another within the external edge.

Measurements.

	M.
Length of inferior molar series	.0082
Width of anterior face of inferior incisor	.0028
Depth of ramus at M. ii	.0090
Width of ramus below at M. ii	.0052

Though this species is larger than any other species excepting the *E. planifrons*, its interorbital width is the least. Its peculiar frontal groove is only approached by some specimens of the *Pleurolicus sulcifrons*. I have only two crania which undoubtedly belong to the *E. crassiramis*, while a third very probably may be referred to it. Both the former have mandibles attached.

John Day River, Oregon.

PLEUROLICUS Cope.

Paleontological Bulletin, No. 30, p. 3, Dec., 1878. Proceed. Amer. Philo. Soc., 1878 (1879), p. 66.

Family *Saccomyidæ*. Superior molars rooted and short-crowned. The crowns with a lateral fissure bordered with an inflection of the enamel sheath, extending to their bases. In the superior molars this inflection is on the external side, and does not divide the crown. Superior incisors not grooved.

This genus is curiously near to the existing *Heteromys* and *Perognathus*, the two genera of *Saccomyidæ* with rooted molars. The former differs in having the molars divided into two columns, each of which is sheathed in enamel, while *Perognathus* only differs, so far as I am aware, in having the superior incisors grooved. It is also very nearly related to *Entoptychus*, and two of the species correspond in various respects with two of those of that genus. In view of the fact that most of the specimens of the *P. sulcifrons* are old individuals with well-worn molars, the idea occurred to me that the rooted character of the molars might be common to the species of *Entoptychus*, but that it might not appear until long use had worn away most of the crown, and the protrusion had ceased. Examination of the bases of the long molars of *E. planifrons* did not reveal any roots. It is also opposed to this view that the maxillary bone of the *Pleurolici* has little depth below the orbital fossa, appropriately to the short-rooted molars, while the depth is considerable in the typical *Entoptychi*, though there is a complete gradation in this respect. But I have demonstrated satisfactorily that *Pleurolicus* is a distinct genus by observations on the *P. leptophrys*. Some of my individuals of this species are young, with the crowns of the molars little worn; yet the roots diverge immediately on entering the alveolus on all the molars. In the species of *Pleurolicus* the lateral fissure of the crown descends to its base, and hence persists longer than in the typical *Entoptychi*.

I am acquainted with two species of this genus. The posterior part of the skull of an individual represents a third species, which I refer provisionally to this genus.

The characters of the species are as follows:

I. Otic and mastoid bullæ continuous.
  Temporal ridges uniting into a sagittal crest; length of skull .043; supraorbital ridges and concave front ..... *P. sulcifrons.*
  Temporal ridges not uniting; length of skull .035; interorbital region flat; no ridges ..... *P. leptophrys.*
II. Otic and mastoid bullæ separated by a deep groove.
  Temporal ridges not united; front concave; size medium; supraoccipital wide ..... *P. diplophysus.*

PLEUROLICUS SULCIFRONS Cope.

Paleontological Bulletin, No. 30, p. 4. Proceedings American Philosophical Society, 1878 (1879), p. 66.

Plate LXIV; fig. 6.

Five crania represent this species in my collection; only one of these includes the posterior portions. In two of them the molar teeth are well worn; in one (the type) they present a medium degree of wear, and in two the roots only are preserved. This species resembles those of the allied genus *Entoptychus* in many respects. The superciliary borders are thickened upwards, forming two ridges, which inclose a groove between them which is more pronounced than in most specimens of the *Entoptychus cavifrons.* The muzzle is plane above and considerably wider than the interorbital space. The base of the malar is thin and oblique, and the *foramen infraorbitale exterius* is well in advance of the molar teeth and at the anterior part of the maxillary bone. A groove passes backwards from its inferior border, terminating in a small foramen which marks a point nearly half way to the first molar. This foramen is present in all the crania. Within this another shallow groove bounds the more prominent median line. The palatal surface exhibits two shallow lateral grooves, which commence opposite the posterior border of the first molar.

The otic bullæ are oval and not keeled, and have the usual bottleneck. The mastoids are convex behind, and carry above an obtuse angle from the inion.

The grinding surfaces of the molars are transverse ovals, only interrupted by the exterior fissure. The first molar is slightly different in form, being larger, and its section, when not much worn, being nearly round. Its

anterior portion extends towards the alveolus, giving an anteroposterior oval on prolonged wear. Each tooth has three roots, one interior and two exterior; in the first they may be described as two posterior and one anterior. The last molar is the smallest, the series exhibiting a regular gradation in size.

Measurements.

No. 1.	M.
Interorbital width	.0050
Width of muzzle at middle	.0080
Depth of cranium at M. ii	.0138
Length of molar series along base	.0080
Diameter of second molar { anteroposterior	.0016
Diameter of second molar { transverse	.0020
Width of face of superior incisor	.0020
No. 2.	
Length of cranium from mastoid bulla to premaxillary, inclusive	.043
Width of skull at mastoid bullæ	.021
Length of superior molar series on base	.008
Width between bases of Pm. iv	.0025

John Day River region of Oregon.

PLEUROLICUS LEPTOPHRYS Cope.

Bulletin U. S. Geol. Survey Terrs., IV, p. 381. American Naturalist, 1883, p. 167, fig. 16 a, b.

Plate LXIV; figs. 7–8.

This species is in its typical form smaller than the last, and resembles in its size and its plane interorbital region the *Entoptychus minor*. Four more or less complete crania represent it, two of which are of young and two of old animals, as indicated by the degree of attrition of the molar teeth. In only two of them is the parietal region so preserved as to show the separate temporal ridges

The interorbital region is flat and without superciliary ridges. The diastema is just twice as long as the series of molar teeth. The auditory bulla is oval and not compressed or keeled, and the mastoid bulla is very convex posteriorly, and carries a very obtuse angle from the inion above. In young individuals the enamel inflection of the Pm. iv extends entirely across the crown. When the internal groove has disappeared on wear, the grinding surface is subround. With age the protuberance of the anterior root is reached, and the form of a horizontal section of the base is pyriform. The width of the front is two-thirds that of the muzzle.

Measurements.

	M.
Length of skull, including mastoid bulla	.0340
Length from front of premaxillary to Pm. iv	.0145
Length of otic and mastoid bullæ	.0100
Interorbital width	.0050
Width of muzzle at middle	.0080
Width between the Pm. iv s	.0028

The exposure of the supraoccipital is wide and subquadrate, resembling only that of the *Pleurolicus diplophysus* among the rodents of this group. The temporal ridges converge gradually in a straight line posteriorly to the supraoccipital bone and then diverge without coming in contact.

The John Day River of Oregon.

PLEUROLICUS DIPLOPHYSUS Cope.

Bulletin U. S. Geol. Survey Terrs., IV, p. 381. American Naturalist, 1883, p. 167, fig. 16 c, d.

Plate LXIV; fig. 9.

A fragment of a skull which includes all posterior to the interorbital region is all that represents this species. The maxillary bones and teeth are lost. The interorbital region is concave, there being on each side a low angular ridge. These ridges continue into the temporal ridges, which have the same character as in the *P. leptophrys*. They are straight and converge to the anterior part of the supraoccipital bone, where they do not come in contact, but diverge to end at the inion. The supraoccipital a triangle with obtuse apex and as wide as long. The tympanic tube is quite short, the shortest found in this group. The mastoid bulla is large, a little exceeding the otic, and has a general convex external face, which is not divided into two planes, an external and a posterior, by a straight angle, as in most of the allied species. There is a small portion homologous with the external face which turns inwards and passes under the squamosal, leaving a considerable fissure-like foramen, which is wanting in most of the other species. The postsquamosal foramen is large, and the hammer-shaped bone very distinct, sending its posttympanic process to the meatus. The otic bulla is cut off from the mastoid by a deep oblique fissure. One end of the fissure is marked by the posttympanic process, and the other by the paroccipital. The bulla is compressed and flattened on both inner and external sides. A strong rib con-

nects the occipital condyle and the paroccipital process, *above* which is the condyloid foramen.

Measurements.

	M.
Length from middle of supraorbital border to inion	.018
Width of interorbital space	.0055
Width between mastoid bullæ	.0190
Width of occipital bone	.0100
Width of foramen magnum	.0050
Length of otic bulla alone	.0100

This cranium is well preserved, and has been perfectly cleaned by weathering. It shows a good many points of difference, as compared with any of the other species of this group. It is to be regretted that the teeth are wanting.

LAGOMORPHA.

PALÆOLAGUS Leidy.

Proceedings Academy Philada., 1856, p. 89; Extinct Mamm. Dakota and Nebraska, p. 331.—Cope, Ann. Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 477.

Family *Leporidæ*. Dentition: I. $\frac{2}{1}$; C. $\frac{0}{0}$; M. $\frac{6}{5}$; or, Pm. $\frac{3}{2}$, M. $\frac{3}{3}$. Superior incisors sulcate, inferior incisors not sulcate. First and last superior molars simple, intermediate ones with an enamel inflection of the inner side, which soon wears out. First inferior molar of one more or less transversely divided column; other inferior molars consisting of two columns in antero-posterior relation. No postfrontal process.

The above characters approximate nearly those of the existing genus *Lepus*. The only distinction between them signalized by Dr. Leidy is the more simple first inferior molar of the extinct genus, which consists of one column more or less divided. In *Lepus* this tooth consists of two columns, the anterior of which is grooved again on the external side in the known species. I am able to reinforce this distinction by a strong character, viz, the absence of the postfrontal process in *Palæolagus*. As compared with the extinct genus *Titanomys* of Meyer,[1] the difference is well marked, as that genus has the molar teeth $\frac{5}{4}$ instead of $\frac{6}{5}$. The last inferior molar is cylin-

[1] *Amphilagus*. Catal. Méth. et Descr. Vertèbres Fossiles de la Basin de la Loire, 1853, p. 42.

dric, consisting of but one column. The first inferior molar consists of two cylinders broadly united, as in the corresponding tooth of *Palæolagus*. As compared with *Panolax* Cope,[1] which is only known from superior molar teeth, this genus may be at once recognized by the simplicity of the last tooth. In *Panolax* it consists of two columns.

Dr. Leidy's descriptions and figures, which are available for the definition of this genus, relate exclusively to the dentition. Characters drawn from the skeleton generally have been derived from my material and are now given.

The nasal bones are wide, and the suture which separates them both from the frontal is concave forwards. The median frontal suture is persistent. The ascending portion of the premaxillary, which attains the frontal, is very narrow. The superior half of the facial plate of the maxillary bone is sharply rugose with reticulate ridges, but whether perforate or not I cannot certainly determine. The *foramen infraorbitale* is small and round, and issues below the reticulate portion of the maxillary. The otic bulla is compressed globular, with very thin walls. The meatus is large and has prominent lips, which open upwards. The mastoid is coössified with the bulla, and extends with a dense surface from behind to above and in front of the meatus. The incisive foramina are very large, enter the maxillary bones deeply, and are confluent posteriorly. The palate may be said to extend to the last molar, but there is a deep though narrow median posterior emargination.

The distal extremity of the *humerus* is not so extended transversely as in *Ischyromys*, and exhibits a moderate epicondyle. The inner flange of the condyles is well developed, and on the posterior face it is supplemented by a flange of the external edge of the condyles, which is as prominent or even more so, forming an intertrochlear crest. The arterial canal is inclosed by a slender bridge, and opens on the inner side above, and anteriorly below. In an ulna supposed to belong to this genus the coronoid process is elevated. The radial facet forms a narrow transverse plane, nearly divided by a wide anterior emargination. The shaft is compressed vertico-obliquely. A radius

[1] Report Lieut. G. M. Wheeler, 4to, IV, p. 296.

exhibits a transversely oval humeral face of the head somewhat angulate at a superior and an infero-lateral extremity, which are diagonally opposed to each other. Beyond the middle the shaft becomes wider, and is flattened obliquely.

The peduncle of the *ilium* has a triangular section, the anterior face being the narrowest, and inclined at a little more than a right angle to the interior face. It expands but little at the sacral extremity, and the crest is very short. The external angle of the peduncle is very prominent and runs into the anterior extremity of the crest, from which proceeds also the more obtuse angle which is continuous with the pectineal line. A third longitudinal angle is seen on the middle of the external side of the sacral extremity, which is not continued on the peduncle. There is a prominent tuberosity on the median or first-described angle on the peduncle, which may or may not be homologous with the anterior inferior spine. There is no tuberosity on the inner bounding angle of the inner face as is seen in *Gymnoptychus*. The pubis leaves the ilium at right angles. Acetabulum nearly round.

The *femur* has well developed great and little trochanters, and a third trochanter, which rises from the shaft in line with the inferior border of the little trochanter. The fossa of the great trochanter is well marked. The head is not separated from the great trochanter by a deep emargination, and projects well within the internal face of the shaft. Its articular surface is prolonged towards the great trochanter. *Fossa ligamenti teris* isolated. The distal extremity of the femur exhibits the superiorly prolonged patellar groove characteristic of this group of rodents. The condyles are more than elsewhere produced downwards and posteriorly, and are well separated.

The spine of the *tibia* is rudimental, and the crest is very obtuse. The inferior continuation of the latter forms a prominent reverted keel on the proximal front of the shaft, which is deeply concave on its inner side. The posterior face is also concave, and is separated by a laminar external bone from the external side. The external border of the head is not deeply notched as in *Panolax*. The fibula unites with the tibia on the proximal part of the latter. The remainder of the shaft is smooth. The external malleolus is large and at right angles to the long diameter of the distal end

of the bone, and its extremity is a facet for contact with the calcaneum. On its external face is a prominent process directed backwards. The external trochlear groove is deeper than the internal, and is well separated from it. The internal malleolus can scarcely be said to exist. It may be represented by a small process on the inner side of the extremity of the shaft.

The *astragalus* is elongate and flat, and the trochlear portion is oblique. The neck is elongate, and convex on the inner side; the constriction is on the inner side immediately behind the head. The long diameter of the latter makes an angle of 45° with the horizontal plane. The external trochlear arc is much larger than the internal. The cotylus, which fits the external condyle of the calcaneum, possesses a peculiar impressed area on its posterior surface. The calcaneum extends nearly as far anterior to its condyle as posterior. The free portion is subcylindric or subquadrate to the end. The internal process for the astragalus is quite prominent. The cuboid facet is directed obliquely inwards, running into a short longitudinal groove. The cuboid extremity is little depressed.

The skeletal characters above enumerated were taken from the bones of *P. turgidus* and *P. haydeni*, excepting in the cases of the ulna, radius, ilium, and calcaneum, which were derived from those of *P. haydeni* only.

A cast of the cranial chamber of a specimen of *Palæolagus haydeni* displays the superficial characters of the *brain*. As in the order generally, the hemispheres are small and are contracted anteriorly. The greater part of the cast of the cerebellum is lost, but enough remains to show that it was large. The olfactory lobes are large; they are not gradually contracted to the hemispheres, but expand abruptly in front of them, being separated by a constriction only. They are wider than long, and than the anterior extremity of the hemispheres. Their cribriform surface is wide, and extends backwards on the outer sides. Traces of the three longitudinal convolutions can be observed on the hemispheres above the *lobus hippocampi*. The internal and median are continuous at both extremities, and with the external to the base of the olfactory lobes. There is no definite indication of the Sylvian fissure. The *lobus hippocampi* protrudes laterally a little beyond the border of the external convolution. Its form is depressed.

As compared with the brain of the rabbit (*Lepus cuniculus*) figured by Leuret and Gratiolet,[1] that of the *Palæolagus haydeni* is distinguished by the absolutely much smaller size of the hemispheres, and by the absolutely larger olfactory lobes, the excess being in transverse dimensions and not in the longitudinal. An important difference is also the absence of the median posterior production of the hemispheres seen in the rabbit, the prolongation in the extinct species being lateral, and extending little behind the *lobus hippocampi.* The indications of the convolutions of the superior surface are similar in the two.

As observed by Leidy, this genus presents the same number of teeth as in the existing rabbits, viz, I. $\frac{2}{1}$; C. $\frac{0}{0}$; M. $\frac{6}{5}$; and the difference consists in the fact that the first molar possesses two columns, while in *Lepus* there are three. Having collected a great number of remains of this genus, I am able to show that it is only in the immature state of the first molar that it exhibits a double column, and that in the fully adult animal it consists of a single column with a groove on its external face. The dentition undergoes other still more important changes with progressing age, so as to present the appearance of difference of species at different periods. These will be explained under the head of the *P. haydeni*, the most abundantly represented in the collections. It may be mentioned here that in neither *P. haydeni* nor *P. turgidus* is there any evidence that more than two anterior molars are preceded by deciduous teeth. The latter are present in many specimens.

Three species of this genus are known to have lived in Colorado during the White River epoch of the Miocene. Bones of two of the species have been found also in Dakota. The *P. haydeni* was probably the most abundant mammal of the fauna of that period.

Depth of ramus at penultimate molar, 9^{mm}; length of molar series, 10^{mm}; no third lobe to molars ..... *P. haydeni.*
Depth of ramus at penultimate molars, 11^{mm}; length of tooth series, 14^{mm}; a third posterior lobe of the molars ..... *P. triplex.*
Depth of ramus at penultimate molar, $12–14^{mm}$; length of tooth series, $13–16^{mm}$; no third lobe ..... *P. turgidus.*

[1] Anatomie Comparée du Systéme Nerveux, Pl. III, Figs. 1, 2.

PALÆOLAGUS HAYDENI Leidy.

Proceedings Academy Philada., 1856, p. 89. Extinct Mamm. Dakota and Nebraska, p. 331. Cope, Ann. Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 478. American Naturalist, 1883, p. 172. *Palæolagus agapetillus* Cope. Paleontological Bulletin No. 15, p. 1 (Aug., 1873). Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 478.

Plate LXVI; figs. 1–27.

The dentition of this rabbit has been fully described by Professor Leidy, but the material at the disposal of this distinguished naturalist did not enable him to furnish either the cranial or skeletal characters. My numerous specimens enable me to supply this deficiency. It is, however, to be observed that I cannot associate the skull with a skeleton as belonging to the same individual in any instance. The characteristic marks of the *Leporidæ* in all the bones of two species found mingled in profusion with the jaws and teeth of the *P. haydeni* and *P. turgidus*, in corresponding numbers, render their correlation sufficiently certain.

The form of the muzzle seen from above is that of an obtusely truncated wedge. The contraction in the width of the nasal bones forward is very slight; at the extremity they are strongly convex, while the posterior region is flat. The canthus rostralis is sharp, consisting of the narrow rib-like maxillary prolongation of the premaxillary bone, which at its anterior third is a little more elevated than the adjacent portion of the nasal bones. Its posterior apex does not extend quite so far posteriorly as that of the nasal bone, and the frontal sends a wedge-shaped prolongation to the outer side of it, which extends as a narrow splint anteriorly between the premaxillary and maxillary. The rugose patch of the maxillary extends more than half way towards the alveolar border of the superior incisors, and is bounded in front by the maxillo-premaxillary suture. It is separated from the orbit behind by a band of dense bone. The foramen *infraorbitale exterius* issues entirely below the rugose patch. The maxillo-premaxillary suture crosses the palate a little behind the middle point between the incisor and first molar, and on the side above the diastema bounds a long process forward. It then returns to the inferior border of the rugose patch, inclosing a notch with the inferior border of the same. The palatine bones are flat and occupy more than half the palate between the molars. Their common suture is at least as long as that of the maxillaries, and extends as far for-

ward as the posterior border of the second molar. From this point the anterior suture extends to the posterior border of the third molar. The palatal notch is rectangular and is not wider than the palatine bone on each side of it.

The last superior molar in this species is not grooved, has a round section, and is smaller than the first molar. The first is also small, and has a deep groove on its anterior face. Of the intermediate four molars the two median are the largest. The crowns of the molars, except the first, are without enamel on the external side, and in the last there is no enamel on the posterior side also. The inner side of the four intermediate molars is deeply grooved for a short distance, which gives a fissure-like notch on attrition. This disappears after use, as does also a less profound crescentic fossa in the middle of the crown, whose concavity is directed outwards. A line connecting the external borders of the molars is strongly convex; that connecting the interior borders but slightly convex. The superior incisors describe a short arc, their triturating surfaces being directed exactly downwards. The groove of their anterior face divides the latter equally. The inner division is more prominent than the outer.

The mandible is contracted forwards, and the inferior outline rises gradually to the short symphysis. The symphyseal articular surface is oval. The ascending ramus rises abruptly opposite the middle of the last molar. Its anterior face at the base is nearly transverse, owing to the sharp prominence of the corresponding inner border of the ascending ramus. In not one of my specimens is the angular portion of the jaw preserved. The condyle is subglobular in front, with a narrow posterior prolongation, as in the *Lepus sylvaticus.* The masseteric muscular insertion is flat and has a regularly convex anterior border, which does not extend beyond the line of the posterior border of the penultimate molar. There are two mental foramina, one on the middle of the depth of the ramus, below the fissure between the second and third molars; and the other, marking the posterior third of the diastema, near its superior border. The pterygoid fossa of the ramus is deep, and its anterior border is well defined; its anterior border is pierced opposite the middle of the vertical diameter of the ramus for the dental artery and nerve. The alveolus of the inferior incisor is marked by a lon-

gitudinal convexity of the inner aspect of the ramus, which extends along its inferior border as far as the fourth molar. A shallow groove separates its posterior half from the inferior border of the ramus.

The first and last inferior molars are smaller than the others. In the intermediate ones the posterior column is smaller than the anterior one, and is in close contact with it. Both are transverse oval in section, and the anterior is a little more prolonged inwards. The inferior incisor is rounded posteriorly, and narrowed; in front the surface is very gently convex, and slightly oblique outwards. The enamel is smooth, folds over, forming a band on the outer side, and does not fold over on the inner side.

The earliest dentition of this species known to me is the presence of the two deciduous molars, the first and second in position, before the appearance of any of the permanent series. Each of these has two roots, and the crown is composed of three lobes. In the first, the first lobe is a simple cusp; the two following are divided into two cusps each; the second is similar, excepting that the simple cusp is at the posterior end of the tooth. The grooves separating the lobes descend into the alveolus on the outer side, but stop above it on the inner. The measurements at this stage are—

Measurements.

	M.
Length of two milk-molars	0.0050
Depth of ramus at No. 2	.0042
Depth of ramus at diastema	.0032

In the next stage the third permanent molar is projected, and has, like the second deciduous, a posterior simple column, whose section forms an odd cusp or lobe. The fourth true molar then follows, also with an odd fifth lobe behind. This lobed form of the molars is so different from that of the adult as to have led me to describe it as indicating peculiar species under the name of *Tricium avunculus* and *T. annæ*.

In the next stage, the fifth small molar appears in view, and the second permanent molar lifts its milk-predecessor out of the way. In a very short time, the posterior, or odd, columns entirely disappear, sinking into the shaft, and the permanent molars assume the form characteristic of the species. The last stage prior to maturity sees the first milk-molar shed, and the younger portion of the first permanent molar protruded. A speci-

men of this age furnished the basis of the *Palæolagus agapetillus*. Its measurements are:

Measurements.

	M.
Length of molar series	.0100
Length of penultimate molar	.0020
Depth at penultimate molar	.0070
Depth at first molar	.0050
Transverse thickness at first molar	.0037

There is the merest trace of a posterior lobe at this time, and that speedily disappears. The anterior lobe is subconical, and is entirely surrounded with enamel. By attrition, the two lobes are speedily joined by an isthmus, and for a time the tooth presents an 8-shaped section, which was supposed to be characteristic of the genus. Further protrusion brings to the surface the bottom of the groove of the inner side of the shaft, so that its section remains in adult age something like a B.

The measurements of a medium-sized adult are—

Measurements.

	M.
Length from interorbital region to end of nasal bones (Spec. No. 1)	0.0250
Length of median suture nasal bones	.0160
Width at interorbital region	.0080
Width between anterior borders of orbits	.0180
Width at front of rugose patches	.0110
Width of nasal bones at middle	.0080
Width of nasal bones at extremity	.0060
Width of anterior incisors together	.0050
Width of posterior incisors together	.0035
Width of incisive foramen at M. 1	.0040
Width of palate at M. 1	.0075
Width of palate at M. 6	.0080
Length of superior diastema	.0120
Length of superior molar series	.0110
Width of first molar	.0020
Width of third molar	.0033
Length of inferior molar series (Spec. No. 2)	.012
Length from M. 1 to end of incisor	.012
Length of diastema	.003
Length of crown of M. 1	.0029
Elevation of crown of M. 1 above alveolus	.0035
Depth at M. 1	.0070
Depth at M. 5	.0085
Inferior diameter of ramus below M. 1	.0040

The shaft of the humerus is subround at the middle. The external crest from the epicondyle extends by a long curve to the posterior side of the shaft where it ceases. The external extremity of the condyles is occupied for the

anterior half by a well-defined fossa. The general form of the ilium is slender. The ilioischiatic suture traverses a concave face behind the acetabulum. The rim of the latter is pronounced. The posterior face of the femur between the little and third trochanters is nearly plane; it is strongly convex on the anterior face. The shaft below the middle is a transverse oval drawn to an obtuse angle at one extremity, on account of the upward prolongation of the angle defining the posterior face. The latter at its inferior part is divided by an obtuse longitudinal ridge which extends to the intercondylar fissure. The condyles exhibit about equal length and width, and their articulating surfaces are not distinctly cut off from that of the patellar groove. The external fossæ are very insignificant. The inner cotylus of the head of the tibia is only about half as wide as the external. The spine, which limits it towards the middle line of the head, is separated by a wide interval from the inner margin of the external glenoid cavity. The external notch of the head, though small, is well-defined. Just above the point of attachment of the distal extremity of the fibula the tibia is triangular in section, the longest side being the inner. Half-way between this point and the distal extremity, the section of the shaft is a transverse oval. As we approach the extremity, two angular lines appear on the posterior face, near the borders, which extend, the one to the external border of the external malleolus, the other to the opposite border of the inner malleolus. Each incloses a narrow groove with the margins of the tibia, which terminate on each side of the distal extremity in a small backwardly directed process. The surface between these lateral ridges is gently concave. On the anterior face the border of the distal extremity is convex forwards. Above the extremity the face is concave, and near the inner border a little further up is a short groove-like fossa separated from the border by a little ridge. Both of these concavities are differently developed in different individuals, and are sometimes obsolete.

Measurements.

		M.
Width of humerus at middle of shaft		.0025
Width of humerus at condyles		.0062
Diameter of head of radius	transverse	.0050
	vertical	.0028
Diameter of shaft of radius distally		.0028
Length of ilium (proximally restored)		.0190

		M.
Diameter of neck of ilium	anteroposterior	.0035
	exterointernal	.0035
Long diameter of acetabulum		.0045
Anteroposterior diameter of ischium below spine		.0030
Width of femur at proximal extremity		.0090
Diameter of head	anteroposterior	.0040
	transverse	.0045
Transverse diameter at little trochanter		.0065
Transverse diameter at third trochanter		.0060
Transverse diameter at middle of shaft		.0040
Transverse diameter at condyles		.0070
Anteroposterior diameter at patellar ridge and condyles posteriorly		.0080
Diameter of head of tibia	anteroposterior	.0080
	transverse	.0085
Diameter of shaft of tibia transversely		.0030
Diameter distal end of tibia	anteroposterior	.0035
	transverse	.0065
Length of astragalus		.0070
Length of trochlea		.0035
Width of trochlea		.0035
Elevation of trochlea	externally	.0032
	internally	.0025
Diameter of head	long	.0030
	short	.0022
Length of calcaneum		.0010
Length of heel of calcaneum		.0045
Width at tibial facet		.0045
Width at cuboid facet (transverse)		.0035
Depth at cuboid facet		.0032

It is very probable that this species is the progenitor of the *Lepus sylvaticus*, which now inhabits North America in such abundance. It will then be interesting to trace the specific characters in which modification was necessary in order to effect the transition. Only the principal ones will be noticed; the few generic characters have already been pointed out.

In the recent species the muzzle is similar in size; the premaxillary bones are more produced on the extremity. The perforations of the anterior part of the maxillary bone are larger and cover a greater extent of surface than in the *Palæologus haydeni*. The posterior emargination of the palate is wider and deeper in *Lepus sylvaticus*. The otic bulla is a little larger in *P. haydeni*, and the mastoid bone is not spongy with perforations as in *L. sylvaticus*. Other parts of the skull cannot now be compared. The preserved portions of the mandibular rami of *P. haydeni* are of the same size as those of *L. sylvaticus*. The symphysis is shorter through the brevity of the inferior portion of the sutural surface in *P. haydeni*. The incisive

alveolàr ridge is not distinguishable from the inferior border in *L. sylvaticus.* In the same species there is but one, the usual mental foramen, in the position of the anterior one of the extinct species. The spongy condition of the rami near the symphysis in the *L. sylvaticus* is not seen in the extinct species. Excepting the first tooth, the inferior molars are of similar size and constitution in the two species.

It is probable that the *Lepus ennisianus*, described a few pages later in the present work, is the intermediate form in the line of descent between the *Palæologus haydeni* and the *Lepus sylvaticus*, or perhaps the *L. auduboni.* This species is from the John Day Miocene of Oregon, a later deposit than the true White River. The last inferior molar is like that of the *P. haydeni*, while the first molar is that of the genus *Lepus.* The postorbital process, though present, is smaller than in any existing North American species.

The *Palæologus haydeni* was excessively abundant during the White River epoch in Dakota and Colorado, as the number of its remains indicate. I find, also, quite a number of maxillary and mandibular bones with teeth, in my Oregon collections, which I cannot distinguish from the present species. I have made the identification provisionally, in anticipation of the discovery of more perfect material.

PALÆOLAGUS TRIPLEX Cope.

Paleontological Bulletin No. 16, p. 4. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 479. Plate LXVI; fig. 28.

This rabbit is known from a single incomplete left mandibular ramus, which supports all the molar teeth in perfect preservation. It belonged to an adult animal, but the first inferior molar is but little worn, showing that the individual had but just attained maturity.

This species is larger than the *Palæolagus haydeni*, and is equal in size to the *P. turgidus.* It differs materially from both species in the constitution of its molar teeth. The first molar is peculiar in having an anterior as well as an external groove, the result being a trilobate instead of a bilobate section. This character would be maintained during the life of the animal, as the groove continues well into the alveolus. The four intermediate molars are characterized by the presence of a third column posterior to the second, and of smaller diameter. It is at first isolated from the second by enamel

investment, but on wearing becomes connected with it. They remain distinct to an advanced age of the animal, since the grooves which bound them descend far into the alveoli before disappearing. Another characteristic of the specimen at least, is seen in the intervention of a wide isthmus between the two principal lobes of each molar, or, in other words, of a narrowed portion of the second column between its transverse portion and the anterior column. The result is that the triturating surfaces of the posterior column of the molar has a quadrilobate outline; one lobe anterior, one posterior, and two lateral.

The tuberosity of the inner side of the ramus, which incloses the incisive alveolus, extends to below the second molar. Its surface, and a portion of that above it, is roughened with small punctiform impressions. The external face of the ramus is smooth and somewhat convex anteroposteriorly and vertically. The anterior border of the masseteric fossa is not prominent, as in *P. turgidus*, is regularly convex, and extends to the line of the posterior border of the penultimate molar.

This species rests on characters which I have observed to be transitional in the *P. haydeni*, and I have attended to the possibility of the individual which has furnished them being a similarly immature *P. turgidus*. In a considerable number of specimens of the latter no approach to the present one is exhibited; the latter is a fully-grown animal, and its characters would remain after long attrition of the teeth.

Measurements.

	M.
Length of molar series	.016
Length of median three molars	.010
Width of median molar	.003
Depth of ramus at median molar	.011

This species is rather larger than the prairie-marmot (*Cynomys ludovicianus*).

PALÆOLAGUS TURGIDUS Cope.

Paleontological Bulletin No. 16, p. 4. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 479.
Tricium paniense Cope, Pal. Bulletin No. 16, p. 5.

Plates LXVI, fig. 28; LXVII, figs. 13–27.

This is the largest species of the genus, and after the *P. haydeni* the most abundantly represented in collections. At the locality which furnished

several hundred specimens of the former species I obtained twenty of this one, including both dental series and their supporting bones, and various portions of the skeleton, but no cranium.

The maxillary bone displays the fossa below the anterior base of the zygomatic arch much better defined than in the *P. haydeni.* The palatine bone extends to the same distance forwards, that is, to opposite the anterior border of the third molar. The portion of the bone at the side of the posterior emargination is narrower, and not so horizontal as in the *P. haydeni.* The notch has the same extent, viz, to the line of the posterior border of the fourth molar.

The superior molars are similar in general to those of the *P. haydeni,* but in none of them do I observe the fissure of the inner side of the crown. In several of them the median crescent persists, so that if the internal fissure exist at any time it must be speedily removed by attrition. In *P. haydeni* it remains after the disappearance of the crescent, as in that species there is no enamel on the external side of the crown.

The mandible is more robust than in *P. haydeni,* but has much the same form. The anterior mental foramen is behind the middle of the diastema, on its superior aspect, and the posterior is below the second molar, *below* the middle of the ramus. The dental foramen is *above* the middle line of the ramus; the last-named two foramina having relations the reverse of that seen in *P. haydeni.* The anterior border of the masseteric fossa is elevated into a prominent rough ridge in most specimens, and reaches to the penultimate molar. The tuberosity inclosing the incisive alveolus does not extend so far posteriorly as in *P. haydeni,* ceasing below some part of the second molar, varying a little in different individuals; its surface is covered with impressed punctæ. The anterior border of the pterygoid fossa of the ramus is not well defined.

There is no groove on the inner side of the first molar. The two columns of the three intermediate molars are closely appressed, and the second is lower, not so wide, but a little longer anteroposteriorly than the anterior column. The last molar is deeply grooved on the inner side; its grinding face is only half as large as that of the first molar. The inferior incisor is not deeper than wide, and is obtuse behind. The anterior face is nearly

plane, and the enamel is marked by numerous approximated, faint transverse undulations in well preserved specimens.

Measurements.

No. 1.

	M.
Length of superior molar series	.0160
Length of second molar	.0025
Width of second molar	.0043
Length of fourth molar	.0030
Width of fourth molar	.0055

No. 2.

Length of molars	0.016
Length of three median molars	.010
Depth of ramus at central molars	.011
Width of central tooth	.0035

No. 3.

Depth of ramus at penultimate molar	.0130

The deciduous molars present much the same character as in *P. haydeni*, except that there is scarcely a trace of the odd posterior tubercle on the second. The posterior root of the latter extends to the bottom of the alveolus. The grooves of crown do not descend to the alveolus on either side. Measurements of such a specimen are—

Measurements.

	M.
Length of two anterior molars	0.0068
Length of first molar	.0032
Width of first molar	.0021
Depth of ramus at first molar	.0085
Depth of ramus at diastema	.0061

I have of this species portions of humeri, femora, tibiæ, and astragalus. They resemble very much the corresponding elements of the *P. haydeni*, but differ strikingly in the much larger size.

The distal extremity of the *humerus* has a greater transverse extent than that of the *P. haydeni*, chiefly because of the greater size of the internal epicondyle. The external trochlea of the condyles extends also a little further outwards beyond the external posterior trochlear flange. The corresponding internal flange is not nearly so prominent as in *P. haydeni*. The olecranar fossa is scarcely perforate; the coronoid fossa is shallow. The external marginal acute edge is prolonged well upwards. The proximal portion of the femur has the characters of that of *P. haydeni*, but the third

trochanter is smaller, and its apex is the end of the truncate external surface of the great trochanter. In *P. haydeni* the two are connected by a thin edge.

The great trochanter projects considerably beyond the head, and the little trochanter is very prominent, and is directed posteriorly. The condyles of the femur are not produced so far backwards as in *P. haydeni*. In all the particulars which I have described as characterizing the distal extremity of the tibia of *P. haydeni*, *P. turgidus* agrees with it, differing only in size. The same may be said of the astragalus, excepting that the inner trochlear ridge is a little less reduced in the *P. turgidus*.

Measurements.

		M.
Diameter of distal end of humerus	anteroposterior, least	.004
	transverse	.012
Width of proximal end of femur		.013
Diameter of head	anteroposterior	.006
	transverse	.0065
Width of femur at little trochanter		.008
Width of femur at third trochanter		.007
Width of femur below third trochanter		.005
Width of condyles of femur		.010
Depth of same at posterior margin		.010
Diameter of shaft of tibia	anteroposterior	.004
	transverse	.005
Diameter of distal end of tibia	anteroposterior	.0055
	transverse	.0110
Length of astragalus		.0110
Length of trochlea		.0056
Width of trochlea		.0060
Elevation	of external ridge	.0048
	of internal ridge	.0040
Diameter of head	long	.0040
	short	.0033

White River beds of Dakota, and of Northeast Colorado.

LEPUS Linn.

Dental formula: I. $\frac{1}{1}$; C. $\frac{0}{0}$; Pm. $\frac{3}{2}$; M. $\frac{3}{3}$. First superior molar simple; first inferior molar with two external grooves; last inferior molars consisting of two cylinders. Postorbital processes present.

I am acquainted with but one extinct species of this genus, and this is from the John Day or Middle Miocene period. It proves the ancient origin

of this genus, now so widely distributed over the earth. Species of *Lepus* are reported by Gervais from the Miocene (Montabuzard) and Pliocene (Montpelier) of France.

LEPUS ENNISIANUS Cope.

Bulletin U. S. Geol. Surv. Terrs., IV, 1881, p. 385. American Naturalist, 1883, p. 174, fig. 21.

Plate LXVI, page 29.

This species is abundant in the Miocene beds of the John Day River, Oregon, associated with a species which I cannot distinguish from the *Palaeolagus haydeni.* The *Lepus ennisianus* exceeds the last-named species in dimensions, being intermediate between it and the *Palaeolagus turgidus.*

The form of the skull and character of the postorbital processes refer this species to the neighborhood of the *Lepus auduboni* and *L. bachmani.*[1] The former has the general outline of that of *Lepus sylvaticus*, with which it nearly agrees in size. The postorbital processes are free and shorter and narrower than those of the *L. auduboni.* The supraorbital notch is insignificant, and is not bounded by either an angle of the border or a process. Behind the postorbital processes the cranium is narrower. The parietal region is convex in both directions. The interorbital and base of the nasal region are flat. The middle of the superior part of the occipital projects table-like beyond the lateral portions, as in recent rabbits. The otic bulla is large and is flattened on the external side. The mastoid presents some subvertical grooves. The paroccipital process is rather short and is turned backwards at the apex.

The mandible has much the form of that of *L. sylvaticus*, with certain differences. A slight convexity of the anterior border of the ascending ramus is the only trace of coronoid process. The posterior border of the same projects very little behind the condyle, and is but slightly concave below that point. The inferior border of the masseteric fossa terminates below the anterior border of the base of the coronoid process, which is posterior to the corresponding position in *L. sylvaticus.* Here the masseteric fossa extends as far forwards as the line of the posterior part of the fourth inferior molar.

[1] See Baird, Mammalia of the U. S., Pac. R. R. Surveys, VIII, p. 574.

The superior molras have the form usual in this genus. The crowns are grooved on both the external and internal faces. The first has less transverse extent than the others (except the sixth), and has a shallow groove on the anterior face. The sixth molar is a small and simple cylinder. Of the inferior molars, the first has the greatest anteroposterior diameter, while the transverse is equal to that of the others. Of its external grooves the posterior is the strongest. The last molar is much the smallest, and its section is a figure 8, with the wider circle next to the fourth molar. The anterior column of the other molars wears so as to be higher than the posterior. Its inner edge carries a shallow groove, while the external edge is narrow and smooth, and their alveoli terminate in a swelling below the first molar (Pm. III). The groove of the superior incisors is nearer the internal than the external side. The inferior incisors are perfectly flat.

Measurements.

	M.
Length of skull from inion to above Pm. II	.048
Length from inion to base of postorbital process (axial)	.032
Width of skull at glenoid cavities	.020
Width of skull behind bases of postorbital processes	.009
Vertical diameter of orbit	.0125
Depth of skull and mandible in place, at middle of orbit	.0310
Depth of mandible at condyle	.0310
Length of mandible to exit of incisor	.044
Depth of mandible at last molar	.011
Depth of mandible at middle of diastema	.005
Length of superior molar series	.012
Width of Pm. II (above)	.002
Width of M. I	.003
Length of inferior molar series	.013
Length of inferior Pm. III	.003

A fragmentary skeleton is associated with jaws and teeth of this species, and they are presumably parts of the same animal. They resemble the corresponding parts of *Lepus sylvaticus*, but are relatively smaller. The centrum of a lumbar vertebra is much depressed. There is a prominent anterior inferior spine of the ilium. On the internal side of the distal end of the tibia the ligamentous groove is more, and its bounding process is less, distinct than in *L. sylvaticus*.

Measurements.

	M.
Width of centrum of lumbar vertebra	.0083
Depth of centrum of lumbar vertebra	.0040

		M.
Diameter of acetabulum		.0060
Diameters of head of tibia	anteroposterior	.011
	transverse	.0105
Diameter of distal end of tibia	anteroposterior	.0046
	transverse	.009
Length of free part of calcaneum		.007

From the John Day River and the north fork of the John Day River, Oregon. C. H. Sternberg.

This rabbit is the oldest species which can be referred to the genus *Lepus*. It is dedicated to my friend Prof. Jacob Ennis, of Philadelphia, the distinguished mathematician and physicist.

CARNIVORA.

This order embraces the clawed mammalia with transverse glenoid cavity of the squamosal bone, confluent scaphoid and lunar bones of the carpus, and well developed cerebral hemispheres. It is well distinguished from all others at present known, but such definition is likely to be invalidated by future discovery. Some of the Insectivora possess a united scapholunar bone, but the reduction of the cerebral hemispheres of such forms distinguishes them. The presence of the crucial fissure of the hemispheres is present under various modifications in all *Carnivora*, except one or two of the *Melinæ* (Garrod), while the parieto-occipital and calcarine fissures are absent.

The many types of existing Carnivora fall into natural groups, which are of the grade termed family in zoölogy. But the distinction of these from each other is not easily accomplished, nor is it easy to express their relations in a satisfactory manner. The primary suborders of pinnipedia and fissipedia are easily defined. Various characters have been considered in ascertaining the taxonomy of the more numerous fissiped division. The characters of the teeth, especially the sectorials, are important, as is also the number of the digits. Turner[1] has added important characters derived from the foramina at the base of the skull, and the otic bulla, which Flower[2]

[1] Proceedings Zoological Soc., London, 1848, p. 63.
[2] Loc. cit., 1869, p. 5.

has extended. Garrod[1] has pointed out the significance of the number of convolutions of the middle and posterior part of the hemispheres. I have added some characters derived from the foramina of the posterior and lateral walls of the skull.[2] Mr. Turner also defines the families by the form and relations of the paroccipital process.

In studying the extinct Carnivora of the Tertiary period it has become necessary to examine into the above definitions, in order to determine the affinities of the numerous genera which have been discovered. To take them up in order, I begin with the foramina at the base of the skull. The result of my study of these has been that their importance was not overrated by Mr. Turner, and that the divisions of secondary rank indicated by them are well founded. Secondly, as to the form and structure of the auditory bulla. Although the degree and form of inflation are characteristic of various groups of Carnivora, they cannot be used in a systematic sense, because, like all characters of proportion merely, there is no way of expressing them in a tangible form. For, if the forms in question pass into each other, the gradations are *insensible*, and not sensible, as is the case with an organ composed of distinct parts. The same objection does not apply so much to the arrangement of the septa of the bulla. The septum is absent in the Arctoidea of Flower (*Ursidæ* of Turner), small in the Cynoidea (Flower, *Canidæ* Turner), and generally large in the Æluroidea (Flower, *Felidæ* Turner). But here occurs the serious discrepancy, that in the Hyænidæ, otherwise so nearly allied to the Felidæ, the septum of the bulla is wanting. Nevertheless, the serial arrangement of the order indicated by Flower, viz, commencing with the Arctoidea, following with the Cynoidea, and ending with the Æluroidea, is generally sustained by the structure of the auditory bulla, and by the characters of the feet and dentition, as well as of the cranial foramina. Turner's arrangement in the order Ursidæ, Felidæ, and Canidæ is not sustained by his own characters, and its only support is derived from Flower's observations on the external or sylvian convolution of the hemisphere of the brain.[3] There are three simple longi-

[1] Proceedings Zool. Soc., London, 1878, p. 377.
[2] Proceedings Amer. Philosophical Society, 1880.
[3] Proceedings Zoological Society, London, 1869, p. 482.

tudinal convolutions in the raccoons; in the civets and cats the inferior convolution is fissured at the extremities, while in the dogs it is entirely divided, so that there are four longitudinal convolutions between the sylvian and median fissures.

An important set of characters hitherto overlooked confirms Flower's order. I refer to those derived from the turbinal bones. In the ursine and canine forms generally the maxilloturbinal is largely developed, and excludes the two ethmoturbinals from the anterior nareal opening. In the Feline group, as arranged by Turner, the inferior ethmoturbinal is developed at the expense of the maxilloturbinal, and occupies a part of the anterior nareal opening. These modifications are not, so far as my experience has gone, subject to the exceptions seen in the development of the otic septa and molar teeth, while they coincide with their indications. The seals possess the character of the inferior group, or Ursidæ, in a high degree.

The characters derived from the paroccipital process are of limited application, as the study of the extinct forms shows.

In view of these facts, I have proposed the following arrangement:[1]

Mr. Wortman has suggested that the Arctoidea should be distinguished as a primary division, since it differs from the Cynoidea in the articulation of the astragalus with the cuboid bone. I do not, however, find this character to be constant in the Arctoid series. It gradually disappears in the Mustelidæ, and is wanting in *Mustela pennantii* and *Procyon nasua.*

External nostril occupied by the complex maxilloturbinal bone; ethmoturbinals confined to the posterior part of the nasal fossa; the inferior ethmoturbinal of reduced size ..... HYPOMYCTERI.

External nostril occupied by the inferior ethmoturbinal and the reduced maxilloturbinal ..... EPIMYCTERI.

While no doubt transitional forms will be discovered, the types at present known fall very distinctly into one or the other of these divisions. The characters are readily perceived on looking into the nares of well-cleaned specimens. The *Hypomycteri* stand next to the *Pinnipedia*, since the maxilloturbinal bone has the same anterior development in that group.

In searching for definitions of the families, it is necessary to be precise

[1] Proceedings American Philosophical Society, 1882, p. 471, where a list of the genera is given.

as to the definition of terms. The meaning of the word sectorial is in this connection important, since there are so many transitional forms between the sectorial and tubercular tooth. A sectorial tooth, then, of the upper jaw is one which has at least two external tubercles, which are the homologues of the median and posterior lobes of the sectorial of the cat. By the flattening and emargination of their continuous edges, the sectorial blade is formed.[1] One or two interior and an anterior lobe may or may not exist. In the genera of the *Procyonidæ*, except in *Bassaris*, the two external tubercles do not form a blade. The inferior sectorial tooth differs from the tubercular only in having an anterior lobe or cusp, which belongs primitively to the interior side. The inferior sectorial teeth with large heels, as in Viverridæ and Canidæ, I have called tubercular sectorials. The sectorial blade is formed by the union and emargination of the edges of the anterior and the principal external cusp. This blade is not well developed in the genus *Cynogale* and still less in the *Procyonidæ* and *Ursidæ*.

In looking for causes in explanation of the modifications of structure cited, one can easily discover that there is a close relation between the arrangement of the teeth and the mechanical laws involved in the performance of their function, that of seizing an active prey and of cutting up their carcasses into pieces suitable for swallowing. It is obvious that in the latter case the flesh-teeth bear the resistance, and the masseter muscle is the power, and that the nearer these parts are together the better is the function performed. As a matter of fact, the sectorial teeth in modern *Carnivora* are placed exactly at the angle of the mouth, which is nearly the front border of the masseter muscle.

Both the muscle and the teeth have, however, moved forwards in connection with the shortening of the jaw behind. This has been due to the necessity of bringing the power (masseter) nearer to another point of resistance, viz, the canine teeth. In the early carnivores (as *Hyænodontidæ*) the long jaws supported more numerous teeth ($\frac{4-3}{4-3}$) than in any modern families, and the fissure of the mouth was probably very wide. The canine teeth were evidently very ineffective weapons. The animals probably only snapped with their jaws, and did not attempt to lacerate or hold on, as do

[1] See "On the origin of the specialized teeth of the Carnivora," American Naturalist, 1879, p. 171.

the cats. The dogs of to-day are long-jawed, and they snap in a manner quite distinct from anything seen among the cats. The only dogs that hold on are the short-jawed bulldogs.

So in the use of the canines, we have the ground of the shortening of the jaw behind and before, and the consequent change of structure, which resulted in the modern perfected *Felidæ*.

The families are then defined as follows:

HYPOMYCTERI.

I. No sectorial teeth in either jaw.
Toes 5–5 ..... *Cercoleptidæ.*
II. Sectorial teeth in both jaws.
α. Toes 5–5.
β. No alisphenoid canal.
True molars $\frac{2}{2}$ ..... *Procyonidæ.*
True molars $\frac{1}{2}$ ..... *Mustelidæ.*
ββ. An alisphenoid canal.
Molars quadrate, $\frac{2}{2}$ ..... *Aeluridæ.*
Molars longitudinal, $\frac{2}{3}$ ..... *Ursidæ.*
αα. Toes 5–4 or 4–4.
Sectorials well developed, an alisphenoid canal ..... *Canidæ.*

EPIMYCTERI.

I. Molars haplodont.
Toes 5–4; no alisphenoid canal ..... *Protelidæ.*
II. Molars bunodont, no sectorials.
Toes 5–5; an alisphenoid canal ..... *Arctictidæ.*
III. Molars bunodont, with sectorials.
α. Otic bulla with septum.
β. Alisphenoid canal and postglenoid foramen, present.
γ. True molars well developed.
Toes 5–5 ..... *Viverridæ.*
Toes 5–4 ..... *Cynictidæ.*
Toes 4–4 ..... *Suricatidæ.*
γγ. True molars much reduced.
Toes 5–5 ..... *Cryptoproctidæ.*
Toes 5–4 ..... *Nimravidæ.*
ββ. No alisphenoid canal; postglenoid foramen rudimental or wanting.
Toes 5–4 ..... *Felidæ.*
αα. Otic bulla without septum.
No alisphenoid canal, nor postglenoid foramen.
Toes 4–4 ..... *Hyænidæ.*

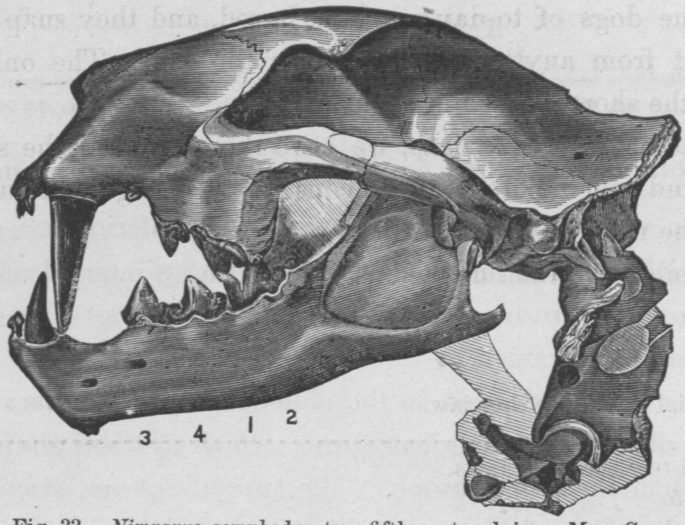

Fig. 33.—*Nimravus gomphodus*, two-fifths natural size. Mus. Cope.

CANIDÆ.

Species of this family were very abundant during the Miocene period in North America as in Europe. Those of the Lower and Middle Miocene epochs belong to genera allied to, but distinct from, *Canis;* while those of the Upper Miocene (Loup Fork) and later horizons pertain to the latter genus, with a few exceptions. The characters of the Miocene genera are as follows:

I. Molar formula $\frac{4}{4}\,\frac{3}{3}$.
  Humerus with epitrochlear foramen ..... *Amphicyon.*
II. Molar formula $\frac{4}{4}\,\frac{2}{3}$.
    a. No anterior lobe of superior sectorial.
  Humerus with epitrochlear foramen.
  Inferior sectorial heel trenchant ..... *Temnocyon.*
  Inferior sectorial heel basin-shaped ..... *Galecynus.*
  Humerus without epitrochlear foramen.
  Inferior sectorial heel basin-shaped ..... *Canis.*
    aa. An anterior lobe of superior sectorial.
  Heel of lower molar not trenchant; no epitrochlear foramen ..... *Ælurodon.*
III. Molar formula $\frac{3}{3}\,\frac{2}{2}$.
  Heel of inferior sectorial trenchant ..... *Enhydrocyon.*
IV. Molar formula $\frac{4}{4}\,\frac{1}{2}$.
  Heel of inferior sectorial basin-shaped ..... *Oligobunis.*
V. Molar formula $\frac{3}{3}\,\frac{1}{2}$.
  First inferior molar two-rooted ..... *Hyænocyon.*

To these genera I refer twenty-five species of the American Miocenes.

AMPHICYON Lartet.

Bulletin Société Géologique de la France, 1836, vii, 217–220; Blainville, Comptes-Rendus, 1837, v, 434; L'Institut, 1837, v, 18–19; Blainville, Osteographie, ix, Subursus, 78–96.

Dental formula: I. $\frac{3}{3}$; C. $\frac{1}{1}$; Pm. $\frac{4}{4}$; M. $\frac{3}{3}$. The true molars of the superior series all tubercular; the last two of the inferior series also tubercular. First inferior true molar a sectorial, with an internal tubercle and a heel with a superior groove, bounded by raised borders. Humerus with an epitrochlear arterial foramen.

Much is yet to be desired in the elucidation of the characters of this genus, especially of the American forms, which are less abundant and of smaller size than those of Europe. The typical species, *Amphicyon major* Blv., was the largest, equaling a bear in size. It is derived from the Miocene of Sansan, and a smaller form of it is found, according to Pomel, at San Gerand-le-Puy. Other species are derived from the latter locality, and all are typical of the Miocene formation in Europe. In the "Mio-pliocene" of India a single species has been discovered, the *A. palæindicus* of Lydekker. Three species occur in the Lower and Middle Miocene of North America, the largest of which about equals the wolf in size. On account of the large development of the inferior tubercular teeth, I have suspected that the *Canis ursinus* Cope, from the Loup Fork group of New Mexico, would prove to be an *Amphicyon*. If so, it is the only representative of this genus in our Upper Miocene.

The three American species differ as follows: The *A. cuspigerus* is small, not exceeding the kit-fox in dimensions. The *A. hartshornianus* is about the size of a coyote, and has rather smaller tubercular molars, especially of the lower series. The *A. vetus* is a little larger, but has the tubercular molars disproportionately larger than those of the *A. hartshornianus*.

AMPHICYON VETUS Leidy.

Daphœnus vetus Leidy, Proceed. Academy Philada., 1853, 393. *Amphicyon vetus* Leidy, l. c., 1854, 157, 1857, 90. Extinct Mammalia Nebraska, Dakota, 1869, p. 32 *partim*. Plate I, figs. 1, 2, and 5.

Dr. Leidy's descriptions last cited above, with the accompanying figures, cover two species, a larger and a smaller, the latter being the *A. hartshornianus*. Of the true *A. vetus* my collection includes a fragmentary skull

with several teeth of both jaws. They indicate a canine animal of about the size of the *Temnocyon wallovianus;* that is, with a skull intermediate in dimensions between those of the wolf and coyote.

The superior sectorial tooth is as long as that of the *Temnocyon altigenis*, but not so thick, and with narrower blade. The anterior base of the crown is concavely emarginate. The second tubercular is more like the first of *Temnocyon coryphæus* than that of *T. altigenis*, but may be readily distinguished by the insignificance of the two external tubercles. The crown is not excavated, and it is traversed across the middle by a regularly curved low ridge, which represents the V-shaped crest of most modern dogs. The internal cingulum is wide and regularly convex. The external cingulum is prominent forwards and outwards, as in *T. coryphæus*, but is obsolete at the base of the second external tubercle.

The crowns of the third and fourth inferior premolars are preserved in a somewhat damaged state. The fourth has a posterior lobe of the border. The sectorial has lost its anterior cusp. It is rather small, and the internal tubercle is well developed, though not so high as in *Amphicyon cuspigerus*. The keel of the heel is not much elevated and is external to the middle line. There is a low inner basal cingulum, readily worn away. The first tubercular is a large tooth, nearly equal to that of *T. altigenis*, and therefore relatively much exceeding that of *A. hartshornianus* and of *T. coryphæus*. It has two opposite tubercles in front of the middle, and one external to the middle posteriorly, and no external cingulum. The alveolus of the second tubercular shows that it also was a large tooth.

Measurements.

		M.
Diameter of crown of superior canine		.011
Diameters of superior sectorial	anteroposterior	.0176
	transverse in front	.009
Diameters of second superior tubercular	anteroposterior	.013
	transverse at middle	.007
Length of inferior Pm. iii iv on base		.022
Length of heel of sectorial		.005
Diameters of first inferior tubercular	anteroposterior	.0006
	transverse	.0066
Length of alveolus of second tubercular		.004

The specimen above described agrees very nearly with the larger of those described by Leidy, and represented by his Plate I, figs. 1–2, of the

extinct Mammalia of Dakota and Nebraska. It differs from all the specimens of *A. hartshornianus*, in the disproportionately larger size of the tubercular molars both above and below, and by the tendency of the heel of the inferior sectorial to form a median keel. I found the fragments lying close together without intermixture of other species, on an exposure of the White River beds in Eastern Colorado, at the same locality which furnished the specimens of *A. hartshornianus*.

AMPHICYON HARTSHORNIANUS Cope.

Bulletin U. S. Geol. Survey Terrs., vi, p. 178.

Canis hartshornianus Cope, Synopsis of New Vertebrata of Colorado, Misc. pub. U. S. Geol. Surv. Terrs., 1873, p. 9. Annual Report U. S. Geol. Surv Terrs., 1873 (1874), p. 505.

Plate LXVII*a*; fig. 4.

This was the most abundant species of the genus during the White River epoch proper. It was originally established on a specimen from Eastern Colorado, and I have subsequently obtained other specimens from the same locality. On an examination of the specimens obtained by Dr. Hayden in the Bad Lands of Dakota, now in the museum of the Philadelphia Academy, I find parts of four skulls, two of which have been figured by Dr. Leidy on his Plate I, figs. 3, 4, and 6, and referred to in the text as belonging to the *A. vetus*. I have also part of a skull with nearly complete superior dentition from the John Day Valley of Oregon, which I cannot distinguish from this species.

The original specimen consists of a portion of the mandibular ramus with the first tubercular molar and alveolus of the second. The species was nearly as large as the *Canis latrans*. The anterior molar preserved has an interrupted cingulum on the outer side, which projects considerably in front, thus interrupting the parallelogrammic outline of the crown. The outer anterior tubercle is much the larger, while the inner ones are both obsolete. In *Galecynus gregarius* Cope the tubercles are equal, and there is no cingulum. Root of tubercular molar subround in section, as in *G. gregarius*.

Measurements.

	M.
Length of bases of M. ii and iii	.0130
Length of base of crown of M. ii	.0090
Width of base of crown of M. ii	.0060
Elevation of crown of M. ii	.0050

A second specimen, which is from the same locality as the last, in Eastern Colorado, consists of the skull anterior to the orbits and the posterior nares, lacking the superior walls. The teeth are all present, excepting one first premolar and five incisors. The form is short and wide, the malar bones much expanded and the muzzle narrowed. The size of the teeth is about that of the *Temnocyon coryphæus*, but the posteriorly-expanded outline is like that of the *T. josephi*. The sectorial is a little smaller than that of the *A. vetus* from the same locality; but the principal difference becomes apparent on comparing the tubercular molars. The second of the *A. hartshornianus* has not more than half the surface area of that of the *A. vetus*.

The external incisor is short and rather stout; the canines are long, curved, and acute, and with convex inner side; the inner cutting ridge is faint, the posterior moderately distinct. They are much more slender than in the *T. coryphæus*. There is a diastema behind the canine equal to the long diameter of its alveolus. The first premolar has a long base and a short anteriorly-placed apex; it is followed by a space equal to its long diameter. The second premolar is low and is prolonged backwards at the base; it is followed by a short space. The second premolar is more symmetrical, but has no distinct basal tubercles; there is a faint trace of a posterior median tubercle. This tooth will distinguish the species from *Temnocyon coryphæus* if other parts are wanting. The sectorial is small for the size of the tuberculars; its inner anterior tubercle is well developed. The first tubercular has a well-developed external basal cingulum. The two external cusps are low; the space between them and the inner border is nearly equally divided by a low V-shaped ridge. This character will distinguish this tooth from those of *Temnocyon altigenis* and *T. wallovianus*. The second tubercular is much smaller and stands much within the external border of the sectorial. Its external border is very oblique, more so than that of the first. It resembles the latter in details, the points being less pronounced; and the external cingulum is obsolete. The third tubercular is opposite the inner half of the second, and its surface area is very small, rather less than that of the base of the first premolar. It is supported on a projection of the maxillary bone, which is separated from the base of the pterygoid process of the palatine by a deep notch. The posterior nareal

orifice is rather narrow and its border presents a median point posteriorly, which separates two deep concavities, about as in *T. coryphæus.*

Measurements of palate, etc.

		M.
Length from premaxillary border to nares		.072
Width of dental series, including canines		.065
Length of canine tooth		.020
Long diameter of canine at base		.007
Length of premolar series		.039
Length of sectorial		.013
Width of sectorial in front		.008
Elevation of sectorial in front		.008
Diameters of first tubercular	anteroposterior	.010
	transverse	.014
Diameters of second tubercular	anteroposterior	.006
	transverse	.009
Width between bases of canines		.017
Width between sectorials posteriorly		.041
Width between third tuberculars		.023
Width of nares		.012

The third or Oregon specimen agrees closely with the one just described. The crowns of its superior incisors are preserved, so that it can be seen that they are obspatulate with angular extremities, and are not notched, as in *Galecynus geismarianus* and various living species.

The best ascertained characters of this species, then, as compared with the *A vetus*, are (1) the much smaller tubercular molars in both jaws; (2) the strongly double tubercular character of the heel of the inferior sectorial as compared with the tendency to a single keel seen in the *A. vetus.*

Dedicated to my friend Prof. Henry Hartshorne, formerly of Haverford College, Pennsylvania.

AMPHICYON CUSPIGERUS Cope.

Bulletin U. S. Geol. Survey Terrs., vi, p. 178.

Canis cuspigerus Cope, Paleontological Bulletin No. 30, p. 8, December 3, 1878. Proceedings American Philosoph. Society, 1878, p. 70. *Amphicyon entoptychi* Cope, Paleontological Bulletin No. 31, p. 3, December 24, 1879. Proceedings Amer. Philosoph. Soc., 1879, p. 372.

Plate LXVIII; figs. 1–4.

This species is considerably smaller than the *A. hartshornianus*, and intermediate in size between the *Galecyni geismarianus* and *gregarius.* It is represented in my collection by two crania, one nearly perfect and with the mandible attached; the other with its superior portions crushed and without incisive region or lower jaw.

The cranium is elongate, and the muzzle is not shortened, but is rather compressed. There are no true postorbital processes, but merely obtuse angles, from which obsolete temporal ridges converge backwards. They do not unite early, as in the *Galecynus geismarianus*, *Amphicyon vetus*, &c., but only combine to form a low sagittal keel near the middle of the parietal bone. The brain-case is rather large, and is moderately contracted behind the orbits, more than in *Vulpes cinereoargentatus* or *Canis latrans* and *C. cancrivorus*. The occipital surface is strongly convex to fit the vermis of the cerebellum. The otic bulla is small and has no tympanic prolongation. This character will distinguish the species from the *G. geismarianus*, where the bullæ are very large. The paroccipital process is short and obtuse, and is well removed from the bulla, not being even connected with it by a ridge, as in recent dogs. The posttympanic process is short and obtuse. The postglenoids are well separated from them, and have a greater transverse extent than in recent dogs. They are not overlapped posteriorly by any part of the otic bullæ. The basioccipital is wide and is marked by a shallow fossa on each side opposite each paroccipital process. This is wanting in the *G. geismarianus* and the *G. gregarius*. Between the bullæ the surface is not keeled, but is flat and slightly concave.

The mandibular rami are shallow, and their inferior margin is not stout. A gentle elevation of the latter commences below the first tubercular tooth, and the alveolar border rises but little behind. The masseteric fossa is deep and well defined.

Sutures.—The ascending branch of the premaxillary is very narrow and elongate, but fails by a little to reach the narrow acute anterior prolongation of the frontal. The nasal bones are quite narrow, and their apices are above the anterior third of the orbit. The fronto-maxillary suture is strongly arched upwards. The parietal bones extend further forwards laterally than on the superior surface of the skull, where their anterior outline is broadly truncate. Below they are extensively in contact with the alisphenoid bone. The squamosal is low and elongate.

Foramina.—The nares are rather small, and the vertical exceeds the transverse diameter. The opening of the infraorbital foramen is above the anterior part of the superior sectorial tooth. There is no postparietal

foramen, but a small mastoid is visible. The *foramen magnum* is large and is subround through its extension inferiorly; its border is notched at the superior base of the condyle. The condylar foramen is small and is near the *f. lacerum posterius*, but entirely distinct from it. The latter is subround and rather large. There is no distinct *f. carotideum* visible. The *f. lacerum anterius* is much contracted. The *f. ovale* is rather large and transverse, and the *f. alisphenoidale posterius* is small and distinct. *Foramen postglenoidale* rather large.

Dentition—The third premolar tooth in both jaws differs from the corresponding one in the *C. gregarius* and in most recent species, in lacking the lobe of the posterior cutting edge, agreeing in this (as regards the inferior series) with the *Temnocyon altigenis*. It is present in the fourth inferior premolar, which has besides, a low heel. The inferior sectorial tooth is characterized by its great robustness; the internal median tubercle is much elevated, while the principal cusp is short. The heel is wide and basin-shaped, with the inner border as much elevated as the outer. The first tubercular molar is characterized by its width as compared with its length, being nearly as wide transversely as fore and aft. It has two anterior cusps followed by a basin with elevated borders simulating two posterior cusps. There are an anterior and an exterior cingulum. The second tubercular is a miniature of the first, differing in the more robust external posterior cusp, and the absence of external basal cingulum. There are no complete cingula on the external bases of the other inferior teeth. The second superior tubercular is well developed, having two external tubercles. The anterior inner cusp of the superior sectorial is distinct and acute, and there is a cingulum along the inner base of the crown. The exserted portion of the canines is long, slender, and with an oval section narrowed behind. The enamel of all the molars is more or less rugose, a character which is only found elsewhere among our extinct dogs in the *G. geismarianus*.

Measurements.

	M.
Length of cranium to inion	.106
Length from premaxillary to condyles	.101
Length from premaxillary to postglenoid	.075
Length from premaxillary to posterior border of second tubercular	.049
Length to anterior border of orbit	.035
Width of occiput at superior border of *foramen magnum*	.023

	M.
Width between inner borders of postglenoids	.023
Width between maxillary bones	.030
Width between orbits	.020
Width of nares	.009
Length of inferior molar series	.041
Length of bases of four premolars	.023
Length of base of second premolar	.005
Elevation of crown of second premolar	.005
Length of base of fourth premolar	.0072
Elevation of crown of fourth premolar	.0055
Length of base of sectorial	.010
Elevation of principal cusp	.006
Width of heel of sectorial	.006
Diameter of first tubercular { anteroposterior	.006
Diameter of first tubercular { transverse	.005
Anteroposterior diameter second tubercular	.0037
Length of base of superior sectorial	.009
Length of bases of two tuberculars	.012
Length of base of first tubercular	.0064

The skull above described displays only two superior tubercular molars on each side, and on this account I supposed the species to belong to the genus *Canis* at the time I first described it. The second skull already mentioned, exhibits the characteristic number belonging to the genus *Amphicyon.* A careful removal of the matrix from the extremities of the maxillary bones of the specimen first described revealed the fact that they had been broken off, since traces of the alveoli of the third superior molar were found. The following characters are presented by the second skull which is the basis of the supposed species cited in the synonymy above.

The superior premolar teeth are rather short in anteroposterior diameter, while the tubercular molars are relatively large There are no posterior lobes on the former; the internal and external cingula are well developed in the first and second of the latter. The third tubercular is about as wide as the second is long. The sagittal crest is only distinct on the posterior part of the parietal region. Estimated length of skull, M. .110; length of superior molar series, .041; length of true molar series, 016; length of first tubercular, .0075; length of second tubercular, .055; width of second tubercular, .0074; length of third tubercular, .0036; width of third tubercular, .052: Length of sectorial width between anterior external angles of first tuberculars, .030.

The teeth of this species are about half the size of those of *A. vetus* Leidy. The entire animal was probably about the size of the kit fox, *Vulpes velox.*

The specimens above described were obtained by C. H. Sternberg and J. L. Wortman, in the Bad Lands of the John Day epoch, in the John Day Valley, Oregon.

TEMNOCYON Cope.

Paleontological Bulletin, No. 30, p. 6, Dec. 3, 1878. Proceed. Amer. Phil. Soc., 1878, p. 68. Bulletin U. S. Geol. Surv. Terrs., vi, p. 179.

Dental formula: I. $\frac{3}{?3}$; C. $\frac{1}{1}$; Pm. $\frac{4}{4}$; M. $\frac{2}{3}$. Two molars in each jaw tubercular. Inferior sectorial with well-developed heel, which is keeled with a cutting edge above. An internal tubercle of the same. A postglenoid, but no postparietal foramen. Humerus with an epitrochlear arterial foramen.

The characters on which I rely at present for the discrimination of this genus from *Canis* are two. The first is the presence of a cutting edge on the superior face of the heel of the inferior sectorial, in place of a double row of tubercles surrounding a basin. When well developed these characters present a broad contrast, but indications of transitional forms are not wanting. Thus, in some extinct *Canes* the internal crest of the heel is less elevated than the external, which is the homologue of the single crest of *Temnocyon*, and in some specimens of *Temnocyon coryphæus* there is a cingulum on the inner side of the median keel, which represents the internal crest of *Canis.* Secondly, the epitrochlear foramen of the humerus, a character common to all of our Lower Miocene *Canidæ* yet known.

The keel of the sectorial, which defines this genus, is simply a repetition on that tooth of the heel which belongs to the posterior premolar teeth of many *Carnivora.* It finds resemblances in such Eocene forms as *Mesonyx* and *Palæonyctis.* Among recent *Canidæ* it is apparently unknown, and is very rare in other groups, The *Cynodictis crassirostris* Filhol, from the French Phosphorites, strongly resembles the species of *Temnocyon* in generic characters.

Three species of the genus are known to me. They may be distinguished as follows. A fourth species, *T. josephi*, is provisionally placed with these:

I. First superior tubercular molar with a wide median fossa, bounded within by a tubercle.
Length of superior molar series from canine, .070; of true molars, .0215. *T. altigenis.*
Length of molar series from canine, .067; of true molars, .014 .... *T. wallovianus.*
II. First superior tubercular molar with narrower basin, bounded within by a V-shaped crest.
Length of dental series from canine, .055; of true molars, .014 ..... *T. coryphæus.*
Length of dental series from canine, .051; of true molars, .013; muzzle narrow, zygomas wide..... .... *T. josephi.*

All of the above species have been derived from the John Day Miocene beds of Oregon. I, however, anticipate the discovery of these or other species of the genus in the White River beds of Dakota and Colorado.

TEMNOCYON ALTIGENIS Cope.

Paleontological Bulletin, No. 30, p. 6 (Dec. 3, 1878). Proceed. Amer. Phil. Soc., 1878, p. 68. Bulletin U. S. Geol. Surv. Terrs., vi, p. 179.

Plate LXVIII, fig. 9; LXX, fig. 11.

This dog was about the size of the wolf, *Canis lupus*. It does not appear to have been as abundant as some other species in Oregon, as I have received portions of only three individuals. Two of these are represented by mandibular rami only, one of which is the specimen on which the species was originally established. The third is that part of a skull which is anterior to the orbits, including the mandible and dentition, and it is considerably crushed.

The first-mentioned mandibular ramus is rather deep and compressed, much more so than in the *Canis latrans*, with which it agrees in the length of the dental series. As compared with the existing species of *Canis* and *Vulpes* of North America, the sectorial tooth is relatively smaller and the premolars larger. In this respect it agrees with most other dogs of the Lower Miocene, and differs from those of the Upper Miocene (Loup Fork).[1] The posterior tubercle is wanting from the premolars, excepting the last,

[1] See Proceedings Academy Philadelphia, 1875, p. 22, where I have discussed the origin and history of the sectorial tooth.

where it is large and obtuse, differing in this respect also from most recent dogs, and from the contemporary *Galeaymus gregarius*. In the sectorial tooth the principal cusp is much elevated above the anterior, while the inner median is small, with its apex in line with the anterior. The cutting edge of the heel is not acute, and is a little external to the median line; there is a weak cingulum-like angle at its inner base. The first tubercular tooth is large, nearly equaling in anteroposterior diameter the base of the third premolar. It is parallelogrammic in transverse section, and supports two principal cusps and an anterior ledge. The cusps are pronounced, and stand exterior to the middle line; their inner side slopes to the base of the crown, where there is no cingulum. The ledge is higher on the inner than the external side. There are no basal cingula on either side of the bases of any of the teeth. The second tubercular molar is lost.

The alveolar margin of the jaw rises behind the sectorial tooth, and the inferior margin begins to ascend below the middle of the same tooth more decidedly than in *C. lupus*, *C. latrans*, or *A. cuspigerus*. The two large mental foramina are situated, the one below the second, the other below the third premolars.

Measurements.

	M.
Length of anterior six molars	.073
Length of anterior four molars	.045
Length of base of second premolar	.011
Elevation of crown of second premolar	.011
Length of base of fourth premolar	.015
Elevation of crown of fourth premolar	.014
Length of base of sectorial tooth	.0185
Elevation of principal cusp of sectorial tooth	.0160
Elevation of anterior cusp of sectorial tooth	.009
Length of heel of sectorial	.007
Elevation of heel of sectorial	.0085
Length of crown of first tubercular	.0115
Width of crown of first tubercular	.0065
Depth of ramus at Pm. ii	.024
Depth of ramus at sectorial	.028
Thickness of ramus at sectorial	.010

The second ramus contains the alveolus of the second tubercular molar.

The third specimen presents a mandibular dentition similar to that above described. The superior canine is large, being longer and more acute than in the wolf. The first and second premolars are damaged; the

third does not exhibit any posterior marginal lobe. The sectorial is small for the size of the other teeth, not quite equaling that of the *Canis latrans.* Its anterior inner tubercle is prominent and acute, but of small size. The tubercular teeth are relatively large, equaling those of the wolf in transverse diameter, but not in anteroposterior. They have a wide internal cingulum, and a single low median tubercle separated by a deep valley from the two prominent external cusps. These are bounded externally by a well-marked cingulum. Enamel wrinkled where not worn.

Measurements.

		M.
Length of superior dental series on base, from canine		.070
Length of crown of canine		.030
Diameters of sectorial	anteroposterior	.019
	transverse in front	.0125
Diameters of first true molar	anteroposterior	.014
	transverse	.020
Diameters of second true molar	anteroposterior	.0075
	transverse	.014
Length of series of inferior premolars		.046

From the John Day Miocene of the John Day River, Oregon. Found by C. H. Sternberg and J. L. Wortman.

TEMNOCYON WALLOVIANUS Cope.

Bulletin U. S. Geol. Surv. Terrs., VI, p. 179, Feb. 11, 1881.

Plate LXX; fig. 10.

This species of *Temnocyon* is more nearly related to the *T. altigenis* than to any other member of the genus. Its anterior dentition is much like that of the species named, but the tubercular molars are not larger than those of the *T. coryphæus.* While they differ in details of composition from those of the latter species, they differ also from those of *T. altigenis.* The species is only known from a cranium from which all posterior to the orbits is lost. Its molar teeth, and most of the incisors, are in good preservation.

The first molar is one-rooted, and the posterior outline of its crown is quite oblique The posterior borders of the crowns of the second and third are without distinct lobes. The sectorial has the same size as that of *T. altigenis* Its blades are not very acute, nor close together. The inner

anterior tubercle is small, and is set well inwards. The first tubercular has a very oblique external border, owing to the rapid contraction posteriorly of the maxillary bone. The two external cusps have the usual direction, so that it results that the anterior external angle of the crown is very protuberant, much more so than in *T. altigenis*. Moreover, the external basal cingulum is not defined at the base of the posterior cusp, as it is in *T. altigenis*. For the rest this tooth resembles the corresponding tooth in the latter species, except as to size. The middle of the crown is occupied by a deep valley, which is bounded within on the anterior border of the crown by a subtrihedral tubercle, which does not send a ridge back to the posterior border, as is usual in dogs. The internal cingulum is wide and flat. The second tubercular molar is relatively small, having about half the grinding surface of that of the corresponding tooth of *T. altigenis*. The posterior external cusp is a mere rudiment, and the cingulum is not well defined. The internal tubercle and cingulum are confounded in a uniform surface within the median concavity. The rugosity characteristic of the *T. altigenis* is little visible in this specimen.

Measurements.

		M.
Length of superior dental series on base from canines		.067
Length of bases of true molars		.014
Diameters of sectorial	anteroposterior	.017
	transverse in front	.011
Diameters of first true molar	anteroposterior	.012
	transverse at middle	.015
Diameters of second true molar	anteroposterior	.005
	transverse	.010

From the John Day Bad Lands, Oregon. J. L. Wortman.

TEMNOCYON CORYPHÆUS Cope.

Proceedings Academy, Philadelphia, 1879, p. 180. Figure 2, in Proceedings American Philosophical Society, 1880 (February). *Canis hartshornianus* Bulletin U. S. Geol. Survey Terrs., V, 1879, p. 58; not Cope Annual Report U. S. Geol. Survey Terrs., 1872 (1873), p. 506.

Plates LXXI; LXXI*a*, figs. 1–7; LXXII*a*, figs. 4–7.

That this dog was the most abundant species of the Oregon Miocene is indicated by the fact that the following material representing it is now in my collection: Seven crania, several of them with mandibles and more

or less complete skeletons; seven more or less fragmentary maxillary bones with teeth, and nine more or less broken mandibles with teeth.

A nearly perfect skull displays the following characters: The orbits are entirely anterior to the vertical line dividing the skull into halves, and the muzzle is proportionately shortened. It is also narrowed anteriorly, and its median line above is shallowly grooved. The interorbital region is greatly convex to the supraorbital region, and is grooved medially. The postorbital processes are mere angles, and are flattened from below. The cranium is much constricted behind the orbits, where its diameter is not greater than the width of the premaxillary incisive border. The sagittal crest is much elevated, and forms a perfectly straight and gradually rising outline to its junction with the incisor. The borders of the latter are very prominent, extending backwards considerably beyond the brain case. The zygoma is rather slender, is elongate, and but little expanded. The otic bullæ are very large; the paroccipital processes are directed backwards, at an angle of 45°, and are rather elongate and acute; they cap the bullæ posteriorly. The lateral occipital crests bound a fossa of the occipital region near the condyles. The occipital surface is directed horizontally backwards above the foramen magnum. This part of it, and its superior portion, are divided by a median keel.

The basioccipital is keeled on the middle line below. The sphenoid is not keeled, and is concave, its borders descending on the inner side of the bullæ. The pterygoid fossa is rather narrow, and the hamular process is short. The posterior border of the palate does not extend anterior to the posterior edges of the last tubercular molar, and its middle portion projects backwards in a triangular process. The palatine fossa for the inferior sectorial is shallow. The superior surface of the postorbital region is roughened.

Foramina.—The *foramen infraorbitale exterius* is rather large, and issues above the anterior border of the sectorial tooth. The *f. incisiva* are short, not extending posterior to the middle of the canines. The *f. palatina* are opposite the posterior border of the sectorial. The *f. lachrymale* is altogether within the orbital border. The *f. opticum* is rather large. This species is peculiar in having the *f. f. spheno-orbitale, rotundum,* and *alisphenoidale anterius* united into one large external orifice. The alisphenoid canal is larger than

in *Canis latrans*; and its posterior foramen small. The *f. ovale* is further removed from the *f. alisphenoidale* than in the coyote, and is exterior to and a little behind the *f. carotideum.*

The nasal bones extend to above the middles of the orbits, and contract gradually to their apex. Their combined anterior border is a regular concave, and the lateral angles at this point are produced outwards and forwards. The posterior apex of the premaxillary bone is separated from the anterior apex of the frontal by a short space. The maxillo-malar suture is deeply notched in front below, and it extends upwards to above the infra-orbital foramen. A very narrow surface of the lachrymal is exposed on the external surface. The pterygoid bone is distinct, and is nearly equally bounded by the sphenoid and palatine on the outer side. The inferior suture of the orbito-sphenoid runs in a groove, which is deepest anteriorly.

Dentition.—The crowns of all the incisor teeth are narrow or compressed, and, though slightly worn, present no indication of notch. As usual, the external ones are much the largest in anteroposterior diameter. The canines have robust fangs and rapidly tapering crowns, which are but little compressed. The first superior premolar is one-rooted, and the crown is simple. The crown of the second is without posterior heel and tubercle, while the third possesses both. The sectorial is relatively short, less so than in *C. latrans.* The blades are low and obtuse as compared with recent species, and the notch separating them is quite open. The anterior external heel is small, and there is no anterior external tubercle. The first tubercular molar is large, and the crown is narrower than that of *C. latrans.* It has an obtuse external cingulum, two external conical cusps, a V-shaped median ridge, and a wide internal cingulum. This crown differs from the corresponding one of *C. latrans* in having conical instead of compressed external cusps, and a simple V-shaped crest within instead of two adjacent cusps. The second tubercular is smaller than in *C. latrans*, and its tubercles are less distinct. There are two outer tubercles, a V-shaped ridge, and an inner cingulum, all very obscure. The enamel of all these teeth is smooth.

Measurements of cranium.

	M.
Length along base of skull, including incisive border and occipital condyle	.160
Length of skull to palatal notch	.075
Length of skull to posterior border of pterygoid bone	.102
Length to front of orbit axially	.046
Width between zygomas (greatest)	.094
Width between orbits (least)	.036
Width at postorbital constriction	.021
Width between bases of canines	.017
Width between bases of second tuberculars	.027
Width between otic bullæ	.009
Width between apices of paroccipitals	.042
Width of foramen magnum	.017
Width of occiput above	.032

The cranium above described is not accompanied by a mandible, but has a cervical vertebra and a scapula associated with it in the same block of matrix.

The mandible of another skull exhibits the following characters: There is a well-developed marginal lobe of the posterior cutting edge of the third and fourth premolars as well as a low posterior heel, and a rudiment of an anterior one The heel of the sectorial is shorter than the remaining part of the tooth, and rises to a cutting edge a little external to the middle line; there is a small tubercle at its interior base. The anterior blade-cusp of the sectorial is much lower than the median, which is conical; the two diverge, diminishing the shear-like character and action of the tooth. The internal cusp is well developed. The first tubercular is of moderate size, and is a longitudinal oval in outline. The crown supports two low tubercles anterior to the middle, of which the external is the larger. The last molar has a single compressed root, and the crown is a longitudinal oval in outline. Its position is on the ascending base of the coronoid ramus, so that the crown is slightly oblique. The masseteric fossa is profound and well defined; its anterior termination is below the middle of the second tubercular tooth. The horizontal ramus is not robust, but is compressed, and rather deep.

Measurements of mandible.

	M.
Length along bases of posterior five molars	.049
Length of base of fourth premolar	.011
Elevation of crown	.008
Length of base of sectorial	.018

	M.
Elevation of crown of sectorial	.012
Length of base of first tubercular	.0075
Width of base of first tubercular	.0050
Length of base of second tubercular	.0050

While the characters of this dog do not separate it widely from the genus *Canis*, many of them are quite different from those presented by the recent species of the genus with which I am acquainted. Thus the union of the foramina spheno-orbitale and rotunda, the anterior position of the orbits, and the postorbital constriction are not seen in the wolf, domestic dog, coyote, jackal, or the North American and European foxes. The size of the brain was evidently less than in those species, and the sectorial teeth quite inferior in the efficiency of their blades. These characters may be considered in connection with the low geological position of the beds in which the species occurs.

One of the crania is accompanied by several bones of the skeleton. These are, seventh cervical and four lumbar vertebræ, commencing with the second; humerus, lacking the middle of the shaft and cuboid bone. The seventh cervical has the centrum as large as that of the coyote, but it is more depressed, and its extremities are more oblique. The opisthocœlous character is not wanting, and the inferior keel is well developed. The neural canal is as large as that of the coyote, but the roof is not so wide anteroposteriorly, and the base of the neural spine extends from one edge to the other. The lumbars are as long as those of the coyote, but the third, fourth, and fifth are narrower than in that animal. The fourth and fifth only have well developed keels. On the fifth the angle from the base of the diapophysis posteriorly is well marked. The anapophyses are invisible on the second lumbar, owing to injury; on the other vertebræ they are only a low ridge reaching the posterior edge of the neurapophysis. The parapophysial tuberosities of the anterior borders of the centra below are almost nil, as in the coyote. See Plate LXXI*a*, figs. 2–4, where they are represented two-thirds the natural size. The extremities of the centra are slightly opisthocœlous, and the articular surfaces of both extremities possess a transverse, curved, shallow groove.

Measurements of vertebræ.

			M.
Diameters of seventh cervical	longitudinal		.017
	anterior	vertical (at middle)	.009
		transverse	.0117
Diameters second lumbar	longitudinal		.023
	anterior	vertical (at middle)	.0115
		transverse	.019
Diameters fifth lumbar	longitudinal		.026
	anterior	vertical (at middle)	.012
		transverse	.018

The greater tuberosity of the humerus is of the usual straight form. As compared with both the wolf and coyote, both tuberosities are more produced, and the internal terminates in an acute edge not found in the two species named. The crest of the external tuberosity is continued farther posteriorly than in the coyote or wolf, surrounding the teres insertion space, and continuing below it on the shaft. The lesser tuberosity on the other hand graduates into the head, without the shoulder seen in *C. latrans* and *C. lupus.* The condyles have a smaller diameter and much greater transverse extent than in either of the species of *Canis* cited, or in the *Vulpes cinereoargentatus*, thus resembling the corresponding part in the Eocene *Oxyænidæ.* This resemblance is heightened by the considerable prominence of the internal epicondyle, which exceeds that seen in the recent Canidæ mentioned.

Measurements of humerus.

			M.
Anteroposterior diameter of head and greater tuberosity			.035
Anteroposterior diameter of head alone			.025
Anteroposterior diameter to bicipital groove			.021
Transverse diameter to bicipital groove			.019
Diameters of condyles	transverse		.021
	anteroposterior	external	.011
		internal	.016
Width of posterior face of condyle			.014

The cuboid is a very little longer than wide. The peroneus longus groove is profound and enters at the middle of the external border.

Measurements of cuboid.

		M.
Length		.012
Proximal diameter	anteroposterior	.007
	transverse	.011

A third cranium is accompanied by some bones, among which is a calcaneum (see Plate LXXI*a*, fig. 7). The characters of this bone distinguish it widely from that of the *Canes lupus*, *latrans*, and *cancrivorus*, and the

Vulpes cinereoargentatus. The sustentaculum is more expanded, and the process to which the external calcaneo-cuboid ligament is attached is considerably more prominent The cuboid facet is shaped much as in the gray fox, being wider than in *C cancrivorus* and *C. latrans*, and not so wide as in *C. lupus.*

Measurements of calcaneum.

	M.
Total length	.035
Length of heel	.021
Width at sustentaculum	.017
Width at cuboid facet	.015
Width of cuboid facet	.011
Depth of cuboid facet	.0076
Depth of heel at extremity	.012

This bone is but little smaller than that of an average coyote.

Restoration, etc.—The proportions of this species may be derived from the second specimen described, where the skull is accompanied by bones of the skeleton. The dimensions have been about those of the *Canis latrans*, with some parts rather more slender. The face had a very different expression, owing to its extreme shortness, as compared with the length of the head from the orbits posteriorly. The latter dimension was the same as in the *C. latrans*, but the muzzle resembled in its proportions those of a skunk or badger. The brain case is smaller than in the coyote, and the crests for muscular insertion much more elevated. As the otic bullæ are absolutely larger than in the coyote, it is fair to infer a delicate sense of hearing.

This was the most abundant carnivore in Oregon during the John Day epoch. Of the seven skulls in my possession I find but little variation in proportions. The one whose mandible is figured on Plate LXXI*a*, figs. 1, 1*a*, is the smallest.

The specimen from which the first description of this species was drawn up was obtained by Mr. J. L. Wortman. Others were previously sent me by Mr. C. H. Sternberg

Temnocyon josephi Cope.

Bulletin U. S. Geol. Surv. Terrs., VI, p. 179, February 11, 1881.

Plate LXX, fig. 9.

The anterior portion of a cranium which supports all the teeth is all that represents this species in my collection. It is distinguished, first, by its

size, being intermediate between the *Tennocyon coryphæus* and the *Galecynus geismarianus* in this respect. Secondly, it may be known by the depression of the face at the orbits and the prominence of the anterior part of the malar bone.

Laid by the side of the skull of *T. coryphæus* so that the posterior borders of the second tuberculars of this species and that one are in line, the canine of *T. josephi* originates in line with the posterior border of the first premolar of the *T. coryphæus*. Of course the molars are absolutely smaller in *T. josephi*, but the sectorial is also relatively smaller. In *T. coryphæus* the length of that tooth exceeds the space occupied by the first and second premolars; in *T. josephi* its length is considerably less. The third premolar of the *T. josephi* lacks the posterior tubercle found in the *T. coryphæus*, but a small basal heel is present. There is a narrow internal basal cingulum of the superior sectorial. The first tubercular is not so oblique as in *T. wallovianus*, and has an external cingulum. It has a strong V-shaped crest within the middle, which is well separated from both the external tubercles and the internal cingular border.

The inferior position of the orbit is indicated by the fact that the distance from its inferior border to the base of the sectorial measures one-half the distance between the anterior border of the sectorial and the posterior border of the canine. In *T. coryphæus* it is three-quarters, and in *T. geismarianus* it is three-fifths that distance.

Measurements.

		M.
Length of dental series from I 3		.062
Length of dental series from canine		.051
Length of three premolars		.025
Anteroposterior diameter of canine		.0075
Diameters of Pm. iii	anteroposterior	.009
	vertical	.006
Diameters of sectorial	anteroposterior	.013
	transverse in front	.007
Diameters of M. i	anteroposterior	.008
	transverse	.011
Diameters of M. ii	anteroposterior	.004
	transverse	.0075
Width of incisor series		.015

The reference of this species to the genus *Temnocyon* is provisional, as the character of its inferior molar teeth is unknown. It is dedicated to

Joseph, the chief of the Nez Percés Indians of Oregon, a man declared by common consent to be possessed of many noble qualities, and whose political record has been altogether creditable.

Found in the John Day beds of the John Day region, Oregon, by Mr. J. L. Wortman.

GALECYNUS Owen.

Quarterly Journal Geological Society, London, 1847, iii, 54–60. "*Cynedon* Aymard, Annales Société du Puy, 1848, xii, p. 244. *Cynodictis* Bravard et Pomel, Notice sur les Ossemens Fossiles de la Debruge, 1850, p. 5. *Cyotherium* Aymard, Ann. Soc. d'Agric. du Puy, 1850, xiv, p. 115"; Bronn.

Dental formula, I. $\frac{3}{3}$; C. $\frac{1}{1}$; Pm. $\frac{4}{4}$; M. $\frac{2}{3}$. Inferior sectorial with internal tubercle, and with a heel with raised or tubercular internal and external borders. First premolar in both jaws one-rooted. A postglenoid but no postparietal foramen. Humerus with an epitrochlear arterial foramen.

This genus, which is abundantly represented by species and individuals, existed during the Upper Eocene epoch in Europe (in the Phosphorites), and also during the White River or Oligocene in North America. As the structure of the feet of the numerous species from these epochs is not yet known, and, therefore, some doubt as to their correct generic reference may still exist, I only regard the genus as a certain inhabitant of North America during the Truckee or Middle Miocene epoch. This is indicated by the *Galecynus geismarianus*, where the number of the toes on the posterior foot has been ascertained.

All the species of the genus from Eocene and Lower Miocene beds, as well as most of those of the Loup Fork epoch, are characterized by the relatively small size of their sectorial teeth. In this they resemble the *Amphicyons*, *Temnocyons*, and other forms of *Canidæ* of the same period, and differ from such true *Canes* as *C. ursinus*, *C. sævus*, and *C. haydeni*, which display the enlarged sectorial teeth of the existing species of the genus. Of course there is every gradation in this respect between the two types. In the older species the internal tubercle of the inferior sectorial tooth is more largely developed than in the later ones, thus approaching some of the species of *Viverridæ*, where it is still more largely developed. As in other characters, there are gradations in this also, so that neither in it nor in the relative size of the sectorials do I find ground for the separa-

tion of the species in question from the genus *Canis*, as has been proposed in the case of some of the species in Europe. Through the kindness of M. Filhol, I possess jaws of a number of the species found by himself and others in the Phosphorites of Central France, including the *Canis velaunus*, the type of the genus *Cynodon* of Aymard. These agree very nearly with the species of dogs from the American Miocene beds as to generic characters. Professor Owen, in the paper above cited, proposed to distinguish the genus *Galecynus* on account of the greater length of the pollex as compared with that found in the existing species of *Canis*. This character appears to me to be of an unsatisfactory nature, owing to the fact that gradations in the length of a digit are difficult to express with precision in other than a specific sense; and the gradations may certainly be expected to occur. I therefore formerly regarded all these species as belonging to the genus *Canis*.

I subsequently found in the *G. geismarianus* a character which separates the genus from *Canis*, viz, the presence of the epitrochlear foramen of the humerus. In this point it agrees with *Amphicyon* and *Temnocyon*. I arrange cotemporary and generally similar species under the same generic head, as the most reasonable course in the absence of direct evidence.

The American species of *Galecynus*, then, may be arranged as follows:

I. Smaller species with little or no sagittal crest.
- *Temporal ridges uniting close behind orbits; otic bullæ small.
  - Small; no external ridge on inferior sectorial..... ... *G. gregarius* Cope,
- **Temporal ridges uniting early; otic bullæ large.
  - Larger; no external ridge on inferior sectorial; teeth robust. *G. geismarianus* Cope.
  - Smaller; an external ridge on lower sectorial; teeth more robust. *G. latidens* Cope.
- **Temporal ridges not uniting anteriorly; otic bullæ large.
  - Least; muzzle narrow; superior tuberculars wide; no external ridge on inferior sectorial..... .... *G. lemur* Cope.

There are three species which are only known from mandibular rami. whose positions in the above analytical table I cannot fix. These are *Canes vafer* and *temerarius* of Leidy, of the Loup Fork epoch, and the *C. lippincottianus* Cope, of the White River. As I can add nothing to Mr. Leidy's descriptions of the first two, I only mention them here. They are probably true *Canes*.

GALECYNUS GREGARIUS Cope.

Bulletin U. S. Geol. Survey Terrs., VI, p. 181.

Canis gregarius Cope. Paleontological Bulletin No. 16, p. 3, August 20, 1873. Annual Report U. S. Geol. Surv. Terrs., 1873 (1874), p. 506. Bulletin U. S. Geol. Surv. Terrs., 1879, p. 58. *Amphicyon gracilis* Leidy. Proceedings Academy Philada., 1856, p. 96; 1857, p. 90. Extinct Mammalia Dakota and Nebraska, 1869, p. 36; Pl. I, fig. 7; Pl. V, figs. 7–9. Not *Amphicyon gracilis* of Pomel.

Plate LXVII*a*, figs. 7–11; LXVIII, figs. 5–8.

In the White River beds of Colorado this species is more abundant than all the other carnivora together, and is the only one that bears due proportion to the numbers of rodentia, on which it no doubt depended for food. Slight and unimportant variations may be observed among the numerous specimens. In the Oregon John Day it is less abundant. It is a common species of the White River bad lands of Dakota and Nebraska.

Mandibles from Colorado present the following characters:

About half the size of the red fox (*Vulpes fulvus*), or equal to the *V. littoralis*, Baird, but with relatively deeper mandibular ramus than either. The premolars are in contact with each other, and the middle posterior lobe is well developed, except in the first, which is also one-rooted. Sectorial, with stout inner tubercle as high as the anterior lobe; heel rather small. First tubercular with two roots relatively smaller than in the species last described, with two anterior and one posterior tubercle. The second tubercular is very small, and has a single subcompressed or round root. It remains in very few specimens, and in a few has evidently never existed A premaxillary with part of the maxillary bone displays parts and alveoli of two incisors, one canine, and the first premolar. There is scarcely any diastema, and the canine is compressed oval in section. The exterior incisor is quite large, exceeding by several times the inner one. The premaxillary bone has but little anterior production.

Measurements.

	M.
Length of molar series	0.036
Length of premolar series	.019
Length of fourth premolar	.006
Length of sectorial	.009
Width of sectorial	.004
Height of sectorial	.006
Depth of ramus at sectorial	.010

A nearly entire skull from the John Day region of Oregon is figured on Plate LXVIII, figs. 5, 8, of the natural size. Its form partakes of the anterior abbreviation common to the *Canidæ* of the Miocene, in which that region is shorter than in recent species of *Canis* and *Vulpes*. The nearest approach to such proportions is made by the *Vulpes cinereoargentatus*, where the length anterior to the orbits enters the length of the skull two and a half times. In the *G. gregarius* the proportions of these lengths are as one to three. The muzzle descends regularly from the parietal region, without convexity or concavity of profile. The premaxillary border is not very prominent. The interorbital region is moderately transversely convex, and has a median longitudinal groove which continues to the saggital crest. The postorbital processes are not very prominent, but appear as angles, chiefly on account of the rather abrupt constriction of the cranium behind them. This constriction is not so great as in *Temnocyon oryphaeus*, and is more anterior in position, but is greater than in *Vulpes fulvus* and *cinereoargentatus*, or *Canis latrans* or *cancrivorus*. The brain-case is quite as large relatively as that of *C. latrans*. The temporal ridges extend obliquely backwards and unite to form a sagittal crest above the coronoid process of the mandible. This crest is a low ridge until it approaches the repressed inion, when it becomes more apparent. The occiput is low and broadly rounded, and its bounding crests not very prominent, resembling a good deal in this respect the gray fox. The lateral crest is continuous and quite prominent over the *meatus auditorius externus*. On the occiput the protuberance for the *vermis cerebelli* is well marked and short and wide; it is much more prominent than in the red and gray foxes. The paroccipital process is small and obtuse, and is directed backwards. It is separated from the otic bulla by a considerable space. The posttympanic process is a rounded tuberosity which does not descend on the bulla, but is in contact with the inferior temporal crest, which is not so distinctly angulate at that point as in most recent species of *Canis*. The postglenoid crest is well marked, and is rather more extended transversely than in recent *Canes*. There is no indication of preglenoid crest The bulla is expanded, but not so much as in the other and cotemporary extinct species of the genus. In this respect the *Galecynus gregarius* nearly resembles the

Amphicyon cuspigerus. It has no reverted lip at the meatus as in most recent dogs. The basioccipital is wide and rather flat There is a faint median ridge posterior to the middle of the bullæ, which has behind, on each side, a shallow concavity, which is much less marked than in the *Amphicyon cuspigerus*, but which is not represented in *Galecynus geismarianus.* The fossa between the occipital condyle and the paramastoid process is deep. The zygomata are broken off, but enough remains to show that they are compressed, and have a lateral masseter surface, which occupies half the width of the malar process.

Sutures.—The ascending process of the premaxillary is long and slender, but does not reach the acuminate anterior process of the frontal. The nasal bones are narrow, and their posterior suture forms an acute angle above the very anterior part of the orbit.

Foramina.—The nareal orifice is oblique and about as wide as deep. The infraorbital foramen is large, and is over the anterior root of the superior sectorial. The *meatus auditorius externus* is large, and has a narrow extension downwards and forwards. The condyloid foramen is, as in recent *Canis*, anterior to the transverse ridge extending to the paroccipital process, and is small, and quite near the *foramen lacerum posterius.* The bulla is closely appressed to the sphenoid, so that the *f. l. anterius* is of very small size. The other foramina are still concealed by matrix. The posterior or nareal border of the palate forms two shallow concavities.

Dentition.—The superior incisors have simple crowns, and the median ones are very small. The crowns of the canines are slender, acute, and with an oval section. The second and third superior premolars have a posterior cutting lobe, though that of the anterior is very small. The sectorial is small and robust. It has a basal cingulum both internally and externally. The tuberculars are moderate, the anterior narrower internally than externally, the second of equal width at both ends. Their tubercles, external cingulum, median V-shaped ridge, and internal cingulum are well developed. The three posterior inferior premolars have a well-marked posterior marginal lobe. The sectorial has no external tubercle at the posterior base of the principal cusp. No external cingula on the inferior molars.

Measurements.

		M.
Length of skull to inion		.087
Length from premaxillary border to edge of palate		.040
Length from premaxillary border to postglenoid process		.060
Length from premaxillary border to paroccipital process		.077
Long diameter of otic bulla		.0135
Elevation of occiput above foramen		.012
Diameter of foramen magnum	transverse	.012
	vertical	.009
Width between posttympanics		.032
Width between bullæ		.008
Width between pterygoids		.0065
Width of zygomata opposite postorbital angle		.043
Width of palate at posterior angles of superior sectorials		.021
Width of palate between canines		.008
Width between orbits above		.019
Length of muzzle to orbit (axial)		.028
Length of superior molar series		.031
Length of superior true molars		.009
Diameter of superior sectorial	anteroposterior	.008
	transverse in front	.0045
Diameters first tubercular	anteroposterior	.006
	transverse	.008
Diameters second tuberculars	anteroposterior	.0035
	transverse	.0066
Length of mandible to condyle		.059
Depth of ramus at Pm. i		.006
Depth of ramus at sectorial		.010

Besides the skull above described, fragments of three other individuals of the *Galecynus gregarius* were obtained from Oregon by Messrs. Sternberg and Wortman. None of them include any portions of the skeleton.

GALECYNUS LIPPINCOTTIANUS Cope.

Canis lippincottianus Cope, Synopsis of Vertebrata Collected in Colorado in 1873. Miscell. Pub. U. S. Geol. Survey Terrs., 1873, p. 9. Annual Report U. S. Geol. Survey Terrs., 1873 (1874), p. 506.

Plate LXVII*a*; figs. 5–6.

Among the numerous remains of dogs associated with those of rodents and insectivora in the White River beds of Colorado, I have observed several portions of mandibular rami with teeth which indicate a species intermediate in size between the *Ampicyon hartshornianus* and the *C. gregarius*. Selecting one specimen as type, which contains the teeth which correspond to those which represent the species last described, I find the following peculiarities: The root of the last molar is much compressed. There is only a trace of cingulum on the penultimate, and the tubercles of the inner

side of the crown are well developed. Dimensions half as large again as in *C. gregarius*, as indicated by many specimens of the latter. In it the anterior lateral tubercles are subequal.

A second specimen from the same locality is a mandibular ramus, with the alveoli of the entire molar series and the last premolar and sectorial perfectly preserved. As compared with a larger number of specimens of *C. gregarius*, the jaw is larger, but is chiefly distinguished by the relatively stouter and broader teeth. The first premolar is one-rooted.

Measurements.

	M.
Length of bases of crowns of M. II and III (No. 1)	0.0095
Length of base of crown of M. II	.0060
Width of base of crown of M. II	.0035
Elevation of crown of M. II	.0030
Length of bases of five anterior molars (No. 2)	.0320
Length of bases of four premolars	.0220
Width of sectorial at middle	.0045
Elevation of sectorial at middle	.0070
Depth of ramus at sectorial	.0130
Thickness of ramus at sectorial	.0055

A fragment of a mandible containing the last three molars found in the John Day basin of Oregon agrees in proportions with the above specimens.

Unfortunately there is not enough material in my hands to render it clear whether the specimens represent a distinct species, or a large variety of the *C. gregarius*. For the present I retain it as distinct.

GALECYNUS GEISMARIANUS Cope.

Canis geismarianus Cope, Paleontological Bulletin No. 30, p. 9, Dec. 3, 1879. Proceedings American Philosophical Society, 1879 (1880), p. 71.

Plates LXX, figs. 2-3; LXX*a*.

This species was about the size of the fishes, *Mustela pennantii*, and was larger than the *G. gregarius*. It is represented in my collection by the greater part of a skeleton accompanied by a skull with lower jaw complete; by a second skull, from which the end of the muzzle and the teeth have been broken; and by a fragment of a mandible which supports a sectorial tooth. On the last specimen the species was originally founded.

The characters of the cranium which demonstrate the distinctness of the species, are (1) the low and long sagittal crest; (2) the large size of the

otic bullæ; (3) the long paroccipital process directed backwards and in contact with the bulla at its base; (4) the absence of lateral fossæ of the basioccipital bone.

The skull is rather elongate, the elongation being behind the anterior border of the orbits. In profile the front is convex, and the top of the muzzle subhorizontal. The premaxillary border is only moderately prominent, and the sides of the muzzle are convex. The interorbital region is convex transversely, and the postorbital processes are small, but rather pinched, so as to be rather acute. Above the cephalic contraction behind these, the temporal ridges rapidly converge to a low sagittal ridge, which only rises into a crest when it extends backwards to join the inion. The lateral occipital crests are quite prominent and project a good deal posteriorly, giving the occiput a narrower outline than that seen in *G. gregarius.* It is not interrupted in its course into the suprameatal crest, as is the case in the coyote. The protuberance for the vermis is distinct. The posttympanic process is inconsiderable and is truncate below, inclosing a fossa between it and the bulla. The basioccipital presents a median longitudinal angle, which disappears between the middles of the bullæ. Basisphenoid nearly plane. Postglenoid processes large, the posterior border very oblique downwards and forwards. The zygomata do not exhibit much lateral convexity, and the postorbital angle is distinct. The rami of the lower jaw have been under vertical pressure, so that their inferior edges are a little flattened. The symphysis extends as far back as the middle of the second premolar. The inferior border of the jaw begins to rise gradually opposite the posterior cusps of the first inferior tubercular molar, and continues with less obliquity into the long and rather narrow angle, which is not incurved, and which extends as far posteriorly as a vertical line from the condyle. The coronoid process is rather broad, and is considerably more elevated above the condyle than the latter is above the angle. The masseteric fossa is well defined all round below the coronoid process, better at the anterior inferior angle than the wolf, coyote, or red fox.

Sutures and foramina.—The surface of the cranium is much fractured, although it preserves its general form. Hence the sutures are not easily observed. The frontomaxillary has the usual upward arch, and incloses a

long strip of frontal bone with nasomaxillary sutures. The nasal bones terminate in a gradual acumination above the anterior border of the orbit. The frontal-parietal crosses the sagittal crest two-fifths the distance to the inion from the postorbital processes. The infraorbital foramen opens above the posterior border of the third superior premolar. The postglenoid is at the bottom of a groove of the postglenoid process. The condyloid foramen is near the *f. lacerum posterius*, and just anterior to the anterior border of the large precondylar fossa. The *foramen magnum* is a little wider than deep, and has its superior border regularly arched, and without notches or angles.

Dentition.—The superior incisors differ from those of *Galecynus gregarius* and some other species, in having their cutting edges interrupted by two notches, excepting in the external teeth, where there is but one notch, and that on the inner side. The notches are wanting or indistinct on the inferior incisors. The canines are slender like those of the red fox, but are more curved. The enamel of the inferior canine is longitudinally wrinkled, as in the fisher; the wrinkling is less distinct on the superior tooth. The superior premolars are separated from each other and from the sectorial by short spaces. Only the third has a posterior marginal lobe. The sectorial is relatively shorter than in the *G. gregarius;* its length is less than that of the inferior sectorial by the length of the anterior lobe of the latter. Its inner lobe is smaller than usual. Both tubercular molars have well-developed external cusps, a valley, and in place of the V-shaped crest, two rather prominent juxtaposed subacute tubercles, much as in the first tubercular of the coyote. Within these is a well-defined valley bounded by a prominent internal ledge. There is a complete external cingulum on the first tubercular; it is incomplete behind on the second tubercular. There is no external cingulum on the sectorial or the other premolars.

The inferior premolars are not so widely spaced as the superior; the third and fourth have well-defined posterior marginal lobes, and small anterior basal tubercles. The inferior sectorials only display thin external faces in the specimen. They have a good deal the form of those of the *Amphicyon cuspigerus*, and probably have wide heels. The first tuberculars are quite robust. The enamel on all the molars has a tendency to wrinkling; and this is most distinct on the inferior sectorial and tuberculars. No external cingula on inferior molars.

Measurements of skull.

	M.
Length of cranium to inion	.116
Length from premaxillary border to condyles	.110
Length from premaxillary border to posttympanic	.096
Length from premaxillary border to postglenoid	.079
Length from premaxillary border to posterior border of second tubercular tooth	.053
Length to anterior border of orbit (axial)	.037
Elevation of occiput above foramen	.023
Width of occiput at foramen	.128
Width between posttympanics (outside)	.040
Width between otic bullæ	.090
Width of zygomata opposite postorbital angle	.048
Width of palate at posterior angles of sectorials	.033
Width between canines	.015
Width between orbits above	.023
Long diameter of otic bulla	.019
Length of superior dental series, including canine	.046
Length of superior premolar series	.028
Length of superior true molars	.013
Length of base of third premolar	.0065
Length of base of sectorial	.0095
Width of base of sectorial in front	.005
Diameters of first tubercular { anteroposterior	.008
Diameters of first tubercular { transverse	.0094
Diameters of second tubercular { anteroposterior	.005
Diameters of second tubercular { transverse	.0075
Length of crown of superior canine	.012
Length of crown of inferior canine	.0095
Length of inferior premolar series	.023
Length of inferior true molar series	.022
Length of base of inferior fourth premolar	.0075
Length of base of inferior sectorial	.0115
Length of base of inferior first tubercular	.0064
Length of base of inferior second tubercular	.0035
Length of ramus mandibuli to angle	.077
Depth of mandible at coronoid	.038
Depth of mandible at sectorial (partly restored)	.012
Depth of mandible second premolar	.010

Of *vertebræ* there are preserved five cervicals, two represented by parts only; ten dorsals, four lumbars, three or four sacrals, and five caudals. The cervicals have the characters of those of typical *Canidæ* and *Viverridæ*. The centra are moderately elongate, and their articular surfaces moderately obliquely opisthocœlous. They are strongly keeled inferiorly, the keel running out into a hypapophysial tuberosity on the posterior border of the centrum, where it terminates abruptly. There are opisthapophyses, or small but distinct tuberosities on the borders of the neural arches of the third and fourth cervicals. The seventh is strongly keeled below, the carina widening into a flat triangle posteriorly, and not produced downwards. The inferior

side of the centrum is sharply defined laterally by an acute border extending posteriorly from the base of the diapophysis. The anterior articular face of the centrum is a transverse oval, looking a little downwards.

The capitular rib-facets of the dorsal vertebræ are quite small, making very slight emarginations of the borders, and those of the last three vertebræ are entirely on the anterior portion of each centrum. The first dorsal is not keeled below, and the second has a slight downward projection of the anterior border. All the other centra are rounded below, and their articular extremities are halves of circular disks, except those of the last, which are more depressed. The centra increase materially in length posteriorly, and the elongate ones show traces of the keel, which is well marked on the lumbars. On the antepenultimate centrum an angle of the circumference of the posterior articular face appears just below the line of the neural canal. On successive centra it becomes more prominent, and descends to the inferior plane. It is so prominent as to be a process on each side on the first lumbar. The succeeding lumbars increase in length so as to be twice as long as the anterior dorsals; indeed, nearly three times as long as the first dorsal. They have a low inferior keel, a lateral angle extending from the diapophysis, and a low keel-like neural spine extending the length of the neural arch. The diapophyses have short and narrow bases at the anterior extremity of the centrum. They commence, as usual, as lateral ridges on the dorsals. The first ridge is visible on the penultimate dorsal, extending obliquely backwards and upwards from the superior border of the capitular facet. The anapophyses are very large on the last three dorsals and the first lumbar. They are small on the antepenultimate lumbar, and absent from the last two. The metapophyses are first developed on the penultimate dorsal. On the first lumbar they are large, and have enlarged rounded summits. They are absent from the last three lumbars. The last lumbar is short, as in most carnivora, and has a rather low neural spine, which extends along the entire length of the neural arch. There are three sacral vertebræ, which have a keel for neural spine, which is most elevated on the last. Four caudal vertebræ are in place, succeeding the sacrum. They all have well-developed diapophyses, which are directed backwards and are of depressed section. The neural arch is com-

plete on all, and not much shortened on the fourth. A more distal caudal has no neural arch, but a median ridge on the posterior half and an elevated lateral process in front. Nearly the entire length is occupied by a thin diapophysis on each side.

As compared with other *Carnivora*, the cervical vertebræ most resemble those of *Canidæ* and *Viverridæ*, as already observed. The dorsals differ from all of the former in their greater elongation, especially posteriorly. The lumbars differ from those of dogs, and from those members of the *Mustelidæ* and *Viverridæ* which are within my reach, in their greater elongation. They resemble those of *Canidæ* in the anterior position and short bases of the diapophyses. They differ from them in the long, low neural spines, and resemble those of *Putorius erminea.* The lumbars also resemble those of that species, and of the *Mangusta apiculata*, in the size and posterior persistence of the anapophyses. In the large development of the processes and arches of the caudal vertebræ the *Galecynus geismarianus* resembles the *Viverridæ.*

The vertebræ above described were found as follows: Two cervicals and parts of two others were taken from one block; one cervical and three dorsals from another; two dorsals from another. Five dorsals and one lumbar were adherent to the side of the skull. Four lumbars were attached to the block containing the sacral and four caudal vertebræ, pelvis, humerus, and fore foot.

Measurements of vertebræ.

			M.
Diameters fourth cervical	anteroposterior		.016
	anterior	vertical	.005
		transverse	.0077
Diameters neural canal of cervical	transverse		.007
	vertical		.006
Diameters seventh cervical	longitudinal		.013
	anterior	vertical	.006
		transverse	.0077
Length centrum of second dorsal			.010
Diameters fourth dorsal from last	anteroposterior		.0117
	posterior	vertical	.0057
		transverse	.011
Diameters last dorsal	anteroposterior		.0145
	posterior	vertical	.006
		transverse	.011
Diameters neural canal last dorsal	vertical		.004
	transverse		.0065

			M.
Elevation of neural spine of last dorsal			.020
Elevation of metapophyses first lumbar			.018
Diameter antepenultimate lumbar	anteroposterior		.024
	posterior	vertical	.0067
		transverse	.012
Length of last lumbar vertebra			.014
Length of sacrum			.025
Length of four anterior caudals			.042
Expanse of diapophyses fourth caudal			.018
Vertical diameter centrum fourth caudal			.0045
Length of centrum longer caudal			.018
Vertical diameter of longer caudal			.006

The *scapula* is in a damaged condition, the coracoid process being lost. The spine is high, most so at the acromion. The glenoid cavity is lost above the line of the spine; the remaining part has the transverse greater than the vertical diameter, and is very little concave. The tuberosities of the head of the humerus are prominent, especially the great one. The latter does not extend as far posteriorly as in *Temnocyon coryphæus*, and is obliquely truncated by the teres facet. The proximal border of the great tuberosity is a ridge, but neither tuberosity develops a ridge of the shaft. The anterior face of the latter is rounded. I find this part of the humerus a good deal more like that of *Canis* than those of *Mangusta*, *Putorius*, or *Mustela*, where the tuberosities continue immediately downwards into angular ridges. The shaft of the humerus is lost. The distal portion is preserved. It resembles that of *Mangusta* rather than that of *Canis* or the *Mustelidæ*. It has greater transverse extent both as to the condyle and the epicondyles than in *Canis* sp., but rather less than in *Temnocyon coryphæus*. The internal flange of the condyle is well developed, but the radial convexity is weak. The olecranar trochlea is narrow, and the fossa is deep, rather narrow and transverse and not double as in some *Mustelidæ*. The proximal parts of the ulna and radius are preserved. The inferior edge of the ulna is turned inwards. The bicipital tuberosity of the radius is well marked, and bounds a fossa which is between it and the head. The latter presents a wide oval to the humerus. The *anterior foot* of the right side remains attached to the block which contains the pelvis, and from which the right humerus was cut. It includes the proximal halves of the metacarpals except the first, and the magnum, unciforme, and cuneiforme of the carpus.

The latter do not differ much from those of *Canis*, with one important exception. The cuneiforme and pisiforme are coössified. Whether this is an individual peculiarity, or a character of the species or of the genus, future observations only can decide. The character does not exist in my specimens of *Mangusta apiculata*, *Putorius erminea*, *Mustela pennanti*, nor in any of the *Canes* in my collection. The second metacarpal has the proximal lateral facet for contact with the first metacarpal, and the small tuberosity below it for ligamentous connection. The shafts of the metacarpals are subequal in diameters and of subround section near their middles.

The *pelvis* is preserved in position nearly entire. Its general form is more elongate and compressed than in *Canidæ* and *Mustelidæ* generally, and more compressed than in *Mangusta*. The postacetabular portion is more like that of the *Felidæ* in its narrowness and compression, but the ischiopubic symphysis is more compressed and keeled than in the latter family. The crests of the ilium are broken off, but fragments show that they reached as far forwards as the anterior margin of the last lumbar vertebra. They are moderately wide and flat, and the external face is gently concave. There is a weak anterior inferior spinous tuberosity. The spine of the ischium is a convexity of the narrow superior edge of the ischium, which descends a little to the flatter part of the border representing the lesser sacroischiatic notch. The portion of the ischium which descends to the symphysis is compressed and subvertical; the notch the opposite sides define, is V-shaped, and deeper than in the species of *Canidæ* or other *Carnivora* above mentioned. The obturator foramina are large and are longitudinally oval.

Measurements.

		M.
Elevation of spine of scapula		.010
Transverse diameter of glenoid cavity of scapula		.0075
Diameters of head of humerus (greatest)	anteroposterior	.020
	transverse	.016
Diameter of head of humerus to bicipital notch		.015
Diameters of shaft of humerus	anteroposterior	.0105
	transverse	.0065
Diameter distal end of humerus (greatest)	anteroposterior	.012
	transverse	.018
Diameters of condyles of humerus	anteroposterior, median	.006
	transverse in front	.012
Diameter of shaft of radius at middle		.0055
Width of palm without pollex		.013

	M.
Probable length of pelvis	.172
Length of ilium (inferential)	.037
Anteroposterior width of ilium at base	.013
Anteroposterior diameter of acetabulum	.013
Depth of pelvis at ischiapubic symphysis	.018
Width of obturator foramen	.011

The fragment of lower jaw above mentioned was the specimen from which the existence of this species was originally inferred. Its characters are as follows:

The mandibular ramus is robust and shallow, and quite distinct from the deep jaw of *A. hartshornianus.* The sectorial has perhaps twice the bulk of those of the *G. lippincottianus* and *A. cuspigerus.* From that of the latter it differs further in the small inner tubercle and contracted heel.

The sectorial part of the tooth is relatively small, not exceeding the heel in length, and its cusps are low. The heel is notable for the elevation of the tubercle of the inner side, which exceeds that of the outer; the latter also is contracted, standing within the external base, which is represented by a short cingulum. A weak cingulum below the sectorial blades. Surface of the enamel rugose where not exposed to friction.

Measurements.

		M.
Diameters of sectorial	vertical, anterior cusp	.006
	vertical, heel	.0038
	anteroposterior	.0115
	transverse, middle	.006
Depth of ramus at sectorial		.012
Thickness of ramus at sectorial		.007

The third specimen, a cranium, already mentioned, displays the base of the skull more distinctly than any other. The condyloid foramina are seen to be close to the *f. l. postica,* and the *f. caroticus* is not externally distinguished from the latter. The *f. alisphenoidale posticum* is small, and is well in advance of the large *f. ovale.* The *f. a. anticum* is within the *f. rotundum.* The latter is large and distinct from the *f. sphenoörbitale.* The postglenoid is rather large. The *meatus auditorius externus* is a subvertical oval; has no slit-like enlargement, nor a recurved lip. The palatine foramina are opposite the inner border of the first tubercular molar. A shallow groove extends anteriorly from each for a considerable distance. The maxillopalatine suture crosses the middle line of the palate opposite the anterior border of the sectorial. The frontal sends a long process anteriorly on each

side of the nasals, which does not meet the ascending process of the premaxillary. It also descends along the external border of the orbit to the lachrymal. The latter presents a very narrow surface external to the orbit, and supports a narrow tuberosity on the prominent border of the latter. The malar ascends to near this tuberosity in a narrow process, which is more acuminate in form than in *Canis latrans* or *Vulpes fulvus* and *V. cinereo-argentatus.* The lachrymal bone is much larger than in any of the above species or the *C. familiaris* or *C. cancrivorus*, and is especially expanded at its superior portion. The orbitosphenoid bone extends as far anteriorly as in those species, but carries no diagonal ridge, as in the latter. The orbito-nasal foramen is much more posterior than in them. The squamosal bone is long and low.

There is a slight concavity on the superior surface at the base of the postorbital process of the frontal bone, as in the recent red fox. The palatonareal border is a regular concavity. The otic bullæ are large and somewhat compressed. They are longer than deep, and as deep as wide.

Restoration.—Although the skull and pelvis of this species have about the size of those of the fisher, the vertebræ and humerus are more slender, and the anterior foot is decidedly smaller. It is probable that the *Galecynus geismarianus* resembled a large *Herpestes* in general proportions rather than a *Canis.* It stood lower on the legs than a fox, and had as slender a body as the most "vermiform" of the weasels, the elongation being most marked in the region posterior to the thorax. The tail was evidently as long as in the Ichneumons. Its carnivorous propensities were as well developed as in any of the species mentioned, although, like all other *Canidæ* of the lower Miocene period, the carnassial teeth are relatively smaller than in the recent types.

History.—The specimen above described, which includes the greatest number of bones, was obtained by my assistant, Mr. Jacob L. Wortman, from the Haystack Valley, Central Oregon, from beds of the John Day Miocene age. The skull last described was found by C. H. Sternberg in the "cove" of the John Day Valley of Oregon. The species is named in honor of Jacob Geismar, an accomplished and skillful naturalist of Philadelphia.

GALECYNUS LATIDENS Cope.

Bulletin U. S. Geol. Survey Terrs., VI, p. 181, Feb. 11, 1881.

Plate LXX; figs. 4, 5.

The specimens which represent this species are the following: (1) A skull distorted by pressure and lacking the portion in front of the sectorial teeth, accompanied by a mandibular ramus anterior to the base of the coronoid process; (2) a mandibular ramus similar to that of No. 1; Nos. 3, 4, and 5, fragments of mandibles supporting sectorial teeth.

The specimens show that the *Galecynus latidens* was intermediate in size between the *G. gregarius* and the *G. geismarianus*, and differed from both in various respects. The crushed condition of the cranium renders the description of the form of the brain-case difficult. The lateral occipital crests are more produced posteriorly than in the allied species. The paroccipital process is much as in *G. geismarianus*, but is more closely appressed at the base to the otic bulla than in it. The apical portion is free from the bulla, and is directed principally downwards. The bullæ are quite large, and are oblique ovals, as wide as deep. The masseteric face of the proximal part of the malar bone is lateral, and extends above the middle of the same. The lachrymal bone is wider above than in most *Canidæ*, but is not so wide as in *G. geismarianus*.

The sectorial molar is short, and its internal tubercle is well developed. The tuberculars are distinguished for their anteroposterior width, both being as wide near their inner as at their external borders. Their external cingula are well developed; their external crests are rather low. They have a median V-shaped ridge, and a wide internal cingulum. There is a short posterior cingulum on the second tubercular.

The mandibular ramus is compressed and rather deep. The teeth are not spaced, and the fourth premolar is obliquely placed, so as to overlap externally the anterior lobe of the sectorial. Both the third and fourth premolars have a well-developed posterior marginal lobe; the second premolar is lost from all the specimens. The third premolar is moderately compressed, but the fourth is more robust in its proportions than in any other species of the genus. Both premolars have an anterior and a posterior heel, the former minute. The sectorial is distinguished by the relative

length and width of its heel, in which it exceeds any other of our species; and by the possession of a narrow tubercle at the *external* base of the principal cusp. This is a little higher than the heel, but not so high as the internal tubercle. This character is seen in the *Vulpes cinereoargentatus* among recent dogs. It is present in the four well-preserved sectorials of my collection. The first tubercular is relatively large. It has four cusps, all marginal, two anterior and two posterior, and an anterior basal ledge; no other basal cingula. The second tubercular is missing from all the specimens. There are two mental foramina, a larger below the posterior part of the first premolar, and a smaller below the third premolar. One of the mandibular rami of this species I described along with the skull of *Galecynus lemur*, under the impression that it belonged to an individual of that species. This error is now corrected.

Measurements.

		M.
Length of skull, exclusive of muzzle, anterior to Pm. iii		.070
Length of skull from anterior border of orbit posteriorly		.060
Length of skull from postglenoid process		.032
Length of otic bulla		.020
Width of otic bulla		.010
Diameters of sectorial	anteroposterior	.007
	transverse in front	.0055
Diameters of first tubercular	anteroposterior	.007
	transverse	.008
Diameters of second tubercular	anteroposterior	.0045
	transverse	.005
Length of inferior dental series		.048
Length of sectorial		.008
Length of heel of sectorial		.0035
Length of inferior tubercular		.055
Depth of ramus at sectorial		.0105

The typical specimen above described was obtained by Mr. J. L. Wortman in the cove of the John Day Valley, Oregon, in the John Day Miocene formation. One of the mandibles was found by Mr. C. H. Sternberg.

GALECYNUS LEMUR Cope.

Bulletin U. S. Geol. Survey Terrs., VI, p. 181. *Canis lemur* Cope. Paleontological Bulletin No. 31, p. 2, December, 1879. Proceedings American Philosophical Society, 1879 (1880), p. 371, exclusive lower jaw.

Plate LXX; figs. 6–8.

This animal is represented in my collection by the following specimens: (1) A cranium with premaxillary region preserved, without lower

jaw and with the parietal region injured; (2) a cranium without muzzle or lower jaw; (3) a cranium lacking all posterior to the frontoparietal suture; (4) a cranium mutilated like the last, and without muzzle or lower jaw; (5) a left mandibular ramus, broken off behind first tubercular; (6, 7, and 8) fragments of three mandibular rami.

This species is the smallest of the genus yet discovered in the Miocene formation of Oregon. It is characterized by the contracted proportions of the muzzle, the width of the front, and the large size of the orbits. The postorbital process is only a short angle. The superior border of the temporal fossa is traceable from the postorbital process. Those of opposite sides embrace a smooth sagittal area of an elongate urceolate form, and unite posteriorly in a very short crest. The species is further characterized by the large size of the first superior tubercular molar and the swollen otic bullæ, which exceed relatively those of any other species of the genus.

While the muzzle is shorter in the species of *Galecynus* described in the present work than in existing species of *Canidæ*, the *G. lemur* still further diminishes the size of this region by lateral contraction. The profile descends gradually and regularly, and the premaxillary bone is quite oblique and prominent below. The interorbital region is wide and is quite flat. The orbit is large, and the postorbital angle of the zygoma well posterior. The occiput is much contracted; its lateral angles are well defined but not very prominent, and become obsolete on the mastoid regions. The tuberosity for the vermis is distinct. The precondylar fossa is narrow, and is, as in other species, bounded by a transverse ridge, which extends from the paroccipital process to the basioccipital median line. The paroccipital process does not descend below the level of the occipital condyles; it is appressed to the otic bulla to near its extremity, which is free and directed downwards. Its external surface, as far as the occipitosquamosal ridge and posttympanic process, is flat. The latter process is a mere tuberosity, and does not descend on the bulla. The postglenoid is narrow and small, as in recent *Canidæ*, and its external border extends obliquely downwards and inwards. The bullæ are very large, and of a moderately compressed oval form. They do not present a prominent lip at the meatus. The zygomata are more widely expanded than in any other species of Lower Miocene

Canidæ of which this part is preserved, excepting Leidy's *Amphicyon vetus* (Pl. I, fig. 1, Extinct Mammalia Dakota and Nebraska). The nareal trough is, by comparison, narrow. The posterior palatal or nareal border is regularly concave. The palate is gently concave.

Sutures.—The premaxillaries do not reach the frontal bones. The lachrymal is wide at its inferior part and narrows upwards as in the foxes. The orbitosphenoid extends to the vertical line from the postorbital process of the frontal. The contact of the alisphenoid and parietal is extensive.

Foramina.—The infraorbital foramen opens above the posterior root of the third premolar. The *f. magnum* is wider than deep, and has its superior margin regularly arched. The *f. condyloideum* is near to the *f. lacerum posterius*, but is distinct. There is a foramen in the position of the *f. carotideum* of the *Viverridæ* on one side; it is wanting on the other, and does not occur in the second skull. I suppose, therefore, that it is abnormal. It is interesting as possibly indicating a tendency to variation in the direction of the civets. The *meatus auditorius externus* is not enlarged downwards, and is an oval directed downwards and forwards. The *f. postglenoideum* is rather large, and is cut off from the meatus by the anterior rim of the latter. The *f. ovale* is large, and is very near the *f. lacerum anterius* and well posterior to the alisphenoid canal. The *f. f. rotundum* and *sphenoorbitale* are large, and are only separated by a thin partition. The *f. orbitonasale* has the posterior position seen in other species of the genus. The *f. f. palatina* are opposite the anterior part of the internal borders of the first tubercular teeth.

Dentition.—Three premolars, two true molars, and an incisor remain in this specimen. The crown of the incisor is worn; the alveolus of the canine indicates usual size for the tooth. Crown of first premolar simple. Third premolar compressed, with a well-developed posterior cutting lobe. Sectorial robust, rather wide in front, but with the inner lobe small. The tuberculars are large, and wide anteroposteriorly, but not so wide as in *G. latidens.* The external cingulum is entire on the first, and disappears posteriorly on the second. The cusps are not elevated, and there are a median V-shaped ridge and internal cingulum, on both teeth.

Measurements (*No.* 1).

		M.
Length of skull to inion		.080
Length of muzzle to orbit		.027
Length to postglenoid process		.056
Length of skull to paroccipital process		.071
Width at middle of zygomata		.040
Width at posttympanics		.030
Width between canine teeth		.007
Width between sectorials behind		.020
Width between otic bullæ		.007
Width of foramen magnum		.009
Width of occiput at foramen		.019
Width between orbits		.0115
Elevation of occiput from foramen		.014
Length of dental series from I. 1		.038
Length of molar series		.027
Length of true molars		.009
Length of sectorial		.007
Diameters of first tubercular	anteroposterior	.005
	transverse	.0078
Diameters second tubercular	anteroposterior	.0038
	transverse	.0052

The second skull already mentioned has its superior walls entire posterior to the interorbital region. The temporal ridges are, as in various species of foxes, first convergent, then divergent, and then convergent again to a very short sagittal crest close to the inion. The measurements of this specimen are as follows:

Length of cranium to front border of orbit, M. .0525; elevation of occiput, .058; length of superior sectorial, .007; length of first tubercular, .0058; width of first tubercular, .0078; width of second tubercular, .005; length of second tubercular, .0035.

The most perfect mandibular ramus was found separately (No. 5). It agrees in all necessary respects with the crania. It is, like the muzzle of the latter, attenuated anteriorly, and the molars have corresponding proportions. The fourth premolar is compressed, and has an acute posterior cutting lobe, besides acute anterior and posterior basal tubercles. The inner tubercle of the sectorial is very prominent; there is no trace of tubercle at the external base of the principal one as is seen in *G. latidens.* The heel is quite concave; like the first tubercular, it is narrower than the corresponding tooth of *G. latidens.* The latter tooth has a wide anterior ledge, two elevated tubercles, and a heel with raised semicircular border.

Measurements of lower jaw.

	M.
Length to end of first tubercular	.033
Length of premolar series	.017
Length of sectorial	.008
Width of sectorial posteriorly	.0036
Length of first tubercular	.0047
Width of first tubercular	.0030
Depth of ramus at sectorial	.0080
Depth of ramus at first premolar	.0050

The enamel of the inferior molars is strongly wrinkled. The mandibular ramus I originally ascribed to this species belongs to the *G. latidens*, as proven by another jaw which was found with the skull of that species.

The specimens Nos. 1, 2, and 5, described as typical of this species, was discovered in the John Day River Beds of Oregon, by J. L. Wortman; specimen No. 3 was found by Mr. Sternberg, at the same locality.

ENHYDROCYON Cope.

Bulletin U. S. Geological Survey, V, 1879, p. 56; American Naturalist, 1879, 131, 1883, p. 245.

Dental formula: I. ?; C. $\frac{1}{1}$; Pm. $\frac{3}{3}$; M. $\frac{2}{?}$. The superior premolars consist of two ordinary and one sectorial; the first and second are both compressed, two-rooted, and in the typical species with median lobe of posterior cutting edge. The two true molars are transverse and tubercular. The three inferior premolars are all two-rooted, and with posterior lobe, in the known species. The heel of the sectorial is cutting, as in *Temnocyon*, and the internal tubercle is present. There is at least one inferior tubercular tooth; specimens are injured so as not to display a second.

The dentition of this genus refers it to the *Canidæ*, but the form of the skull resembles that of *Putorius* and *Lutra*. Unfortunately no other part of the skeleton of this genus is known.

ENHYDROCYON STENOCEPHALUS Cope.

Bulletin *loc. sup. cit.*, 1879 (Feb. 28), p. 56.

Plate LXIX; figs. 3-5.

In a nearly complete cranium belonging to this species we observe the shortness of the facial part of the skull as compared with the length of the cerebral, and also the constriction of the skull behind the orbits. The

zygomatic arches are robust and expanded, and the sagittal crest is high. The auditory bullæ are inflated and thin-walled. The orbits look somewhat forwards and very little upwards. The superciliary region is slightly prominent, and there is a prelachrymal concavity. The infraorbital foramen is moderate, and is situated mostly above the posterior part of the fourth premolar. The muzzle is flat above, and the nasal bones are wide, and are not emarginate above the osseous nares, as in many recent *Carnivora*. Posteriorly, the superior border of the brain-case descends, but the parietal bones maintain a gently convex outline in their high sagittal crest. The supraoccipital region is elevated, and projects posteriorly. The lateral occipital crests are prominent to the base of the paroccipital process. The latter projects strongly posteriorly, and is connected with the bulla by an osseous mass which is continuous with the inner border of the process. It is connected with the posttympanic by a longitudinal crest, which includes a deep groove between it and the otic bulla. The posttympanic is a tuberosity which extends downwards below the middle of the *meatus auditorius*, and is not in contact with the bulla. The postglenoid process has greater transverse extent than in the recent species of *Canis*. There is no trace of preglenoid crest.

The basioccipital bone is elevated on the middle line, so as to include a deep fossa on each side between it and the otic bullæ. There is no transverse ridge connecting this ridge with the paroccipital process, as in *Canis*, *Galecynus*, and *Temnocyon*, but the fossa above mentioned is continuous with the precondylar fossa. The basisphenoid is not keeled, and its lateral borders rise on the otic bullæ in a thin lamina on each side. The pterygoid fossa is narrow for the size of the skull, but is appropriate to the attenuation of the postorbital region. The posterior nareal border does not advance in front of the posterior line of the last molar tooth, and is a double concavity, the dividing angle being little prominent. The maxillary is not notched on each side of the palatine on its posterior border, as in the *Amphicyon hartshornianus*. The palate is medially flat, but its sides descend to the alveolar borders, rendering the whole convex upwards. The face is concave behind the canine alveoli. The orbits are small, and the postorbital processes are obtuse angles. The postorbital process of the zygoma

is not prominent. An obtuse bridge extends upwards to the postfrontal process along the superior border of the orbitosphenoid bone, as in recent dogs.

Sutures and foramina.—As the skull is that of an old animal the sutures are obliterated. The anterior nares are small and but little oblique, though not so vertical as those of the *Lutra valetoni, fide* Filhol. They are about as wide as deep. The infraorbital foramen is rather small, and is widely oval in form. The palatine foramina are opposite the posterior part of the sectorial, more anterior than in *Galecynus lemur*. There are, however, two other foramina of smaller size, one opposite the anterior part of the first tubercular, the other behind the posterior margin of the second tubercular, near the posterior nostril. Lachrymal foramen rather large; orbitonasal medium. Optic moderate; *f. f. sphenoörbitale* and *rotundum* separated by a lamina only, the latter receiving the *f. alisphenoidale anticum. F. a. posticum* small and in a fossa common to the rather small *f. ovale. F. lacerum anterius* small, divided into two, and bounded inwardly by an obtuse ridge of the sphenoid directed forwards from the anterior region of the bulla. No distinct carotid foramen. *F. lacerum posticum* small and linear. *F. condyloideum* rather large, situated between the anterior and posterior portions of the large precondylar fossa. *Foramen magnum* rather small, wider than deep. Mastoid very small; postparietal large; no postsquamosal. *Meatus auditorius* nearly round, without reverted lip separating the postglenoid from it.

Dentition.—The teeth of this skull are worn with age and use. The sectorial is short and is widened anteriorly. The first tubercular is large, and has considerable transverse extent; it is a little wider externally than internally, and has much the form of the corresponding tooth in *Canis*. The second tubercular is transverse and small, not being much more than half the length of the first, and is situated in contact with it.

Measurements.

	M.
Total length of cranium	0.170
Width across zygomatic arches	0.114
Least width behind orbits	0.024
Depth of cranium with crest at otic bulla	0.070
Vertical diameter of orbit	0.025
Length from orbit to end of muzzle (axial)	0.040

	M.
Interorbital width	0.043
Width of muzzle above second premolar	0.018
Length of superior molar series	0.051
Length of fourth premolar	0.012
Length of sectorial	0.016
Length of first tubercular	0.008
Width of first tubercular	0.015
Width of second tubercular	0.0085

The dentition is better displayed by a second specimen. This consists of the middle portion of a mandibular ramus and anterior part of the maxillary of a young animal. The teeth are not fully protruded and their crowns are beautifully perfect on exposure. The principal cusps of the inferior premolars present cutting edges, as does the median posterior lobe. In both third and fourth there is a small conic heel posteriorly, but an anterior basal tubercle on the fourth only. The sectorial is large and robust, and the heel is short, with an absolutely median cutting edge. The first tubercular is longer than wide, and presents a nearly median cusp in front, which is joined to a low one on the internal border of the crown.

The superior canine has an obtuse cutting edge on the anterior and posterior borders of the inner side. The first (third) superior premolar is near to it, and is rather large, displaying a median cutting lobe and low posterior heel. The fourth is similar but larger.

Measurements of No. 2.

	M.
Anteroposterior diameter of second superior premolar	0.010
Anteroposterior diameter of third inferior premolar	0.013
Width of base of third inferior premolar	0.0065
Elevation of crown of third inferior premolar	0.010
Diameter of inferior sectorial { transverse	0.010
Diameter of inferior sectorial { anteroposterior	0.021
Width of first tubercular	0.006

Remarks.—The *Enhydrocyon stenocephalus* is an aberrant member of the family *Canidæ*. Besides the generic characters already pointed out, it presents numerous specific peculiarities. Especially to be noticed is the arrangement of the parts between the postglenoid process and the occipital condyle. These do not present striking affinities to any form outside the *Canidæ*, so far as I can ascertain.

Restoration, etc.—Without limb-bones the general form of this species

cannot be inferred. It was as large as the coyote in all probability, and its facial physiognomy must have been that of a large mink or otter. Its canine teeth are formidable from their size, and the high sagittal crest and wide zygomata indicate great power in the action of the lower jaw. If anything may be derived from similarity of cranial form to the otter, its habits were aquatic. Its large otic bullæ indicate a well developed and sensitive sense of hearing. In the development of these parts it is only exceeded among the *Canidæ* here described by the *Galecynus lemur*.

OLIGOBUNIS Cope.

American Naturalist, 1881, June (May 19), p. 497; 1883, p. 246.

The dental formula is, I. $\frac{3}{3}$; C. $\frac{1}{1}$; Pm. $\frac{4}{4}$; M. $\frac{1}{2}$. The single superior tubercular molar is similar in general to that of other *Canidæ*. The inferior sectorial has an internal cusp and posterior heel, the latter with a basin and low cutting edge on one side. Inferior tubercular well developed.

The only known species of this genus I formerly referred to *Icticyon* of Lund, which it nearly approaches. It seems, however, that in that genus there are two tubercular superior molars, and the heel of the inferior sectorial is trenchant as in *Temnocyon*.

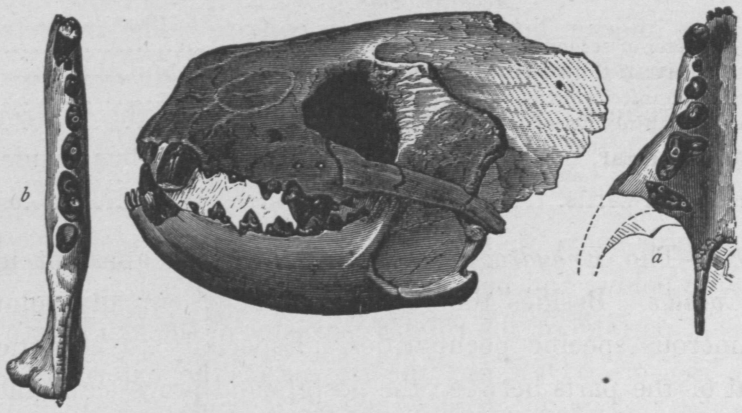

FIG. 34.—*Oligobunis crassirultus* Cope, one-half natural size. *a*, right maxillary bone with teeth from below; *b*, right mandibular ramus from above. From the John Day river of Oregon.

OLIGOBUNIS CRASSIVULTUS Cope.

American Naturalist, 1881, p. 497, and 1882, p. 246, fig. 14. *Icticyon crassivultus* Cope. Proceedings Academy Philadelphia, 1879, p. 190.

Plate LXIX; fig. 1, 2.

The specimen representing this species is a skull with both mandibular rami in place, and without the parietal and occipital regions. These parts belonged to an animal of about the size of the American badger (*Taxidea americana*).

The snout is short and robust, and the profile from the parietal region is straight and descending. The premaxillary border projects but little beyond the line of the extremity of the nasal bones. The muzzle is slightly contracted in front of the orbit and above the fundus of the canine alveoli. The latter cause a swelling on the side. The interorbital region is somewhat cracked, but appears to have been nearly flat medially; laterally it descends steeply to the supraorbital border. The orbit is not large, and the zygomatic fossa is short. The nasal bones are narrowed posteriorly, a little contracted medially, and expanded anteriorly, their lateral portions being produced along the premaxillaries. Their combined nareal border is concave, and is without the notches of some forms. The foramen infraorbitale exterius is of medium size, and issues above the interval between the sectorial tooth and the one in advance of it. The mandibular ramus is quite robust, and its inferior border is gently convex. The masseteric fossa is bounded by elevated borders especially inferiorly, and the angular hook is prominent and robust. The condyle is situated on the horizontal line of the tubercular molar, or a little above the others, and has a wide transverse extent, chiefly inwards. The coronoid process is high and wide, and is turned backwards so as to vertically overhang the condyle. Its anterior border is wide below, and becomes horizontal above.

The teeth partake of the robust character of the skull, with the exception of the incisors. Of these, the crowns of the external are long and narrow, and the median small in the premaxillaries, while those of the lower jaw are all small, and in a regular series. The canines in both jaws are quite robust, and those of the lower jaw are rather abruptly recurved. The first premolar is small, and has a simple crown and single root. The

crowns of the other premolars are wide at the base and form each a simple cone, with a short posterior basal heel. The sectorial is relatively not long, but is robust, and with thick blades. The internal heel is well developed as in *Canis*, while a cingulum represents an anterior lobe. The tubercular molar is narrower in fore and aft diameter than in *Temnocyon coryphœus*, or *Canis latrans*, although it presents the same details. These are a wide obtuse external cingulum, two external tubercles, a median, an obtuse internal tubercle, and a wide internal cingulum. The premolars of the lower jaw are similar to those of the maxillary bone. The inferior sectorial is quite robust, and the internal cusp is well developed. The heel is shorter than the blades of the crown, and is wide and without tubercles in its somewhat worn condition. Its external border rises to an edge. The tubercular is wider than the corresponding tooth in the cotemporary species of *Canidæ*, although not so wide as long. Its crown rises in two low tubercles which stand transversely near the middle.

Measurements.

	M.
Length of skull to orbit (axial)	.049
Depth of skull to orbit (axial)	.042
Interorbital width	.040
Width of nares	.017
Length of superior molar series	.038
Length of bases of three premolars	.019
Length of base of sectorial	.013
Width of sectorial in front	.009
Width of first tubercular anteroposteriorly	.006
Width of first tubercular transversely	.014
Length of mandible to angle	.093
Elevation at coronoid	.051
Elevation at sectorial	.020
Length of inferior molar series	.045
Length of inferior sectorial	.014
Length of heel of inferior sectorial	.003
Length of inferior tubercular	.006
Width of inferior tubercular	.005

Van der Hoeven has given[1] descriptions and figures of the skull and dentition of the *Icticyon venaticus* of Lund, of Brazil. From these it appears that the present species differs from the latter in the greater development of the inner part of the tubercular molar of the superior series; in *I. venaticus* this part is much reduced. The tubercular molar of the lower jaw is also

[1] Overhet Gestlackt Icticyon; wis. en natucirk. vert. der Koninkl. Akademie Amsterdam, Deel III.

much smaller in the living species, the angular and coronoid processes less developed, and the condyle less extended transversely. The cranium of the *I. crassivultus* is much more robust, but not much longer than that of *I. venaticus.*

Discovered by Mr. J. L. Wortman in the John Day beds of the John Day River region of Oregon.

HYAENOCYON Cope.

Palæontological Bulletin No. 31, 1879, p. 3 (Dec. 24) (*definitione falsâ*); Proceedings American Philosophical Society, 1879, p. 372 (*definitione falsâ.* American Naturalist June (May 19), 1881, p. 497 (*definitione emendatâ*).

This genus rests on the characters furnished by two species, which are represented by but few remains. Its family position is doubtful, and my reference of it to the *Canidæ* is only provisional. It may, so far as the evidence goes, be a member of the *Mustelidæ* or even of the *Felidæ.*

Dental formula: I. $\frac{?}{3}$; C. $\frac{1}{1}$; Pm. $\frac{3}{3}$; M. $\frac{1}{11}$. Last superior molar robust, transverse, like that of the *Canidæ* generally. Inferior premolars all two-rooted, and with well-developed posterior cutting lobe. Inferior sectorial large, with heel. Probably no inferior tubercular tooth.

The characters above given agree with those of *Oligobunis* in the superior true molars, but differ in the absence of the Pm. I. and the M. II. in both jaws.

The typical species is the *Hyænocyon sectorius* (*Enhydrocyon basilatus partim* Cope olim.), from the John Day beds of Oregon.

HYAENOCYON BASILATUS Cope.

Bulletin U. S. Geol. Surv. Terrs., vi. 181, Feb., 1881. *Enhydrocyon basilatus* Cope, Bulletin U. S. Geol. Survey Territories, v. 1879, p. 57. American Naturalist, 1882, p. 246, fig. 13e.

Plate LXXV; fig. 3.

This rare species is certainly represented in my collection by parts of only one individual which is known from the greater part of both rami of a mandible, from which only the sectorial, one canine, and some incisors of one side have been lost.

These portions indicate an animal of the same general character as the *Enhydrocyon stenocephalus*, but of larger and more robust proportions, and characterized by many dental peculiarities. These will be at once pointed

out. The canine is directed upwards and a little outwards, and possesses two obtuse ridges bounding the interior face. The third incisor is compressed and truncate superiorly and distally. The first (second) premolar is two-rooted, compressed, and trilobate. It consists of a principal cutting edge little elevated, and a small accessory lobe at each extremity of the crown; its base is expanded posteriorly. The principal cusp of the third premolar is more elevated, and, besides the anterior and posterior tubercles, there is a basal posterior heel, which is continued as an expansion of the inner base of the crown. In the fourth premolar, the base of the crown is expanded, especially posteriorly; the principal cusp has a nearly circular section at the base, and the posterior median lobe is a subconic tubercle standing on the middle of the heel. The sectorial is large and relatively rather narrow, but the details of its form are not ascertainable.

Measurements.

	M.
Length of dental series, including canine and sectorial	0.076
Length of the base of the sectorial	0.024
Length of the premolar series	0.037
Length of the fourth premolar	0.016
Width of the fourth premolar	0.009
Length of the third premolar	0.013
Width of the third premolar	0.008
Length of the second premolar	0.009
Width between centres of crowns of fourth premolars	0.034
Length of symphysis	0.035

This species was probably of the dimensions of the Gray Wolf. Found by Mr. Sternberg in the same region as the *E. stenocephalus.*

HYÆNOCYON SECTORIUS Cope.

American Naturalist, 1882, p. 246, fig. 13 d. *Hyænocyon basilatus* pars Cope *locis alteris citatis.*

Plate LXX; fig. 1.

This species is represented by a right maxillary bone in which the last three molars remain, with the alveolus of the first molar and the canine. I formerly supposed this piece to belong to the *H. basilatus*, and it furnished the characters of the genus *Hyænocyon* in the peculiar dental formula it presents. It belonged to too small an animal to be referable to that species.

The alveolus of the canine tooth shows that the latter is of large size, and that the root and base of the crown have a round section. The first premolar (second) follows without interspace, and all the teeth succeed each

other without interruption. The second premolar is two-rooted, but the roots are close together, and the anterior is the smaller. The long axis of the tooth is oblique to that of the jaw, and the posterior root is within as well as behind the anterior. The axis of the third premolar is very little oblique. It is a robust tooth, and the crown is a little wider anteriorly than posteriorly. The apex is subconical, and there is a posterior intermediate tubercle whose section is wider than long. The heel is narrowed and not recurved. There is no anterior tubercle or cingulum.

The sectorial tooth is relatively of large size, its proportions being those of the *Felidæ* and *Hyænidæ*. Its crown is broken in front, and where not broken, is worn by use. It displays the peculiarity of a remarkably short blade posterior to the lateral external notch; and the base of the middle cusp of the crown is wide for a sectorial tooth, and was apparently subconical when complete. It is also situated remarkably posteriorly, showing either that the anterior sloping edge is long as in *Archælurus debilis*, or that there is an anterior basal lobe, as in the species of *Ælurodon* (figs. 35, 36). The internal lobe is altogether anterior, and, though worn off in the specimen, was probably small. The long axis of this tooth is that of the jaw.

The tubercular or first and only true molar is as large a tooth as in *Canidæ* generally, but its external border is more oblique to the line of the other alveoli. The posterior external cusp is well developed, though smaller than the anterior; and the anterior external angle of the crown is so prominent as to become worn by use like the true cusps. The latter are placed well within the external base of the crown, which is prominent, but rounded, not forming a distinct cingulum. The internal half of the crown is broken away. The internal root comes so near the posterior edge of the maxillary bone as to prove the non-existence of a second tubercular molar. The enamel is smooth in all these teeth, and there are no cingula.

Measurements.

	M.
Length of dental series from posterior edge of canine alveolus	.058
Length of base of Pm. ii	.008
Length of base of Pm. iii	.013
Width of base of Pm. iii	.008
Diameters of sectorial { anteroposterior	.024
Diameters of sectorial { transverse in front	.013
External width of m. i (oblique)	.013
Transverse width m. i, including internal root	.021

This species, as already remarked, has some resemblance to the *Felidæ* in its very short face, and large sectorial tooth. It clearly does not closely approach any of the species of the *Nimravidæ* of contemporary age. A principal peculiarity is the large size of the tubercular molar. Such also is the robust form of the second and third premolars. These resemble somewhat those of *Enhydrocyon stenocephalus*, but are not so much compressed. They resemble those of the species of *Ælurodon* more than those of any other carnivore. Finally, the cylindric base of the canine tooth is that of the *Canidæ* rather than the *Nimravidæ*.

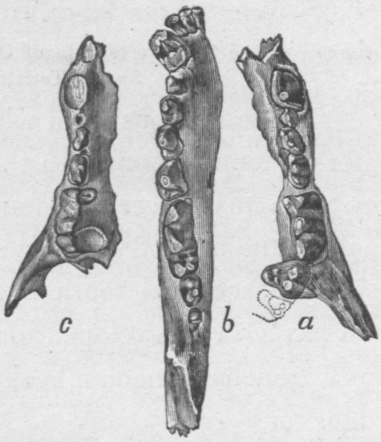

FIG. 35.—Jaws of *Ælurodons*, three-eighths natural size. Figs. *a*, *b*—*Æ. wheelerianus* Cope, from Nebraska. Fig. *c*—*Æ. hyænoides* Cope, from Nebraska. (The second true molar lost.) Both from Loup Fork beds.

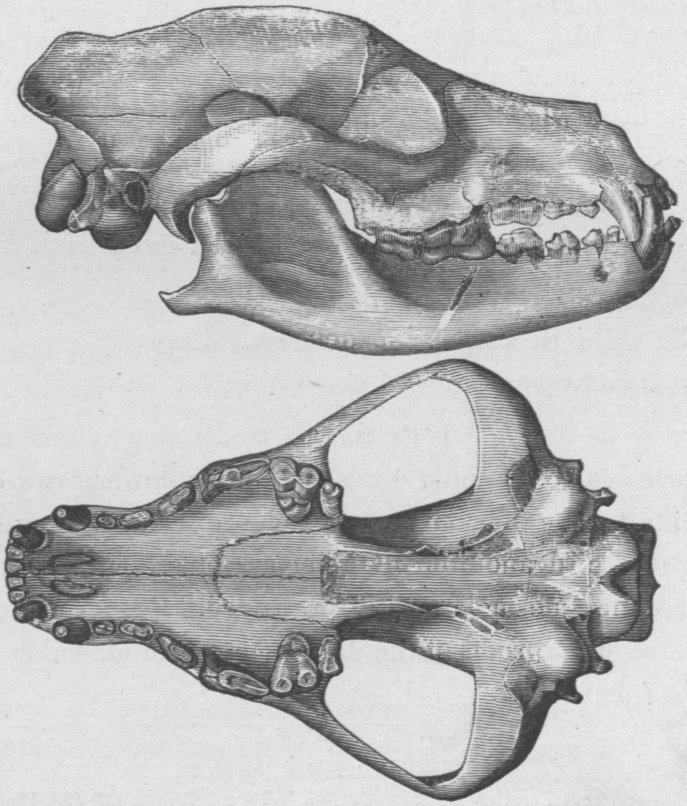

Fig. 36. *Ælurodon sævus* Leidy, from the Loup Fork beds of Nebraska, three-eighths natural size. Copied from Plate CXVIII of this work.

BUNÆLURUS Cope.

Synopsis of the New Vertebrata of Colorado, 1873, p. 8. Annual Report United States Geological Survey Territories, F. V. Hayden, 1873 (1874), p. 508.

The specimens from which this genus is known exhibit a part of the inferior dentition only, so that the number of premolars is unknown. It is probable that there are four premolars however, and there are two true molars, the first of which is sectorial.

The sectorial tooth is like that of *Putorius*. It has no internal cusp, and has a well developed blade. It has also a well developed heel, which has a trenchant median keel. Tubercular molar one, with a median cutting edge.

This genus probably belongs to the *Mustelidæ*, and is allied to *Putorius*, and perhaps to *Gulo*. It is not probable that it has the reduced number of premolars of the former genus, but is more apt to agree with the latter genus, and with *Plesiogale* Pom. in its formula. I have even referred to it under the name of *Gulo*,[1] from which *Plesiogale*[2] has never been really distinguished. The form of the tubercular tooth is, however, very peculiar, and is different from what is seen in any of the species of the genera last named. Structurally the term tubercular does not apply to it, as it is a cutting tooth, without cusps or tubercles. An approach to this form is found in *Putorius*, but in *Galictis* the tubercular molar is of the ordinary type. I know but one species of *Bunælurus*.

BUNÆLURUS LAGOPHAGUS Cope.

Synopsis New Vertebrata Colorado, 1873, p. 8. Annual Report U. S. Geol. Survey Terrs., 1873 (1874), p. 508. *Plesiogale* Cope, on plate of the present volume.

Plate LXVII*a*; figs. 13, 14.

This species is represented by parts of the lower jaws of two individuals, one adult, the other immature. The latter is the more instructive, as it presents the third and fourth premolars emerging from the jaw, and the first and second true molars fully protruded. The crown of the fourth premolar is between the roots of the deciduous sectorial, which still remains attached to the jaw.

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[1] Bulletin U. S. Geol. Surv. Terrs., VI, p. 45. The best description of the dentition of this genus is given by Coues.—The Fur Bearing Animals of America, pp. 39, 40, 1877.

[2] See Filhol Mammiferes Fossiles de Saint Gerand le Puy, 1879, pp. 177–190, Plate 25, who refers the species to *Mustela*.

The crowns of the premolars are simple, and narrow anteroposteriorly, and without posterior lobe. They expand at the base both fore and aft, but do not present basal tubercles. In the sectorial, the median cusp is much more elevated than the anterior. Its posterior face is flattened-convex, while its anterior cutting edge is acute. The cutting edge of the anterior cutting ridge is horizontal, and is separated from that of the larger cusp, by a deep closed notch. No trace of internal cusp. The heel is shorter than the anterior lobe, and is about as wide as long. The inner side of the median keel is concave, and is bounded below by a cingulum, while the external side is convex, and has no cingulum. The second true molar has two roots, and is longer than wide. It narrows posteriorly. Its median cutting edge curves a little inwards anteriorly, and the external base forms a small angle of the opposite side. No cingula.

The deciduous sectorial differs from the permanent, in having a concave heel (perhaps partly worn), and a slight angular trace of the internal cusp.

Measurements.

		M.
Length of four last molars on bases		.0140
Length of permanent sectorial fore and aft		.0050
Length of heel of do		.0010
Elevation of anterior cusp do		.0030
Elevation of median cusp do		.0045
Diameters tubercular molar	anteroposterior	.0022
	transverse	.0013
Diameters sectorial of No. 2	anteroposterior	.0058
	vertical of median cusp	.0040
Depth of ramus mandibuli, No. 2, at sectorial		.0070

From the White River beds of Northeastern Colorado, found by myself with bones of *Peratherium*, *Eumys*, *Palæolagus*, etc. It is quite possible that the animal from the same locality which I named *Canis osorum* (see Plate LXVII a), is the same, or a second species of the genus. The typical specimen is not in a good state of preservation.

NIMRAVIDÆ.

The dental characters of the *Nimravidæ* are in general those of the *Felidæ*, the higher genera having the same dental formula. Descending the scale, the number of molar teeth increases at both ends of the series in the lower jaw, and anteriorly only in the upper, but the number of the true

molars never exceeds $\frac{1}{2}$. The following table gives the definitions of the genera. I unfortunately do not know the foramina in *Pseudælurus*. I introduce *Proælurus* for comparison, although as I have pointed out,[1] it is a member of the *Cryptoproctidæ*. I do this the more readily as it is quite possible that when the number of the digits of some of the species now included under the *Nimravidæ* comes to be known that they may prove to have them five on both feet, and hence to be members of the *Cryptoproctidæ*.

I. Lateral and anterior faces of mandible continuous; no inferior flange.
  a. Inferior sectorial with a heel; canines smooth.
    Molars $\frac{41}{42}$; inferior sectorial with interior tubercle ..... *Proælurus.*
    Molars $\frac{31}{31}$; inferior sectorial without interior tubercle ..... *Pseudælurus.*
II. Lateral and anterior faces of mandible separated by a vertical angle; no inferior flange; incisors obspatulate.
  a. No anterior basal lobe of superior sectorial; inferior sectorial with a heel (and no internal tubercle); incisors truncate.
    Molars $\frac{41}{32}$; canine smooth ..... *Archælurus.*
    Molars $\frac{31}{32}$; canine denticulate ..... *Ælurogale.*
    Molars $\frac{31}{22}$; canine denticulate ..... *Nimravus.*
III. Lateral and anterior faces of mandible separated by a vertical angle; an inferior flange; incisors conic; canines denticulate.[2]
  a. No anterior basal lobe of superior sectorial;[3] inferior sectorial with a heel; no posterior lobes of the crowns of the premolars.
    Molars $\frac{31}{32}$ ..... *Dinictis.*
    Molars $\frac{31}{31}$ ..... *Pogonodon.*
    Molars $\frac{2\text{-}3}{2}\,\frac{1}{1}$ ..... *Hoplophoneus.*
    Molars $\frac{?\,?}{11}$ ..... *Eusmilus.*

It is readily perceived that the genera above enumerated form an unusually simple series, representing stages in the following modifications of parts: (1) In the reduced number of molar teeth; (2) in the enlarged size of the superior canine teeth; (3) in the diminished size of the inferior canine teeth; (4) in the conic form of the crowns of the incisors; (5) in the addition of a cutting lobe to the anterior base of the superior sectorial tooth; (6) in the obliteration of the inner tubercle of the lower sectorial, and (7) in the extinction of the heel of the same; (8) in the development of an inferior

[1] American Naturalist 1881, p. 339. *Proælurus* has also been shown by M. Filhol to be one of the *Cryptoproctidæ*. It is also uncertain whether *Pseudælurus* belongs to the *Nimravidæ*.

[2] Gervais' figures of the canines of *Eusmilus bidentatus* represent no denticulations, but the figure is not clear.

[3] Rudimental in *Hoplophoneus*.

flange and latero-anterior angle of the front of the ramus of the lower jaw; (9) in the development of cutting lobes on the posterior borders of the larger premolar teeth.

(1) The reduction in the number of molar teeth. The dental formula of *Proœlurus* is that of some *Viverridæ* and *Canidæ*, and the reduction from this point to the end of the series is obvious. In *Eusmilus*, as in *Smilodon*, the number of molars is less by one in the inferior series than in *Lynx* and *Neofelis*, where the formula is the smallest known among *Felidæ* proper, viz: $\frac{21}{21}$. (2) The enlarged size of the superior canine teeth. In *Proœlurus* and *Pseudœlurus* the canines of both jaws are developed as in recent *Felidæ*. In *Archœlurus* the superior is the larger, but does not, relatively to the molars, exceed that of *Felis*. It is rather compressed in form and has a sharp cutting edge posteriorly. In *Nimravus* the superior canine begins to have the enlarged size of the saber-tooths, but its form is peculiar in the *N. gomphodus*, being spike-shaped rather than saber-shaped. We find the true saber shape first in the *Dinictis*, where it is compressed, and with a denticulate cutting edge on both front and rear. In *Pogonodon* it has reached a very large size, and it does not display much increase in this respect until we reach the last genus of the series, *Eusmilus*, where its proportions are enormous, almost as large as in the feline genus *Smilodon*, where they appear to have been an inconvenience to the animal. (3) The diminished size of the inferior canines becomes evident in the lower genera of the third division (supra) of the *Nimravidæ*, but is most decided in the highest genera, *Hoplophoneus* and *Eusmilus*. (4) The incisor teeth have the usual obspatulate or obovate outline in the genera of the first and second divisions of the family, including *Nimravus*. They are conic in the true saber-tooths with flared lower jaw, beginning with *Dinictis* and ending with *Eusmilus*. (5, 6, and 7) The structure of the sectorials. The presence of a heel and an inner tubercle of the lower sectorial are well-known characters of a majority of the *Carnivora*. In only the most highly organized genera are they wanting, and among them are included all those of the *Felidæ* that still exist. In the *Nimravidæ* the inferior genera have both in a reduced degree, and they soon disappear as we ascend the scale. Thus, the inner tubercle is only present in the species of *Proœlurus*, *Dinictis*, and

Hoplophoneus. The heel, on the other hand, remains throughout the entire family. The anterior basal lobe of the superior sectorial has the same history, its absence being characteristic of the inferior *Carnivora*, and of all the genera of *Nimravidæ* except *Hoplophoneus*, where it is rudimental. It is well developed in *Drepanodon* as in recent *Felidæ*, and is sometimes double in *Smilodon.* (8) The development of the inferior flange and latero-anterior angle of the mandibular ramus. There is a successive advance in the development of these characters, beginning with the second group, for in the first they are wanting. The latero-anterior angle is developed in *Archœlurus* and allied genera, and is merely continued on the inferior border of the ramus. In the third group it is much more acute, and is deflected downwards, forming the well-known flange of the saber-tooths. It is longest in the *Eusmilus bidentatus* Filh. (9) The highest genera of *Nimravidæ*, e. g. *Hoplophoneus*, differ from true *Felidæ* in the absence of the cutting lobes on the posterior edges of the crowns of the larger premolar teeth. But, according to Filhol, these lobes are present in the generalized genera *Procelurus* and *Pseudœlurus*, which are thus brought into a relation with the *Felidæ* not possessed by the *Nimravidæ.*

A characteristic perfection of the *Felidæ* is seen in the genus *Smilodon;* that is, the vertical direction of the ungual phalanges, by which the claws become retractile. This is well displayed by the two splendid specimens of *Smilodon necator* from Buenos Ayres, which have been preserved.[1] Unfortunately, these phalanges have not yet been described in any species of the *Nimravidæ*, and it is not yet certain what their structure really was. Among the true *Felidæ* the genus *Cynœlurus* displays a less degree of development in this respect than the other genera, the ungual phalanges lacking the proximal process below the articular facet. Such a condition is to be looked for among the less perfect genera of *Nimravidæ.*

The succession of genera above pointed out coincides with the order of geologic time very nearly. Those belonging to groups first and second belong to the Lower and Middle Miocene, except *Ælurogale*, which is perhaps Upper Eocene, and *Pseudœlurus*, which is Middle Miocene. The genera of the third division have the same Lower Miocene age, except *Eusmi-*

[1] See American Naturalist, December, 1880, fig. 12.

lus, which has been found in the same formation (Phosphorites) as the *Ælurogale*. Among *Felidæ*, *Drepanodon* is Upper Miocene, and *Smilodon* is Pliocene.

The relations of these genera are very close, as they differ in many cases by the addition or subtraction of a single tooth from each dental series. These characters are not even always constant in the same species, so that the evidence of descent, so far as the genera are concerned, is conclusive. No fuller genealogical series exists than that which I have discovered among the extinct cats.

As to the phylogeny of this family, there are flesh-eaters of the Eocene period which may well have been the ancestors of both the *Nimravidæ* and *Felidæ*.[2] I have suggested that this position is most appropriately held by the *Oxyænidæ*, a family of several genera, which included the most formidable, rapacious mammals of that early period in both continents. The interval between them and the *Nimravidæ* is, however, great; for in the *Oxyænidæ*, when there is a superior sectorial tooth, the first true molar in the upper jaw is utilized instead of the last premolar, and the second true molar below is a sectorial as well as the first. Several intervening forms must yet be found to complete the connection, if it have ever existed. It is, however, very likely that the true *Felidæ* were derived from the genus *Proælurus*, through *Pseudælurus*, if indeed these two genera be not the primitive members of that family, for, as above remarked, the evidence of their possession of the characters of the *Nimravidæ* has not yet been obtained. There can be no reasonable doubt that the genera *Drepanodon* and *Smilodon* in the *Felidæ* are the descendants of *Hoplophoneus* and allied genera. In fact, the *Nimravidæ* and *Felidæ* are "homologous groups," having corresponding terms in the manner I foreshadowed as a general principle in 1868 (Origin of Genera).

[1] M. Filhol has shown the range of variation in the *Ælurogale intermedia* to be considerable. While the normal dental formula is as given above, molars $\frac{3}{3}\,\frac{1}{1}$, he believes that it may range to $\frac{3}{4}\,\frac{1}{2}$ in one direction, and $\frac{3}{2}\,\frac{1}{1}$, or $\frac{3}{2}\,\frac{1}{1}$, in the other direction. It never attains the formula $\frac{4}{4}\,\frac{1}{2}$ of *Archælurus*, while the occurrence of two premolars in the lower jaw is rare. Originally M. Filhol was inclined to believe that there were three species, and this view is confirmed by the range in size. The largest specimens measure .085 M. on the alveolar line behind the canine, and the smallest .030, or less than half as long. The discovery of various intermediate sizes led M. Filhol to combine the three species into one. I incline to think M. Filhol's belief in three species to have better foundation than his belief in but one. Were the animals living, it is probable that their characters would be much more readily defined than is possible with the jaws only. Memoires sur quelques Mammiféres Fossiles des Phosphorites du Quercy, Toulouse, 1882.

[2] See On the Genera of the *Creodonta*, by E. D. Cope, Proceed. Amer. Philos.. Soc. July, 1880.

The following list shows the number and distribution of the species of the *Nimravidæ*. The position of a cross on a line indicates an intermediate geological position.

	Upper Eocene.	Lower Miocene.		Upper Miocene.		Pliocene.	
	Europe.	Europe.	America.	Europe.	America.	Asia, Europe.	America.
Pseudælurus hyænoides Blv				+			
Pseudælurus edwardsi Filh	+						
Archælurus debilis Cope				+			
Ælurogale intermedia Filh	+						
Ælurogale minor Filh	+						
Ælurogale mutata Filh	+						
Nimravus gomphodus Cope,				+			
Nimravus confertus Cope				+			
Dinictis felina Leidy			+				
Dinictis cyclops Cope				+			
Dinictis squalidens Cope			+				
Pogonodon platycopis Cope				+			
Pogonodon brachyops Cope				+			
Hoplophoneus oreodontis Cope			+				
Hoplophoneus primævus Leidy			+				
Hoplophoneus occidentalis Leidy			+				
Hoplophoneus cerebralis Cope				+			
Hoplophoneus strigidens Cope				+			
Eusmilus bidentatus Filh	+						

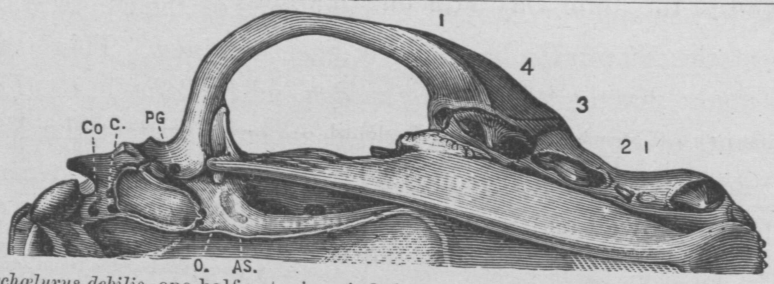

FIG. 37.—*Archælurus debilis*, one-half nat. size; inferior aspect. Foramina: AS, alisphenoid; O, ovale; PG, postglenoid; C, carotid; Co, condylar.

ARCHÆLURUS Cope.

American Naturalist, 1879, p. 798*a*. Proceed. Amer. Philos. Soc., 1879, p. 372 (Jan. 1880). Paleontological Bulletin, No. 31, p. 3, Dec. 24, 1879.

Dental formula I., $\frac{3}{3}$; C., $\frac{1}{1}$; P-m., $\frac{4}{3}$; M., $\frac{1}{2}$. Mandibular ramus without flaring inferior border anteriorly. Superior canines without cut-

ting edge anteriorly; posterior edge not serrate. Incisors with short, slightly spatulate crowns. Postglenoid and postparietal foramina present. Superior sectorial tooth without anterior lobe. Inferior sectorial with heel, and without internal tubercle. No intermediate posterior lobes of the premolars.

This genus is of interest as completing the connection between the saber-tooth and primitive unspecialized groups of the cats, a transition also clearly indicated by the genus *Nimravus*. In dentition it adds a tooth to the number belonging to that genus in both jaws, and has a smooth-edged canine; it is otherwise identical with that genus, unless, indeed, the exostosis supporting the inferior sectorial tooth in the *A. debilis* be introduced into this category; a position I am not prepared to assume. The molar dentition only differs from that of *Dinictis* in the addition of a single tooth to the superior series, but that genus has the compressed superior canine and flared mandibular ramus of the saber-tooth. *Archœlurus* also eases the passage from these genera to the *Proœlurus* of Dr. Filhol, a highly interesting genus obtained by that gentleman from the phosphatic deposits of Central France. *Proœlurus* has one more molar in the inferior series, and its inferior sectorial exhibits an internal tubercle similar to that seen in *Dinictis*. Like *Archœlurus*, it is not a saber-tooth.

But one species of *Archœlurus* is known thus far, and this one has been found in the John Day Miocene of Central Oregon.

ARCHÆLURUS DEBILIS Cope.

American Naturalist, December, 1879, p. 798 *a* (published Dec. 4). Palæontological Bulletin, No. 31, p. 3, Dec. 24, 1879. Proceed. Amer. Philos. Soc., 1879, p. 372.

Plate LXXI*a*, figs. 8–16; plate LXXII.

This species, which is about the size of the panther (*Uncia concolor*), is represented in my collection by parts of the skeletons of three individuals. First, a cranium with mandible complete, and the atlas; second, a cranium without mandible, but otherwise complete; third, a cranium anterior to the zygomatic fossa, without dentition or mandible, but accompanied by a lumbar vertebra; proximal part of scapula; both extremities of humerus; proximal part of ulna; fifth metacarpus; both extremities of tibia;

the astragalus and first metacarpal. As the cranium first mentioned furnishes the greatest number of characters, I select it for description.

The profile of the skull is convex, much as in the panther, but it appears to be somewhat less so, owing to the greater prominence of the premaxillary border. The front is rather wide at the postorbital region, and it is convex on each side of a wide shallow median longitudinal concavity. The nasal bones are rather stout, and carry their width backwards before contracting to an apex, which is above a point posterior to the lachrymal foramen. The external portion of their anterior extremity is continued as a process of moderate length along the premaxillary bone, about as far as the width of the superior border of each nostril. The superior process of the premaxillary does not reach the frontal bone by $.17^{m}$. The superior face of the frontal region is prolonged backwards so as to be partly diamond-shaped, owing to the gradual approximation of the anterior borders of the temporal fossæ. This form differs from that seen in the panther and leopard, and is more like the shape found in the jaguar and tiger. The extinct species differs from all of these in the very small development of the postorbital process. This is simply a slight prominence of the superciliary border; in only one of the three specimens deserving so much as the name of an angle. The brain-case is not more contracted behind the orbits than in the *Uncia concolor*. Anterior to the orbit the face is shallowly concave above the region external to the canine alveolus, which is convex. The sagittal crest is low, and the lateral crests of the inion are not very prominent. The latter do not overhang the foramen magnum so far as in the panther. The zygomatic arch is characterized by its slenderness, and the rudimental character of the postorbital process, so well developed in the existing *Felidæ*. It is less expanded posteriorly; that is, it is more nearly parallel with the axis of the skull than in the large recent cats. The occiput is not elevated. Its posterior face is divided by a short keel which descends from the inion one-third the distance to the foramen magnum. The latter is wider than deep, and its superior border is not furnished with the tuberosities so well marked in the panther, and less so in the leopard and tiger. The foramen magnum is much as in the *Lynx rufus*. The paroccipital process is moderately long, is acute, and is directed

obliquely backwards. The front tympanic process is an obtuse tuberosity whose anteroposterior diameter exceeds its longitudinal. The occipital condyles are well separated below. The basioccipital is first flat below, and is then divided by a delicate median keel. The latter soon terminates, sending off a curved line to the anterior inner border of each otic bulla. The area on each side of the keel is divided into three shallow fossæ and an anterior plane. Anterior to the keel the base is plane, except a shallow fossa on each side. The posterior margin of the palate is gently concave to the line of the principal cusp of the superior sectorial. It is not so deeply concave as in the panther. The otic bullæ are large, as in existing cats.

The rami of the mandible are quite slender, in correspondence with the character of the zygomata. The inferior border of the masseteric fossa, though prominent, accompanies the inferior edge of the ramus for a short distance only, and gives it little width. The symphyseal portion rises abruptly from the rami; it is narrower below than above, and is concave in transverse section near the middle The angle which separates the lateral from the anterior face of the ramus is rounded, and is continuous with the inferior border. This form is not seen in the species of *Felis*, *Uncia*, and *Cynœlurus*, and is a trace of the characteristic angle and flange of the sabertooths. The posterior angular process is straight, compressed, and acute, and the condyle is quite narrow. The osseous tuberosity beneath the inferior true molar teeth is a most peculiar feature. It looks as though the external alveolar border had been greatly extended, and then folded down and attached to the side of the ramus. Its free borders are a vertical and a horizontal, which are connected by a rounded angle. The ascending border passes into the base of the coronoid process by a roughened ridge. The inferior border and external face are also slightly roughened.

Foramina.—The incisive foramina are large. The *f. infraorbitale exterius* is especially large, and opens forwards. Its external border is thin, and is convex in profile; it is above the posterior edge of the last superior premolar, when the skull is resting on a plane surface. The *f. opticum* is rather large, and occupies the position usual in existing cats. The *f. sphenoörbitale* is quite large, and is round. The *f. rotundum* is smaller than the

optic foramen and issues in the posterior side of the *f. sphenoörbitale*, and not separately as in the species *Uncia* at my disposal, the *Cynœlurus jubatus*, and in several species of *Felis*. An alisphenoid foramen. The *f. ovale* is ransverse in direction and is well separated from the *f. lacerum anterius*. The latter is contracted. The *f. postglenoidum* is nearly as large as the *f. ovale*, and is near the anterior border of the meatus of the ear. The latter is small, and is bounded below by a distinct ossification, probably a tympanic bone, which is thickened so as to resemble somewhat a sesamoid. I find it in the two specimens where the region is preserved. There is no *foramen lacerum medius*, and the *f. carotideum* is well defined from the *f. l. posterius*, which it about equals in size. The *f. condyloideum* is quite distinct from the latter, of about the same size, and does not enter it from behind so as to have a common opening, as in the species of *Felis*, *Uncia*, *Cynœlurus* *Crocuta* and *Hyœna*. Supraglenoid, postquamosal, subsquamosal, and mastoid foramina wanting. The postparietal is rather small, and is situated in the anterior inferior part of the posterior third of the parietal bone. There are two lateral and two anterior mental foramina on each side. Of the former, the posterior is below the posterior part of the second premolar, and the anterior below the first premolar.

Dentition.—There cannot be said to be any diastema in the superior dental series excepting that between the canine and the first incisor. The inferior diastema occupies the usual position, but has diminished length. The first and second superior incisors are quite small; their crowns are about as wide as their roots, and, meeting the inferior incisors squarely, are truncated by wear. The external superior incisor is several times as large as the others, and its crown is expanded outwards at the base. It presents an external worn face several times as long as its apical face. The superior canine is relatively about as long as in the panther. It is a good deal more compressed than in that species, and has a sharp posterior cutting edge which extends from near the alveolus to near the apex. This edge is not crenated. There is no corresponding anterior edge, though the wearing of the inner side of the crown by the inferior canine produces an artificial one near the apex. The front of the canine is rounded, but is not as wide as in existing cats.

The first superior premolar is one-rooted, and is of moderate size. The second is two-rooted and is small. The third is abruptly larger. The anterior face of its principal cusp is wide, and has no basal lobe; it is not trenchant posteriorly. The heel is long and rather obtuse. The fourth premolar or sectorial is relatively large. There is no anterior basal lobe, and the internal lobe is small. The cusp is robust, and not very acute posteriorly. The heel is long. The true molar is of medium size, and its external face reaches the line of the external faces of the premolars. Its grinding face is oblique upwards and backwards.

The inferior incisors are much like the superior, excepting the external one, which is only about twice as large as the others, and of the same form. The section of the inferior canine is nearly the quarter of a circle, the angle looking backwards from the inner side. It is much larger than the superior external incisor. The first inferior premolar is one-rooted, and its alveolus is as large as that of the first superior premolar, and is situated close to that of the second. The second (third) is quite large; it has an anterior basal angle, and a short posterior heel, but no posterior lobe of the principal cusp. The last premolar is larger. With the inferior sectorial it is concealed in part by the superior teeth, as the lower jaw has not been removed from its position. The posterior part of the sectorial shows a distinct, rather acute heel, like that of the *Nimravus brachyops*. The tubercular or second true molar is small and obtuse, and is directed more anteriorly than superiorly, owing to its situation on the base of the coronoid process. In all the teeth the enamel is smooth, and there are no cingula.

Measurements of skull.

	M.
Axial length from occipital condyles to premaxillary border	.180
Axial length from inion to premaxillary border	.191
Axial length from premaxillary border to canine tooth	.008
Axial length from premaxillary border to anterior border of superior sectorial	.058
Axial length from premaxillary border to palatal border	.075
Axial length from premaxillary border to end of maxillary bone	.080
Axial length from premaxillary border to postglenoid process	.135
Length of nasal bone from notch	.050
Length of sagittal crest from inion	.064
Width of premaxillary bones at canines	.034
Width of anterior nares	.027
Width of nasal bones at middle	.020
Least width between orbits	.028
Width at postorbital processes	.060
Width behind postorbital processes	.034

	M.
Width of zygomata at anterior border of orbits	.080
Width at meatus auditorius	.130
Width between paroccipital processes	.053
Width of occiput at middle	.032
Elevation of occiput above foramen	.032
Width of foramen magnum	.022
Depth of foramen magnum	.014
Width between etic bullæ	.016
Width of posterior nares	.013
Width of chin at base	.020
Width of chin at summit	.027
Length of superior canine	.026
Anteroposterior diameter at base	.013
Anteroposterior diameter at middle	.010
Transverse diameter at middle	.0065
Length of superior molar series	.057
Length of bases of Pm. i and ii	.0105
Length of base Pm. iii	.018
Elevation of crown of Pm. iii	.010
Length of base of Pm. iv	.024
Width of base in front	.010
Elevation of base in front	.012
Width of M. i (transverse)	.011
Length of base of inferior Pm. iii	.014
Length of base of inferior Pm. iv	.015
Elevation of base of inferior Pm. iii	.011

The *atlas* attached to the cranium above described is not entirely cleaned from the matrix. It displays a vertebrarterial foramen piercing the base of the transverse process posteriorly, as in various species of *Felis* and *Uncia*, and as distinguished from the lion. The base of the transverse process has a smaller anteroposterior width than in any of the species of *Felidæ* or Hyænas accessible to me. The neural arch has a similar character; a low tuberosity represents its neural spine.

The second specimen mentioned resembles the one already described so nearly as to render extended notice unnecessary. The crowns of the small first premolars have been broken off, but traces of their roots remain.

The third specimen displays the root of the first premolar with the others. The palatal surface exhibits a fossa opposite the heel of the superior sectorial to receive the apex of the inferior flesh-tooth. A last or seventh lumbar vertebra, belonging to this specimen, is represented on Plate LXXI*a*, fig. 8. It is a little smaller than that of *Uncia concolor*, and is quite similar in general proportions, especially in the form of the centrum. It differs in the following points: (1) The expanse of the postzygapophyses

is a little less than the width of the centrum; in *U. concolor* it is a little greater. (2) The posterior edge of the neural spine is narrow and simple; in *U. concolor* it is wide and grooved. (3) There is no reverted process near the base of the diapophysis, as in *U. concolor*. (4) The metapophyses are more compressed, and rise higher than in *U. concolor*. As in the puma, there are no anapophyses.

Measurements of seventh lumbar vertebra.

		M.
Anterior diameters of centrum	vertical	.018
	transverse	.027
Length centrum on side		.030
Posterior diameters of centrum	vertical	.017
	transverse	.030
Expanse of prezygapophyses at middle		.025

The differences between this vertebra and the corresponding one of *Uncia concolor* are nearly those which distinguish it from the lion, leopard, and cheetah, with the following exceptions: In the lion the neural spine is thin behind, and the metapophyses thin and elevated, as in *A. debilis*. In the leopard the angle of the transverse process is not produced, and is more distal. The diapophysis in the cheetah is quite as in *A. debilis*, slender and without posterior angle.

Portions of the *scapula* and of the fore and hind limbs of this specimen are represented on Plate LXXI*a*, figs. 9–16. The glenoid cavity of the former narrows forwards to a subacute apex, which is not truncate, as in the panther. The coracoid hook, if it were present (the specimen is injured), originated farther above this apex than in the panther, leopard, or common cat. The characters may be compared with those of the recent cats, as follows:

Uncia leo. Coracoid rudimental; anterior tuberosity acute; posterior border of neck truncate; adjacent angle-ridge not continued.

Archælurus debilis. Anterior tuberosity acute; posterior border truncate and rugose for insertions; no adjacent angle-ridge.

Uncia concolor. Coracoid distinct; anterior tuberosity truncate; posterior border of neck truncate and rugose for insertions.

Uncia pardus. Coracoid distinct; anterior tuberosity acute; posterior edge not truncate; no adjacent angle-ridge.

Cynælurus jubatus. Coracoid distinct; anterior tuberosity acute; posterior edge not truncate; adjacent angle-ridge not defined.

Felis domestica. Coracoid present, not separated by notch, and continuous with anterior tuberosity; posterior edge openly grooved on account of adjacent posterior angle-ridge.

The head of the *humerus* presents some characters which distinguish it from those of the species of cats above mentioned, although it resembles them strongly in general features. While rather smaller than those of the panther and leopard, the greater tuberosity is more prominent, and the bicipital groove wider and deeper. The proximal surface of the lesser tuberosity is more distinct from the head, and is less decurved posteriorly. Viewed from the inner side its proximal surface is nearly straight and makes a right angle with the prominent posterior bicipital crest instead of being continuous with it, as in the panther and domestic cat, more nearly resembling the leopard and the lion. The tricipital fossa is larger than in any of those species, being well defined by a strong ridge posteriorly. The *fossa musculi teris* is quite small, less than in the *Uncia concolor* and *U. leo* and *Felis domestica.* The distal extremity of the humerus displays characters intermediate between those of the existing *Felidæ* and the flesh-eaters of the Eocene period. This is shown in its rather greater transverse extent; or, to particularize, in the greater length of the radial part of the trochlea and greater production of the internal epicondyle. The former has its proximal anterior border notched, and its face has a corresponding slight contraction not seen in any of the recent *Felidæ*, but not quite as strong as that of the *Crocuta brunnea* and the *Canidæ.* The distal extremity of the internal epicondyle is a truncate half-circle. Its production interior to this is withdrawn to a more proximal position. The olecranar fossa is well marked, and has a slight perforation. The radial fossa is wanting.

The *fifth metacarpal* is, relatively, smaller than in *Unciæ leo, pardus,* and *concolor, Cynælurus jubatus* and *Felis domestica.* It displays all the special characters of these species, including the keel-like interlocking process connecting it with the fourth metacarpal, so characteristic of the *Felidæ.* The proximal extremity resembles that of the lion rather than that of the panther in the plane surface of insertion of the external articular ligament.

Measurements of fore limb.

		M.
Diameters of glenoid cavity of scapula	anteroposterior	.029
	transverse at middle	.021
Diameters of head of humerus	transverse, extreme	.049
	transverse to groove	.033
	through lesser tuberosity	.036

		M.
Diameters of distal end of humerus	transverse, extreme	.044
	transverse of condyles	.033
	anteroposterior, at flange	.020
	anteroposterior at middle of condyle	.014
Length of fifth metacarpal		.039
Transverse diameters	proximally	.007
	distally (epicondyles)	.011

From the above measurements it may be seen that the fifth metacarpal bone is relatively only three-fifths as long as that of the recent *Felidæ* above mentioned.

The head of the *tibia* is about the size of that of a rather small adult *Uncia concolor* from Texas in my collection, and does not differ from it materially in characters. The anterior external tuberosity is not prominent, resembling that of *Felis domestica* rather than that of the larger cats. The external cnemial, and the popliteal fossæ are more deeply excavated than in any of the five *Felidæ* above mentioned, and the external posterior angle is acute. The distal extremity strongly resembles the corresponding part in the recent species of *Felidæ*, the external astragaline fossa being a little more expanded outwards. There is but one groove for the tendon of the peronaeus muscle instead of the two which are more or less distinct in all the species named; and its anterior bounding crest extends to the distal border of the malleolus, as in *Uncia concolor*, and does not cease above it, as in the other *Felidæ* above mentioned, and as in *Canis lupus*. The peroneal ridge is well marked.

The *astragalus* differs from that of all the *Carnivora* mentioned in this article in the shortness of its neck and the extension of the internal trochlear crest to the border of the navicular surface, from which only a narrow groove separates it. The trochlear face is a little narrower than in the species of *Felidæ* and *Hyænidæ* cited, and the inner side is more oblique outwards and downwards than in any of the species cited, excepting the *Uncia concolor*. On this side there is a well-marked tuberosity on the inferior margin posterior to the middle. Above and anterior to it the astragalus is concave. The navicular bone must have an extensive proximal external production, judging from the extent of the recurved external part of its facet on the astragalus. The trochlear groove of the astragalus is distinct, but is less profound than in the recent *Felidæ* and *Hyænidæ*. The first *metatarsus* is

much shorter and more slender than that of *Uncia concolor*, *U. pardus*, *Cynælurus jubatus*, or *Crocuta maculata*. What its length relatively to the other digits is, cannot be readily ascertained at present. Its proximal extremity is formed much as in the recent *Felidæ* and *Hyænidæ*, except that there is scarcely any external angle, from which it results that the bone is narrower when seen from the front. The shaft is subcylindric, is distally somewhat flattened, and is gently bowed forwards. The epicondyles and extremital keel are well developed, and much as in the recent species.

Measurements of posterior limb.

			M.
Head of tibia, diameters	transverse		.045
	anteroposterior at middle	greatest	.043
		least	.020
Diameters of shaft at distal fourth	transverse		.017
	anteroposterior		.016
Diameters of distal end of tibia	transverse		.030
	anteroposterior		.019
Diameters of astragalus	transverse at middle		.024
	anteroposterior		.033
Length of trochlea on external crest			.029
Width of head			.018
Length of first metacarpal			.067
Anteroposterior diameter metacarpal v	proximal		.017
	distal		.013
Width of shaft at middle			.009
Width at epicondyles			.013

Restoration.—It is probable from what has preceded, that the *Archælurus debilis* was an animal presenting much the appearance of the existing cats, and of about the size of the American panther. Omitting more technical characters, it differed from this and other species of the *Felidæ* in the greater slenderness of its feet. Its head was characterized by less breadth through the posterior part of the cheeks, and by a greater convexity of the forehead between the eyes, and a greater prolongation backwards of the same region.

Its structure plainly indicates that this species was of less sanguinary habits than the exising *Felidæ*, since its prehensile organs, both of the feet and dentition, are less robust. The slender zygomata and rami of the lower jaw show also that the impact of its bite was less powerful, although the large size and narrow form of the sectorial teeth furnish an effective cutting apparatus, which in some degree supplements the deficiency of strength. The weakness of the rami is further provided against by the curious exos-

tosis at the base of the inferior sectorial already mentioned. This growth is symmetrical on the two sides of the skull, and is evidently normal; traces of it are seen in the species of *Nimravus*.

History.—The first description of this species was given by myself under the head of the *Nimravus brachyops* (*Machærodus brachyops*. Paleontol. Bulletin 30, p. 10, Dec., 1878), from a skull found by Mr. Sternberg, under the impression that it might belong to a female of that species. Subsequently a nearly perfect cranium, obtained by Mr. Wortman, demonstrated the distinctness of the animal, both as to species and genus. I published a wood-cut of this skull in the American Naturalist for December, 1880.

Horizon and locality.—The remains of the *Archælurus debilis* have so far been only found in the Middle Miocene formation of the John Day River, Central Oregon. Judging from the remains, it was, after the *Nimravus gomphodus*, the most abundant feline of that region.

NIMRAVUS Cope.

Proceedings of the Philadelphia Academy, 1879, p. 169.

Dental formula: I. $\frac{3}{3}$; C. $\frac{1}{1}$; Pm. $\frac{3}{2}$; M. $\frac{1}{2}$. Superior canines elongate, denticulate. Mandibular rami not flared downwards in front. Incisors with short subspatulate crowns. Superior sectorial without basal anterior lobe; inferior sectorial with well developed heel, and no internal tubercle. No intermediate posterior lobes of the premolars. Postglenoid and postparietal foramina present.

This genus has the dental formula and characters of *Hoplophoneus*, with the addition of a tubercular inferior molar tooth. It is, moreover, not a true saber-tooth, as is that genus, since it does not display the inferior anterior flange of the mandible. This is represented by an obtuse angular border, quite as in the species of *Archælurus*, in which genus *Nimravus* finds its nearest ally. The constant absence of the anterior premolars in both jaws distinguishes it sufficiently from that genus. On this account, and in view of the larger development and denticulated edge of the superior canine teeth, *Nimravus* may be considered as occupying a position between the two genera above named.

Two species are known to me, a larger and a smaller, both from the Middle Miocene formation.

NIMRAVUS GOMPHODUS Cope.

American Naturalist, 1880, p. 844. Bulletin U. S. Geolog. Surv. Terrs., 1881, p. 167.

Nimravus brachyops Cope. Proceeds. Phila. Acad., 1879, 170; not *Machærodus brachyops*. Proceeds. Amer. Philos. Soc., 1878, p. 72.

Plates LXXIII; LXXIV, figs. 1–2.

This feline is represented in my collection by parts of three individuals. The first includes a skull with one side and part of the other completely preserved, with the cervical and some dorsal vertebræ; the second is known from the posterior part of a mandibular ramus supporting three molar teeth; the third specimen embraces an entire mandibular ramus with all the teeth, and a femur, both having been found lying close together in the rock.

The skull of the first specimen has the mandible attached, with the mouth partly open, as represented on Plate LXXIII. It is as large as the large forms of the panther, and exceeds slightly the skull of the *Archælurus debilis*. It has very much the general proportions of that of the panther in the regular convexity of the profile of the frontal and nasal regions, the length anterior to the orbit, and in the degree of production of the inion. The length anterior to the glenoid cavity is relatively greater than in the panther, so that the mandible is longer. The front is moderately convex in transverse section, and is prolonged farther posteriorly than in the panther, through the more gradual convergence of the borders of the temporal fossa, resembling in this the tiger rather than the other species of *Uncia*. The obtuse postorbital angle is more prominent than in the *Archælurus debilis*, but does not deserve the name of a process, as it is in the large recent cats. The side of the face in front of the orbit is gently concave; in front of the *foramen infraorbitale exterius* it is nearly plane. The contraction behind the orbits is about as in the panther. The zygomatic arch is quite as prominent anteriorly as in the recent cats, but at the middle of its course it is less convex or flatter, as in the *Archælurus debilis*. The inion projects beyond the vertical line of the occiput, but not so far as in the tiger or the *Pogonodon platycopis*. The occiput is not higher than wide above, and it is divided by a keel which fades out on the inferior third. The lateral crest is low above the paroccipital process, where it divides into two low ridges. One of these goes to the paroccipital process and the other to the base of

the posttympanic, where it turns forwards and becomes the acute supra-meatal crest. The two tuberosities on the superior border of the foramen magnum are rudimental. The paroccipital process is directed posteriorly. It is acute and rather long, is convex behind and flat in front. The posttympanic is short, and its extremity forms an obtusely rounded tuberosity. There is an osseous tuberosity below the meatus of the ear which is doubtless the same as the piece in the *Archælurus debilis* which I identified with the tympanic bone. The basioccipital is divided by a median keel, while the basisphenoid is smooth. The palatal surface is injured in this specimen.

The ramus of the mandible is longer, deeper, and more compressed than in the recent species of *Uncia* and the *Pogonodon platycopis*. It is more robust than in the *Archælurus debilis*, and the exostosis below the last two molars is wanting. It is represented by a thickening of the external alveolar border, which is larger in some specimens than in others. The inferior border is gently convex below the teeth, and rises slightly below the anterior part of the masseteric fossa. It is continued into the hooked angular process, which is as wide as deep, and is not incurved. Anteriorly the inferior border is continued as an obtuse angle slightly everted but not in the least decurved below the diastema, and it then rises, running obliquely forwards and forming the obtusely angular border of the flattened symphyseal region. The inferior border of the symphysis descends below the level of the inferior border of the ramus. The condyle measures half the distance between the angle and the summit of the coronoid process. The latter is wide and is obtusely rounded above, where it does not extend posterior to the vertical line from the condyle The masseteric fossa is deep and wide; its narrow anterior border is reverted, while the inferior region is excavated abruptly below the general plane. There is a secondary fossa in its posterior part whose superior boundary marks half the distance between the last molar tooth and the summit of the coronoid process.

Sutures.—The premaxillary bone rises in its narrow portion to the horizontal line of the superciliary border. The maxillo-frontal suture is regularly convex upwards, and its anterior extremity falls short of the premaxillo-maxillary suture by .008 m. The nasomaxillary extends farther posteriorly, *i. e.*, to above the anterior third of the orbit, the palate and basioccipital

being the horizontal base. The fronto-parietal suture is coarsely zigzag squamosal, and although it is entirely within the temporal fossa, it extends further forwards than in the recent cats. This extension is represented in the panther[1] by some curious produced laminæ, one on each side, reaching the frontal angle. The parietal and alisphenoid bones have an extensive contact. I do not find the large supraoccipital wormian bone of the recent large cats.

Foramina.—The *foramen infraorbitale anterius* is rather large, is a vertical oval in form, and is presented forwards. Its external border is above the posterior lobe of the second superior premolar. The optic foramen is large, and is separated from the much larger *f. sphenoörbitale* by a short interval. The *f. rotundum* is near the latter, but is entirely distinct from it; it is a little smaller than the *f. opticum*, and larger than the *f. ovale*. The *f. ovale* is well anterior to the *f. lacerum anterius*. An alisphenoid foramen. The *f. postglenoideum* and *f. caroticum* are well defined; the latter is separated from the jugular, and this in turn from the condyloid foramen. The *f. postparietale* is in the upper part of the inferior half of the parietal bone. There are no mastoid foramina. There are two lateral mentals, one below the anterior (third) premolar, and one below the diastema. The *foramen magnum* is large, and is wider than deep, as in *Archœlurus debilis*.

Dentition.—The crowns of the superior incisors are flattened in front, where they have vertically oval outlines. The face of the external incisor is about twice as large as those of the others, and is bounded externally by a considerable face of contact for the inferior canine. The superior canine is of peculiar form, and does not exactly resemble that of any known species of the family *Felidæ*. The anterior border of the crown is a straight line from a point near the base to near the apex. The posterior outline is also nearly straight, having a slight concavity near the base and a slight convexity near the apex. As the anteroposterior diameter at the base is not large, and as the length of the crown is considerable, the resulting form is peculiarly slender and pike-shaped. The external face is strongly convex anteriorly, turning into a transverse anterior face, which is separated from the inner face by a right-angled ridge. Next to this ridge on the basal

[1] I find it in skulls which I have examined.

half of the crown, excepting near the base, the anterior face is thrown into a shallow groove. The ridge is not denticulate, while the acute posterior edge of the tooth is distinctly so from the base to the apex. The (first) second superior premolar is very small, and is two-rooted; it is a little nearer the base of the third premolar than that of the canine, leaving two diastemata. The third premolar is of large size, and consists of a triangular cusp and a short lobe-shaped acute heel. The superior sectorial is rather large. The apex of its anterior cusp is directed well backwards, and its posterior border is acute. The heel is long, and its cutting edge rises to half the height of the cusp. The external extremity of the crown of the tubercular molar is narrower than the internal; it just reaches the vertical plane of the alveolar border of the maxillary bone. Its size is moderate.

The inferior incisors are smaller than the superior, and of similar form. The external is only a little larger than the others. The inferior canine is much larger, and is nearly half the length of the superior canine. Its crown is directed somewhat outwards, and its inner face is moderately beveled above the apex of the external incisor. A section of the crown is an oval whose long axis is anteroposterior at the base, and more inwards posteriorly to an angle higher up. This angle is the posterior cutting ridge, which extends from the inner side of the base to near the apex, and is strongly denticulate. The diastema following the inferior canine is remarkably long in this species, relatively longer than in any of the large existing cats. The third inferior premolar (first present) is also remarkable for its large size, differing in this respect from true cats and saber-tooths alike. Its cusp is elevated, and the posterior basal heel is very short. There is no anterior basal tubercle. The fourth premolar has a greater longitudinal extent, and its apex is not quite so elevated as that of the third. Its anterior and posterior basal lobes are trenchant, and of equal anteroposterior extent. The inferior sectorial is large, and its principal lobes are large, and with acute cutting edges. The anterior lobe is longer than high, and the posterior higher than long, and its posterior edge is acute. The heel is small and acute. There is no trace of internal tubercle. The tubercular molar is small, and its diameters are subequal, and similar to that of the heel of the sectorial. In one of the three mandibles in my collection, represented on Plate LXXIV, fig. 1, this tooth is wanting.

The enamel is smooth, excepting on the superior canine and the anterior part of the anterior inferior premolar. Here it is roughened by minute impressed punctæ. No cingula.

Measurements of skull.

	M.
Axial length from occipital condyles to premaxillary border	.206
Axial length from inion to premaxillary border	.220
Axial length from premaxillary border to canine tooth	.017
Axial length from premaxillary border to anterior border of superior sectorial	.066
Axial length from premaxillary border to posterior extremity of maxillary bone	.097
Axial length from premaxillary border to postglenoid process	.162
Length of nasal bone from nasal notch	.065
Length of sagittal crest from inion	.082
Width of premaxillary bone (greatest)	.019
Width of each nasal bone at middle	.008
Width of each frontal bone at middle of orbit	.028
Width of each frontal bone at postfrontal angles	.035
Width of skull at anterior part of zygoma	.098
Width of zygomata at temporal fossa	.111
Width of skull at meatus auditorius	.074
Width of skull between apices of paroccipital processes	.054
Width of occiput at middle	.044
Width of foramen magnum	.024
Elevation of occiput above foramen	.036
Width of chin at base	.022
Width of chin at summit	.028
Depth of chin	.040
Depth of ramus at diastema	.027
Depth of ramus below last premolar	.031
Length of ramus	.157
Elevation of condyle	.033
Elevation of coronoid process	.071
Length of superior canine	.045
Diameters of base of superior canine { anteroposterior	.016
Diameters of base of superior canine { transverse	.008
Anteroposterior diameter at middle	.010
Distance from canine to third premolar	.016
Length of molars, including third premolar	.045
Length of base of third premolar	.018
Elevation of cusp of third premolar	.013
Length of base of sectorial	.025
Elevation of cusp of sectorial	.015
Width of tubercular	.009
Elevation of inferior canine	.024
Anteroposterior diameter of inferior canine at base	.012
Length of inferior diastema	.022
Length of inferior molar series	.063
Length of third premolar	.0175
Elevation of third premolar	.0175
Length of fourth premolar	.020
Elevation of fourth premolar	.015
Length of sectorial	.025
Elevation of median cusp of sectorial	.016

The *cervical vertebræ* have about the size and proportions of those of the leopard and the panther, differing only in minor respects. The centra are moderately depressed, and have oblique articular extremities, but the obliquity is rather less marked than in *Unciæ leo, concolor* or *pardus*, or *Felis domestica*. All are perforated by the vertebrarterial canal, excepting the sixth, as usual. The transverse processes of the atlas are about as wide as in the species named, but are more contracted at the base. The latter is pierced posteriorly, and in the middle inferiorly, by the vertebrarterial canal. The neural arch of the axis is more elevated in front than in the recent large cats, so that the interspinous foramen is larger. The axis also differs from the recent species in having the posterior borders of the arch above the zygapophyses regularly concave, and not filled (*U. leo*, *F. domestica*) or interrupted (*U. concolor*, *U. pardus*) by the opisthapophysis. The neural arch has the median posterior prolongation usual in *Felidæ*. The transverse process is acuminate, and extends as far posteriorly as the vertical line of the postzygapophyses. The hypapophysial keel of the axis is weak, but a little stronger than in the lion. The other cervicals can scarcely be said to be keeled, though traces are present on some of the centra, which on the third, fourth, and fifth, spread out posteriorly into triangular areas. Opisthapophyses are only present on the third and fourth cervicals. In the recent species I find them present, as follows:

Nimravus gomphodus, 3–4;
Uncia leo, 2–3–4–5–6–7;
Uncia concolor, 2–3–4–5;
Uncia pardus, 2–3–4–5–6–7;
Cynælurus jubatus, 2–3–4;
Felis domestica, 2–3–4–5–6–7.

All the cervicals behind the third have well-developed neural spines, that of the seventh covering the entire length of the neural arch by its base. The transverse processes present some peculiarities. The principal feature is the greater prolongation downwards of the diapophysial element, and hence less separation from the parapophysial than in the species above mentioned, especially in the fourth and succeeding vertebræ. The parapophyses have considerable expanse both transversely and fore-and-aft.

The first and second dorsal vertebræ differ from those of all the *Felidæ*

above mentioned, in having the superior half of the posterior face of the neural spine grooved. The inferior half has a keel, which becomes very prominent to a point opposite the commencement of the zygapophyses and then suddenly subsides, as in *U. concolor*. The postzygapophyses are recurved outwards on the first dorsal; on the second they are plane, and slope downwards outwards. The center of both are as long as those of the last cervicals, are depressed, and have two weak angles on the inferior face.

Measurements of vertebræ.

			M.
Length of cervical vertebræ			.200
Transverse extent of atlas			.090
Transverse extent of transverse process of atlas			.025
Length of centrum of axis on side			.022
Elevation of centrum and neural canal of axis anteriorly			.029
Diameters of centrum of fourth cervical	anteroposterior		.025
	vertical in front		.012
	transverse in front		.020
Transverse extent with processes			.054
Diameters sixth cervical	anteroposterior		.024
	posterior	vertical	.013
		transverse	.026
Diameter with transverse processes			.050
Expanse of prezygapophyses			.035
Diameters centrum first dorsal	anteroposterior		.022
	anterior	vertical	.013
		transverse (without rib facets)	.017
Elevation of neural canal in front			.011
Elevation of neural arch and spine			.055
Expanse of postzygapophyses			.025
Expanse of postzygapophyses second dorsal			.022
Expanse of diapophyses second dorsal			.050
Anteroposterior diameter neural spine at base			.017

These vertebræ are represented in Pl. LXXIIa, fig. 3.

The second specimen of the *Nimravus gomphodus* consists of the posterior part of a mandibular ramus supporting teeth. Its dimensions are a little smaller than those of the type.

The third specimen includes a complete mandibular ramus with all the teeth, some dorsal vertebræ, and a femur. These pieces were found in juxtaposition in the same block of stone, and agree in proportions. The specimen was as large as No. 1. The *left femur* is perfectly preserved, and is represented in Plate LXXIV, fig. 2. It is rather long and slender, having nearly the size and proportions found in the leopard and panther. Its little trochanter is more prominent than in either of those species, and the

trochanteric fossa descends lower down. The *fossa ligamenti teris* communicates with the neck by a groove, a character not seen in any of the five recent species at my disposal. The external *linea asper* forms a prominent ridge on the proximal half of the shaft, while the internal *linea asper* is short and only prominent proximally. Distally, the external rotular crest extends farther posteriorly than the internal. The rotular surface is a little narrower than in *Unciæ leo*, *concolor*, or *pardus*, and while as narrow as in *Felis domestica* and *Cynœlurus jubatus*, is prolonged farther posteriorly. The lower portion of the shaft is oval in section. The intercondylar fossa is divided into three areas, viz, an anterior and posterior subtriangular separated by a deep oblique fossa. The former are the points of insertion of the internal and external crucial ligaments. The fossa between them is characteristically much deeper than in any of the recent feline animals above mentioned.

Measurements of femur.

		M.
Total length		.260
Transverse width	at proximal extremity	.052
	at distal extremity	.046
	at middle of shaft	.023
Anteroposterior width	of head	.024
	of great trochanter	.027
	of shaft	.018
	of condyles	.045
Width of rotular face at middle		.020

Restoration.—The *Nimravus gomphodus* is as large as the full-grown panther of the large varieties. It probably stood as high above the ground, but whether the body had the elongate proportions of that animal, or the more robust form of the leopard and jaguar cannot be ascertained in the absence of necessary material. Unless the animal had pendulous upper lips, a thing unknown among cats, the superior canine teeth must have been distinctly displayed on each side of the chin, their points descending entirely below the lower margin of the lower jaw when the mouth is closed. As these points are less compressed than in the true saber-tooths, they were less liable to fracture from lateral blows, but were more apt to be broken by fore-and-aft strains, owing to their slenderness.

The long canines of this species testify to bloodthirsty habits, for as weapons for penetrating wounds they are without rival among carnivorous

animals. They resemble considerably the teeth of some of the *Dinosauria;* for instance, those of the Triassic *Clepsysaurus.* The sectorial apparatus is especially effective, and no tissue could long resist the combined action of the opposing blades of the two jaws. Nevertheless, this species did not, probably, attack the large *Merycochœri* of the Oregon herbivores, for their superior size and powerful tusks would generally enable them to resist an enemy of the size of this species. They were left for the two species of *Pogonodon,* who doubtless held the field in Oregon against all rivals. The compressed mandibular rami of the *Nimravus gomphodus,* though less slender than those of the *Archœlurus debilis,* are not so well calculated to resist lateral strains as the more robust jaws of the majority of the existing *Felidæ.*

History.—The first notice of this species was based on a mandible. As it is exceptionally without tubercular tooth, I referred it to the genus *Hoplophoneus;* and since its proportions are very similar to those of the *Pogonodon brachyops,* of which no mandible had been found up to that time, I identified it with that species. The reception of other specimens enabled me to distinguish the genus *Nimravus,* but it was not until some time later that I became satisfied that it was distinct from the species to which I originally referred it. The reasons for this conclusion are given under the head of *Pogonodon brachyops.*

NIMRAVUS CONFERTUS Cope.

Bulletin U. S. Geol. Survey Terrs., VI, p. 172, Feb., 1881. American Naturalist, 1880, p. 849, fig. 10.

Plate LXXI a; fig. 17.

This species is as yet represented by a mandibular ramus only. It is one-third smaller than that of *N. gomphodus.*

The inferior border of the ramus is broken off, excepting for a space below the diastema. The general form is narrow, as in *N. gomphodus,* and there is a projecting ledge along the inner base of the sectorial similar to that seen in the latter species. The angle separating the side from the front of the ramus is rather stronger than in *N. gomphodus,* but there is no indication of an inferior flare. The diastema is shorter than in the typical species, its length equaling that of the base of the third (first) premolar; in *N. gomphodus* it is half as long again. The symphysis is correspondingly shorter, ceasing a little in advance of, and at the posterior border of, the

inferior canine tooth, while in *N. gomphodus* it continues for one diameter of the canine behind its posterior border.

The crown of the inferior canine tooth is directed backwards, and its serrate cutting edge is presented almost entirely inwards. The interno-anterior face of the crown is flat, and has a low shoulder at the base. The molars have the proportions of those of *N. gomphodus*, differing only in their smaller size, which is very apparent, as can be seen by the measurements. The first (third) premolar is a little longer on the base than high, has no anterior tubercle, and has a short cutting basal heel. The fourth premolar has subequal anterior and posterior basal cutting lobes, and the base is longer than the elevation of the median cusp. The sectorial tooth has a short cutting heel, but no trace of inner tubercle. The anterior lobe is as long as the median, but not so high. It overlaps the fourth premolar as far as the base of the median cusp. No incisor teeth are preserved in the specimen. Tubercular small.

Measurements of skull.

	M.
Depth of ramus at diastema	.020
Depth of chin	.027
Elevation of inferior canine	.016
Diameter of inferior canine at base	.010
Length of inferior diastema	.014
Length of inferior molar series	.053
Length of third premolar	.014
Elevation of third premolar	.010
Length of fourth premolar	.016
Elevation of fourth premolar	.013
Length of sectorial	.022
Elevation of median cusp of sectorial	.015

Although a left mandibular ramus is all that I have been able to obtain of this cat, the evidence is sufficient that it is specifically different from the others enumerated in this chapter. It is inferior in size, and peculiar in the reduced symphysial and incisive parts of the mandible. It was found by Mr. Wortman in the bad-lands of the John Day Valley, Oregon.

DINICTIS Leidy.

Proceed. Philada. Academy, 1854, p. 127. Extinct Mammalia of Dakota and Nebraska, 1869, p. 64.

With this genus we enter the group of the primitive saber-tooths, commencing with the most generalized form. The skeleton is yet unknown,

but the skull and dentition are those of a true saber-tooth, and there seems to be no ground for believing the Musteline affinities suggested by Leidy.[1] It occupies the lowest position on the line of the saber-tooths, on account of its numerous and simply constructed molar teeth, and stands in immediate connection with the false saber-tooth group, having exactly the dental formula of *Ælurogale* Filh. On this account I formerly united the two genera, but now believe that the absence of the inferior flange of the mandible in *Ælurogale* is sufficient ground for maintaining them as distinct. The latter genus, in this respect, exactly resembles *Archælurus* and *Nimravus*.

Remains of this genus are quite abundant in the White River formation in Nebraska and Colorado. They principally belong to the longest known and typical species, *D. felina* Leidy. Specimens are much less numerous in the John Day beds of Oregon. Two species have been obtained from the former horizon, the *D. felina* and *D. squalidens*, and one from the latter, the *D. cyclops*. The characters are as follows:

Dental formula: I. $\frac{3}{3}$; C. $\frac{1}{1}$; Pm. $\frac{3}{3}$; M. $\frac{1}{2}$. The superior canine is long and compressed, and reposes against an inferior marginal flange of the mandible, whose surface is separated from that of the symphysis by a strong angle. Unworn incisors with wedge-shaped crowns. Superior sectorial without anterior basal lobe. Inferior sectorial with posterior cutting heel, and an inner tubercle of small size. Postglenoid and postparietal foramina present. No intermediate posterior lobes of the premolars.

The three species may be distinguished by the following characters:

First inferior molar two-rooted; first superior very small; cranium shorter behind. *D. cyclops.*

First inferior and superior molars two-rooted, the latter larger; cranium longer behind ..... *D. felina.*

First inferior molar one-rooted; mandibular flange short, rounded..... *D. squalidens.*

Dinictis cyclops Cope.

Proceedings Academy Philadelphia, 1879, 176 (read July 8). American Naturalist, 1880, p. 846, fig. 8. Plate LXXV; fig. 1.

The profile of the skull is very convex, the planes of the nasal bones and sagittal crest meeting at an angle of 135°. The place of the angle is

[1] Extinct Mammalia, Dak., Nebr., p. 64.

occupied by the regularly rounded posterior frontal region. The postorbital angle is exactly half way between the inion and the anterior edge of the premaxillary bone. In the *D. felina*, according to Leidy's figure, which I find to agree with the specimen which it represents, the last-named distance is equal to the space between the postorbital angle and the postparietal foramen. Thus the region covered by the temporal fossa is shorter in the *D. cyclops*. The front is also convex transversely, excepting where it is interrupted by a median longitudinal shallow open groove. The postorbital angles are quite prominent, are subacute, and have a triangular section. They mark lateral angles equidistant between the apices of a diamond-shaped space, the posterior angle being the junction of the temporal ridges, and the anterior being theoretically situated between the anterior extremities of the frontomaxillary sutures. The nasal bones are shortened in front; their lateral angles are but little produced, and their anterior borders are concave. The premaxillaries rise high on each side of the nasals, but do not reach the frontals. The face is flat in front of the orbit, and the surface is roughened for a space just in front of its border. The zygomatic arches are strongly convex, but somewhat flattened medially, and a little more expanded posteriorly than anteriorly. They are less slender than in *Archælurus debilis* and *Nimravus gomphodus*, but their postorbital angle is not larger, being a mere angle. The brain-case is rather large, and is separated from the frontal region by a moderate constriction. The inion does not project so far posteriorly as in some of the cats, and the occiput is higher than wide, and is divided in its superior third by a weak median keel.

The paroccipital process is small and acuminate; it is directed posteriorly opposite the superior part of the occipital condyle. An obtuse ridge proceeds downwards and forwards from its base, and terminates in the posterior angle of the posttympanic process. The lateral occipital crest is continued as a delicate ridge into the external angle of the posttympanic process. The latter is well below the paroccipital; it is directed downwards, ceasing opposite the middle of the posterior face of the zygoma. Its extremity is truncate and triangular, the apex of the triangle being external. The suprameatal border is prominent and thin, and the inferior border of the meatus is the deeply set border of the bulla.

There are two areas of insertion on the basioccipital bone, separated by a low median keel, and extending anteriorly as far as the front of the otic bulla. Each is interrupted in front of the middle by a rugosity. Basisphenoid flat. The otic bullæ fit the adjacent bones closely, so as to close everything but the foramina. The pterygoid alæ are well produced downwards. The palate of *Dinictis cyclops* is flat; and is, at the widest part, as wide as long. The posterior border of the palate forms two concavities, uniting medially in a slight angle. Thus the form is that of the lynx and the leopard, and different from the panther, tiger, and jaguar. The forms of the palates of these animals are as follows:

I. Two deep excavations separated by a point: *Hoplophoneus oreodontis;* and *H. cerebralis.*
II. Two shallow excavations, separated by an angle: *Felis domestica; Uncia pardus; Lynx rufus; Hoplophoneus oreodontis; Dinictis cyclops; Proælurus julieni.*
III. A regular shallow concavity: *Archælurus debilis; Uncia tigris.*
IV. A deeply excavated concavity: *Uncia concolor.*
V. A triple concavity; two lateral, separated by a deep median notch: *Uncia onca.*

The mandible is compressed, but is rather low at the front of the masseteric fossa. It is more robust than in the known species of *Archælurus* and *Nimravus.* The inferior anterior flange is well marked and compressed. It is short, but not so broadly rounded as in *D. squalidens.* The anterior symphysial face is flat and deep, and the incisive border elevated.

Sutures.—The frontomaxillary suture rises from the anterior border of the orbit, and then extends, with some irregularity, horizontally to the frontonasal suture, as described by Leidy in the *D. felina,* and not descending, as in *Nimravus brachyops.* The lateral nasal sutures are very little convex outwards posteriorly, and form a segment of a circle posteriorly. The frontoparietal suture is obliterated, but the superior squamosal suture does not reach it. The premaxillo-maxillary suture of the palate incloses a triangular space.

Foramina.—The *foramen infraorbitale exterius* is very large, is subtriangular, and is directed forwards. Its posterior border is above the anterior border of the superior sectorial tooth. The incisive foramina extend to a point a little behind the middles of the superior canines. The *f. f. palatina* are opposite the cusp of the third premolar. There is no alisphenoid fora-

men. The oval *f. lachrymale* is of medium size. The *f. opticum* is far posterior and close to the *f. sphenoörbitale*, which has twice its vertical diameter. On account of the early connection between the temporal and pterygoid parts of the sphenoid, the *f. sphenoörbitale* and *rotundum* are thrown together and forwards. They are, however, completely divided. A narrow alisphenoid canal enters the *f. rotundum* from behind, connecting it with the *f. ovale*. The *f. ovale* is large and transverse. The *f. lacerum anterius* is subround and rather large. The *f. postglenoideum* is rather small, and is in the anterior wall of the *meatus auditorius externus*. On the posterior border of the *bulla otica* are two foramina; an external larger, and an internal smaller. The latter occupies the usual position of the jugular foramen, but is probably the *f. carotideum*. The other may have carried a branch of the jugular vein, although it is in the position of the stylomastoid foramen. The anterior condylar foramen is small, and is situated far posterior to the two foramina just mentioned. A small foramen just above the paroccipital process I suspect to be the mastoid. The postparietal foramen is large, and is situated below the middle of the parietal bone. The *f. magnum* is wider than deep, and has a regularly arched superior border, without tuberosities.

Dentition.—The superior canine is quite long, and has a regularly lenticular section, without facets. Its anterior and posterior edges are denticulate. The external incisors are much larger than the internal, and have subconic crowns. The crowns of the others are subcuneiform. The first superior premolar is very small, much less developed than in *D. felina*. I originally described it as having one root, but there are indications of a second in an obsolete alveolus, filled partly by bone and partly by remains of the root. The tooth is lost from both sides of the specimen. The second premolar has a distinct anterior tubercle on the inner side, a character not seen in *D. felina;* the anterior angle of the superior sectorial is more produced than in that species. The crown of the superior tubercular looks partly inwards, is rather long, and has three roots. The inferior canines are considerably larger than the incisors. The latter are regular, and do not overlap each other. The second and third inferior premolars have well-developed basal lobes anteriorly and posteriorly. The heel of the sectorial is well developed. The tubercular is very small, and has a semiglobular

crown. It is present on both sides of the specimen. The enamel of all the teeth is smooth. No cingula.

Measurements.

	M.
Length of skull on base	.140
Width of skull, measured below	.111
Length of palate	.060
Width of palate between posterior angles of sectorials	.062
Width of palate between canines	.026
Length of skull to front of orbits (axial)	.050
Vertical diameter of orbit	.031
Interorbital width (least)	.045
Elevation of inion from foramen magnum	.032
Length of inferior molar series	.050
Length of inferior sectorial	.018
Length of base of inferior first premolar	.055
Depth of ramus at sectorial	.016
Depth of ramus at first premolar	.021
Depth of ramus at flange	.026

From the Miocene beds of John Day River, Oregon. Found by J. L. Wortman.

This species was as large as the fully grown Canada lynx. Although of an inferior position in the system of *Carnivora*, its powers of destruction must have excelled those of the catamount. While the skull is generally less robust, its sectorial teeth are not smaller nor less effective than those of that animal, and the canines far excel those of the living species as instruments for cutting their prey.

DINICTIS FELINA Leidy.

Proceedings Academy Philadelphia, 1854, 127; 1856, 91; 1857, 90. Extinct Mammalia Dakota and Nebraska, 1869, p. 64; Plate V, figs. 1–4.

This species, whose dental and cranial characters have been described by Leidy, is known from a number of crania and jaws. The former differ in their proportions from those of the *D. cyclops*, having a relatively longer cerebral and shorter facial part of the skull. The anterior premolar teeth, especially in the upper jaw, were stronger than those of *D. cyclops*.

I introduce the *D. felina* here for the purpose of mentioning its geographical range. Since the original specimens were brought from Northern Nebraska by Dr. Hayden, I have obtained a mandible from Northeastern Colorado, and the Princeton Scientific Exploring Expedition procured part

of a skull from the same region. The examination necessary for this determination was kindly permitted me by Professor Guyot.

The Colorado mandible differs from that of the *D. squalidens* from the same locality in having a shallow symphysis; that is, it descends but a short distance below the inferior anterior mental foramen. The roots of the first inferior premolar are well separated. The third (fourth) has a well-developed anterior basal tubercle.

DINICTIS SQUALIDENS Cope.

Proceedings Academy Philadelphia, 1879, p. 176. *Daptophilus squalidens* Cope, No. 16, p. 2 (August 20, 1873). Annual Report U. S. Geol. Survey Terrs., 1873 (1874), p. 508.

Plate LXVIIa; figs. 15–16.

Two mandibular rami belonging to two individuals represent this species. The one on which the species was proposed is immature, with the sectorial tooth partly protruded (fig. 15), and the tubercular invisible. Having failed to find any trace of the latter in the jaw, I proposed to regard the species as typical of a genus distinct from *Dinictis*, remarking at the time that should such a tooth be ultimately found, the genus would have to be abandoned. Evidence of the existence of this tooth was afterwards obtained. Still later, another saber-tooth was found with precisely the formula supposed to characterize this discarded genus (*Daptophilus*). Under the circumstances I thought best to give the former a new name, *Pogonodon.*

In this species the first lower molar tooth has but one root, while in the others there are two. The canine tooth of the typical specimen has also a very peculiar form. The crown is short and wide, like that of a *Carcharodon* shark, or somewhat like that of the saber-tooth *Drepanodon latidens* Owen. As the first true molar tooth of this specimen was not fully protruded, it is possible that this canine belongs to the deciduous series.

The jaw of the adult specimen contains parts of the alveoli of but two inferior incisors; the existence of a third is very doubtful. The canine is large and is directed outwards. Its crown is lost. The diastema descends, and is short, not exceeding in length the length of the base of the anterior lobe of the sectorial. The alveolus of the root of the first (second) pre-

molar is elongate anteroposteriorly, and has a very slight median constriction, indicating traces of opposite grooves on the root. The alveolar border is lost at the base of the third premolar, but from the remains of its alveoli it was not much smaller than the fourth. The fourth premolar has lost its cusp; it has a well-developed trenchant basal anterior lobe, not so large as in the known species of *Archælurus* and *Nimravus*. The base of the sectorial is absolutely and relatively shorter than in the specimens of *D. felina* figured by Leidy. The portion anterior to the heel is equal in anteroposterior extent to the fourth premolar; it is longer in the specimens above mentioned. The alveolus for the tubercular molar indicates a larger tooth than that of the *D. cyclops*.

The flange of the ramus is prominent, but short and rounded, extending but little below the symphysis, which itself is continued considerably below the inferior anterior mental foramen. The superior anterior mental foramen is below the middle of the symphysis. The anterior external mental foramen is below the anterior part of the alveolus of the first premolar. The ramus is quite robust, and is convex on both faces below the sectorial. The masseteric fossa is deep, but with sloping borders in front and below. A gradual rise towards the coronoid process begins on the inner side, at the posterior base of the sectorial.

Measurements.

	M.
Length of entire dental series	.064
Length of molar dental series	.048
Length of diastema	.008
Length of base of Pm. ii	.005
Length of base of Pm. iv	.013
Length of base of sectorial	.017
Height of anterior lobe of sectorial	.010
Long diameter of base of crown of inferior canine	.009
Depth of symphysis	.025
Depth at flange	.025
Depth at front of sectorial	.017
Width of front of sectorial	.007
Width of front of symphysis	.012

The immature specimen is instructive in displaying the last two deciduous molars, with more of the crown of the sectorial than is seen in the other specimen. The latter shows the short trenchant heel, and the internal tubercle, which is on the posterior edge of the middle lobe of the crown,

about half way above the base, and a very little inside of the line of the edge of the heel. Its base is a little longer than that of the other specimen. The penultimate deciduous molar has equal anterior and posterior basal cutting lobes. The median cusp is higher than the length of its own base. The last deciduous tooth is a sectorial; its anterior lobe alone remains. The entire crown of the superior canine was found with this lower jaw (see fig. 15 *a b*). Its crown is quite short and compressed, and both edges are denticulate. It is probable that it is the temporary canine. It is much shorter than the permanent canine of any North American species.

Measurements.

	M.
Length of base of deciduous penultimate molar	.010
Elevation of cusp	.007
Elevation of anterior cusp of last deciduous molar	.007
Length of permanent sectorial	.018
Length of base of crown of superior canine	.011
Elevation of crown of superior canine	.025

The adult jaw above described differs from that of *D. felina* in the considerably shorter tooth-line, as well as in the single-rooted first premolar. As compared with Leidy's figures, it is shorter than one of them by the length of the tubercular tooth; and shorter than the other by the length of that tooth plus the heel of the sectorial.

Both specimens were found by myself in the beds of the White River formation at a single locality in Northeastern Colorado. With them were associated a multitude of jaws and bones of *Marsupialia*, *Carnivora*, *Rodentia*, *Ungulata*, *Reptilia*, etc.

POGONODON Cope.

American Naturalist, 1880, p. 143, (published January 31).

Dental formula: I. $\frac{3}{3}$; C. $\frac{1}{1}$; Pm. $\frac{3}{3}$; M. $\frac{1}{1}$. Inferior border of mandibular ramus flared downwards in front; lateral and anterior faces of ramus separated by a pronounced angle. Superior canine compressed, with anterior and posterior cutting edges. Superior sectorial without anterior basal lobe; inferior sectorial with a heel. No tubercular molar. No lobes on the edges of the crowns of the premolars. Incisors with conic crowns. Postglenoid and postparietal foramina present.

This genus represents a station on the line connecting *Dinictis* with the higher saber-tooths, being intermediate between the former genus and *Hoplophoneus*. It lacks the tubercular inferior molar of *Dinictis*, and possesses the second inferior premolar characteristic of that genus, which is wanting in *Hoplophoneus*. One species is certainly known, and a second is provisionally referred here. The two are the largest of the saber-tooths of North America, the type, *P. platycopis*, equaling in dimensions the largest species of *Drepanodon*, being only exceeded among the true saber-tooths by the species of *Smilodon*. Unfortunately, only the skull of the typical species is known. Several bones of the *P. brachyops* have been discovered.

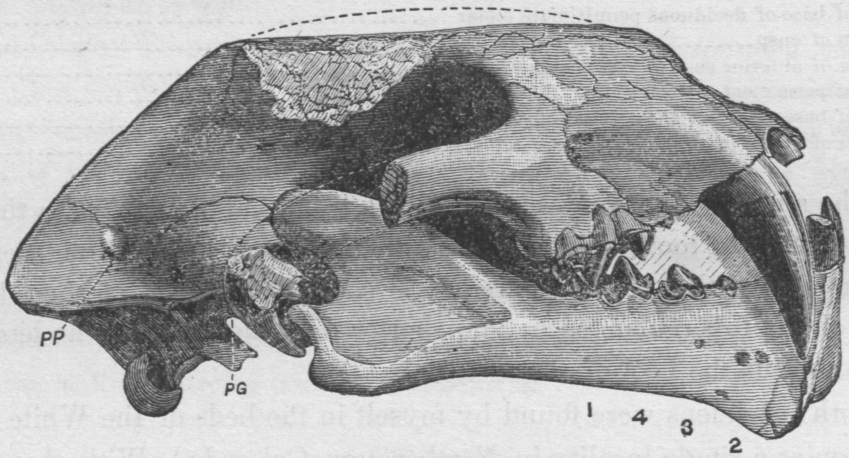

FIG. 38.—*Pogonodon platycopis*, less than two-fifths natural size. Mus. Cope.

POGONODON PLATYCOPIS Cope.

American Naturalist, 1880, p. 143. *Hoplophoneus platycopis*, American Naturalist, 1879, p. 798a, December. Proceed. Amer. Philo. Soc., 1879, p. 373 (December 24).

Plate LXXIV a.

The skull on which this species was established remains a unique. It is in good preservation, not wanting any important part. The median portions of both zygomata are wanting, and the frontal region is crushed and parts of it weathered away.

The cranium is characterized by the relative elongation anterior to the sagittal crest, the latter being a little more than one-third the length of the skull from its posterior apex to the premaxillary border, and equal the distance from the junction of the temporal ridges to the anterior rim of the orbit.

The sagittal and frontal planes make an angle with each other much as in the recent cats of large size. The brain-case is relatively smaller than in any of the *Felidæ* described in this book, and the sagittal crest and inion are more prominent. The face in front of the orbit is flat. The position of the alveolus of the superior canine is not defined posteriorly, but the surface follows it anteriorly, turning inwards to the premaxillary bone, from which it is separated by an angular groove. The free borders of the nasal bones are injured, and their posterior extremities are lost. The frontonasal suture indicates that their outline is acuminate posteriorly. The zygomata are rather short in comparison with the length of the skull. They are strongly convex and quite robust, though the vertical diameter at the orbit is rather small. This is explained by the fact that the masseter surface is mostly inferior instead of lateral. The cranium is more constricted posterior to the orbits than in any of the recent species, not excepting the *Uncia concolor*, where it is most constricted. The occiput is high and much narrowed, and its superior portion inclines at an angle of only 12° above the horizontal line passing through the occipital condyles and mandibular flanges, on which the skull rests. There are three fossæ on each side; two at the summit, separated by a keel, and two on each side, successively lower down. The inferior one is a fissure, turning upwards and outwards, only well defined by its upper border. The paroccipital process is short and acuminate, and is directed outwards and backwards. Its superior and inferior posterior borders are continued backwards, inclosing a fossa between them and the occipital condyle. The anterior border is continued as an angle which separates the lateral and inferior surfaces. The posttympanic process descends below the plane of the paroccipital process, but not so far as in the *Hoplophoneus cerebralis*. It has no inferior face, for the external and internal faces meet at an angle. The external face is an elongate triangle, with the apex upwards and outwards, and the base turned inwards. It is shallowly grooved in its length. The roof of the external meatus of the ear is prominent, and is continued as a ridge as far as a fossa which is above the space between the postglenoid and paroccipital processes. The base of the cranium being yet covered by the matrix, I cannot give its characters. The sutures of the skull are generally obliterated by coössification. The premaxillo-maxillary is

sufficiently preserved to show that the premaxillary bone ascends high on each side of the nasals, so as nearly to reach the frontomaxillary.

The mandibular rami are robust, and not so high and compressed as in *Nimravus* and its allies. It deepens anteriorly to the inferior flange, which, though prominent, is not so much produced as in some of the species of later times. The anterior border of the side of the ramus is produced and acute below the superior third of its depth. The chin is deep and flat, with the median line prominent below. The masseteric fossa is very pronounced, the inferior border of the jaw at that point spreading outwards, with thick, round, horizontal border. The condyle has an appropriately large horizontal extent, but its vertical diameter is small. The angles are broken from both rami, but they were about as far below the condyle as the elevation of the coronoid process above it. The latter have an elongate anterior border, which turns backwards at the summit, and the posterior border projects as far as that of the condyle. The superior half of the coronoid process differs from that of all the other *Felidæ* here mentioned in being convex instead of concave.

Foramina.—The infraorbital foramen is large, subround, and a little wider than deep. Its posterior border is in the base of the zygoma, and above the middle of the posterior lobe of the sectorial, when the skull rests on the lower jaw. With the basicranial axis horizontal, it falls above the anterior cusp of the same tooth, so that its position is behind that observed in any of the recent or extinct cats mentioned in this book. The inferior border of the lachrymal foramen falls below the superior border of the external infraorbital foramen. The *f. postparietale* is large, and is at the border of the inferior fourth of the parietal bone, measuring from the summit of the crest. There is a small mastoid foramen. The *f. condyloideum anterius* is separate from the *f. lacerum posterius.* The *f. postglenoideum* is rather small, and is in the anterior wall of the *meatus auditorius externus*, near its inner terminus. The *foramen magnum* is rather small for the size of the skull, and is wider than high. It is not so transverse, however, as in the species already described, as its superior border forms a higher arch, and is without marginal tuberosities. There are three lateral mental foramina, one below the second (first) premolar, and the others larger and near

together, anterior to it. There are three anterior mentals on each side, a superior smaller, and two inferior larger.

Dentition.—The crowns of the superior incisors are all broken off, while they remain on two of the corresponding inferior teeth. The latter are acutely, but not regularly, conical; the internal face is oblique forwards, while the external face is slightly convex from base to apex. The external incisors are twice as large as the internal, and the inferior canines are one-half larger than the external incisors in linear diameters. Their crowns are lost. The external superior incisors are a little smaller than the inferior canines, and the superior median incisors are half as large again in linear diameters as those of the inferior series. The superior diastema is rather short, or about as long as the base of the third inferior premolar. The superior canine is a very large tooth, exceeding in size that of any North American feline. It is similar in form to that of the European *Machærodus cultridens.* Both its cutting edges are denticulate, the posterior having thirteen teeth in $.005^{m}$. The crown, near the apex, has a regularly lenticular section, but the anterior edge turns gradually inwards until it leaves an anterior face external to it, which presents at right angles to the external face. These faces unite by a regular curve. The posterior edge is straight in the vertical plane. The second (first) superior premolar is quite small, and is probably only one-rooted, though I cannot be sure of this. Its position is near the base of the third premolar. The base of the latter is as long as the space between it and the canine. It is relatively smaller than in the species *Archælurus debilis* and *Nimravus gomphodus*, and consists of only a principal rather obtuse cusp and a moderately long cutting heel. The sectorial tooth is not as large relatively as that of the species just named, and is less compressed in form, both its cusp and heel being comparatively obtuse. The tubercular or true molar has remarkable transverse extent. Its external and posterior borders are all that can be seen in the present condition of the skull. The latter presents two concavities of the crown, separated by a low median elevation. The second inferior premolar is longer than the corresponding tooth of the superior series, and has one stout and much compressed root. The crown has a semicircular profile, and is more convex externally than internally. The third premolar

is smaller than the corresponding tooth of the upper jaw, and much less than the same tooth of the known species of *Archœlurus* and *Nimravus*. Its cusp is obtuse; besides, it has a short cutting heel and an anterior basal tubercle. The fourth premolar is larger, and has an anterior basal cutting tubercle, which is shorter than the cutting heel. The sectorial is small for the size of the skull, and its cusps are robust. The heel is short and thick, and has the peculiarity, entirely unique in the family, of a flat grinding surface.

Measurements of skull.

	M.
Length from inion to premaxillary border	.280
Length from inion to chin	.290
Length from premaxillary border to superior canine	.019
Length from premaxillary border to line of orbit	.090
Length from premaxillary bone axially to end of maxillary bone	.096
Length from inion to occipital condyle (horizontal)	.048
Length from inion to postglenoid process	.113
Length from inion to furcation of temporal ridges	.115
Width of zygomata (estimated)	.192
Width of occiput at middle	.037
Width of occiput at condyles	.056
Width of foramen magnum	.025
Width between posttympanic processes	.074
Width of chin at base of symphysis	.040
Length of mandibular ramus	.177
Height of chin medially	.050
Height of chin at flange	.048
Height of ramus at Pm. iii	.035
Height of ramus at M. i	.030
Height of ramus and coronoid process	.075
Length of superior dental series including canine	.090
Long diameter of base of canine	.026

Restoration and habits.—As the greater part of the skeleton of the *Pogonodon platycopis* is unknown, little can be said as to its general proportions. The skull is one-sixth shorter than that of the usual size of the tiger (*Uncia tigris*), and is equal to the largest Brazilian variety of the jaguar, and is considerably larger than the Texan form of that species.

The development of the dentition is concentrated in the canine teeth, and the powers of destruction of the animal would seem to be disproportioned to its ability to appropriate its prey as food. The molar teeth are rather small, as is the case with the earliest representatives of the canine family. The inferior sectorial is primitive and peculiar in its robust heel. We can suppose this species to have been a great destroyer of contemporary

mammalian life, and that the largest ungulates of the John Day fauna were its victims.

History.—Science has hitherto had little knowledge of this species, and owes what is here recorded to a fortunate chance. The exploring party which I had sent into the John Day River valley under the direction of Mr. Jacob L. Wortman, in 1879, examined the bad lands in the locality known as The Cove. In passing the bluffs on one occasion, a member of the party saw on the summit of a pinnacle of the crag what appeared to be a skull. The large shining objects supposed to be teeth attracted his attention, and he resolved to obtain the specimen. He, however, was unable to climb the cliff, and returning to camp narrated the circumstance. The other men of the party successively attempted to reach the object, but were compelled to descend without it, and in one case, at least, the return was made at considerable peril. A later attempt, made by Leander S. Davis, of the party, an experienced collector, was more successful. By cutting notches with a pick, in the face of the rock, he scaled the pinnacle and brought down the skull, but at considerable risk to limb and life.

POGONODON BRACHYOPS Cope.

American Naturalist, 1880, p. 849, fig. 11 *Machærodus brachyops* Cope (*partim*). Paleontological Bulletin No. 30, p. 10, 1878 (December 3). Proceedings American Philosophical Society, 1878, 72.

Plates LXXIV *b*; LXXIV; figs. 3–10.

This species is the second in size of the cats of the Truckee Miocene epoch. It is represented in my collection by a fragmentary skull of one individual, and by the maxillary bone and several bones of the skeleton of a second.

The skull first mentioned includes the left side of the face, a part of the front, and the posterior regions, lacking one temporal bone. The maxillary bone is broken off at the infraorbital foramen, and the teeth are broken off. The following characters are noteworthy. The fronto-maxillary suture is transverse from the orbital border, and then turns slightly upwards rather than downwards as is usual. It most resembles the form in *Dinictis cyclops*. The face is slightly concave in front of the orbit, and is marked by an impressed fossa immediately anterior to the orbit, of about the size and form of half of the end of the human thumb. In front

of the infraorbital foramen the face is gently and regularly convex to the premaxillary border. The premaxillary ascending ramus is long, but does not appear to reach the frontomaxillary suture. The fragment of the front shows that the temporal ridges converge gradually, and that the middle line is concave. The posterior part of the skull shows a high sagittal crest and inion, and a brain case of the absolute size of that of the *P. platycopis*, and therefore relatively larger. The inferior part of the lateral occipital crest is obsolete, continuing into a low rounded ridge which is continued as the prominent superior border of the *meatus auditorius externus*. A posterior ridge goes to the external superior base of the paroccipital process; another ridge extends from the internal superior base, and the space between is divided by a median ridge. The paroccipital itself is short and is directed backwards. A perpendicular ridge descends from its external base to the posterior angle of the posttympanic process. The latter has a truncate downlooking extremity of a triangular form; the longest side being anterior, and the internal and external angles of about equal length. The occipital condyles are rather small.

Foramina.—The *f. infraorbitale* is large. So is the *f. postparietale*, which is situated immediately at the base of the sagittal crest, or higher up than in any of the species here described. The *meatus auditorius externus* is contracted, owing to the more than usual approximation of the posttympanic and postglenoid processes.

Dentition.—The bases of the crowns of the superior incisors are so robust and the external so cylindric, as to render it very probable that their form is conic, as in the *P. platycopis* The superior canine is large, and has a lenticular section at the base of nearly equal acumination of front and rear. The posterior edge is denticulate. (See specimen No. 2.) The second (first) promolar is quite small, and is situated two-thirds way from the canine to the third premolar. Its root is grooved on the inner side, but I cannot say whether it is double. The third premolar is large, and is separated from the canine by a space five-sixths the diameter of the latter. There are no other teeth in the specimen.

Measurements of No. 1.

	M.
Elevation from diastema to frontomaxillary suture	.069
Width from orbit to premaxillary nareal border	.036
Length of bases of three incisors	.016

		M.
Diameters of base of canine	anteroposterior	.019
	transverse	.011
Length from canine to third premolar		.016
Oblique elevation of sagittal cusp above meatus of ear (partly estimated)		.066

The *maxillary* bone of the second specimen contains all the molars, the third and fourth somewhat mutilated. The second is plainly two-rooted, and is half way between the canine and the third, which teeth are separated by a space equal to the length of the base of the anterior lobe of the latter. This tooth has no anterior basal lobe, but the posterior heel is rather elevated, though short. The sectorial is large; its cusps are lost. The tubercular molar is small, and is especially remarkable for its small transverse extent, which is about equal to that of the *Nimravus gomphodus*, and less than half that of the *Pogonodon platycopis*. It has nevertheless three roots, the median of which is posterior. The external end of the crown is visible from the side, behind the sectorial. Parts of both canines are preserved. A fragment from the front of the crown shows that the anterior cutting edge becomes lateral, and is denticulate. The anterior face has a shallow groove next the cutting edge. Enamel slightly roughened.

The *foramen infraorbitale* is higher than wide in this species, and its external border is above the anterior border of the anterior root of the sectorial, the superior border of the molar being horizontal. The masseteric surface of the molar is vertical, not horizontal.

The remaining parts of this specimen are two dorsal and three lumbar vertebræ, portions of both femora; a patella; proximal end of tibia; both calcanea; the cuboid and navicular bones, and first metatarsal. The vertebræ are well preserved; see Plate LXXIV, figs. 3–5. To compare with these I have at hand the corresponding parts of *Uncia leo*, *U. concolor* and *U. pardus*, *Cynœlurus jubatus* and *Felis domestica*. The dorsal vertebræ are shorter and a little wider than those of *U. concolor* and *U. pardus;* also flatter below, and more distinctly medially keeled. Their proportions are more as in the lion, where they are, however, regularly convex and not keeled. The anterior three lumbars are, on the other hand, of the proportions seen in *U. concolor*, *U. pardus*, and *C. jubatus;* that is, relatively longer than in the lion and shorter than in the common cat. Their centra are medially keeled below, but not so strongly as in the three species

first named; while the lateral tuberosities are more pronounced than in any of the species excepting *U. pardus* and *F. domestica*, where they are stronger. In *U. concolor* an *U. leo* they are weak, and in *C. jubatus* wanting. As in these cats, they are below the line of the base of the diapophysis. The anapophyses are large on the last two dorsals and the first lumbar; on the second and third lumbar they are small, apparently shorter than in the *Felidæ* above mentioned excepting *Cyn. jubatus*, where they are smaller still. The posterior borders of the neural spines of the lumbars are nearly straight from their origin behind and above the postzygapophyses, and their summits are not much expanded. There is no trough-like excavation between the postzygapophyses above, as is seen in the panther, and in a less degree in the leopard and lion. The centra are not so much depressed as in the panther, leopard, and cat, or even as the lion, where they are the least depressed.

The femora are a good deal injured, and the heads and trochanters are gone. It is evident, however, that they were of the same general proportions as those of the *Nimravus gomphodus*, and not very different from those of the panther. The external *linea asper* is acute, and the rotular groove high and rather narrow. The fossa between the insertions of the crucial ligaments between the condyles is deeper than in recent cats. The head of the tibia is also injured. (See fig. 6.) The internal posterior surface for the attachment of the cruciform ligament is large. The patella is a little narrower and more convex within than that of the panther. The bones of the foot preserved show clearly that, as in the case of the *Archælurus debilis*, the extremities are relatively smaller than in recent *Felidæ* of similar general size. While the portions of the skull of the *Pogonodon brachyops* indicate an animal of rather larger size than the *Uncia concolor*, the bones of the hind foot are considerably smaller. The calcaneum is about three-fourths as long; the navicular is narrower though nearly as deep anteroposteriorly; the diameters of the cuboid are all less excepting the inferior facet anteroposteriorly; the first metatarsal is more slender, and its proximal facet is little over half as wide. One character of the calcaneum which I do not find in any of my skeletons of *Felidæ* or *Hyænidæ*, is the presence of a longitudinal fossa for the insertion of the external lateral ligament,

just below the external astragaline facet. The external border at the cuboid extremity of the calcaneum is even more prominent and recurved than in the existing cats, and the groove for the internal calcaneocuboid ligament is profound. The groove of the cuboid for the tendon of the *peroneus longus* muscle is deep, and commences at the anterior face of the bone, that is, anterior to its position in *Uncia concolor* and *pardus* and *Cynœlurus jubatus*, but its bounding ridge is not carried so far distally as in the panther. The small calcaneal face of the navicular is distinct from the astragaline surface. The character of the internal (free) surface of the head of the second (first) metatarsal shows that there was no hallux (first metatarsal).

Measurements of No. 2.

			M.
Length of superior dental series from canine tooth			.064
Length from canine to Pm. iii			.015
Length of base of Pm. iii			.019
Elevation of crown of Pm. iii			.013
Length of base of sectorial			.024
Width of base of tubercular			.008
Long diameter of base of canine			.017
Diameters of centrum of penultimate dorsal	anteroposterior		.028
	anterior	vertical	.017
		transverse	.026
Diameters of centrum of third lumbar	anteroposterior		.039
	anterior	vertical	.020
		transverse	.026
Elevation of last dorsal with spine			.055
Elevation of third lumbar with spine			.064
Diameters of middle of shaft of femur	anteroposterior		.019
	transverse		.025
Transverse diameter of head of tibia			.047
Length of calcaneum			.066
Width calcaneum at sustentaculum			.027
Diameters of navicular bone	longitudinal		.010
	horizontal	transverse	.016
		fore-and-aft	.025
Diameters cuboid	longitudinal		.017
	proximal	transverse	.019
		fore-and-aft	.012

Although I do not possess a mandible of this species, I am satisfied that it is more nearly allied to *Dinictis* and the present genus than to *Nimravus*. It differs from the species of that genus and *Archœlurus* in the following points: (1) the truncate triangular posttympanic process; (2) the transverse frontomaxillary suture; (3) the preorbital impressed depression; (4) the superior position of the postparietal foramen.

Restoration.—This was a most formidable animal, and its dental characters indicate a high degree of efficiency of both the lacerative and of the biting functions. While the *P. platycopis* has a larger development of the canine teeth, it is inferior in the relative size of the sectorials. In the latter respect the *P. brachyops* resembles the species of *Nimravus* and *Archœlurus*, but these are furnished with smaller or more slender canines. It, however, resembled the latter in having the feet relatively smaller than in the recent cats, a character which indicates inferior prehensile power. Unfortunately, no ungual phalanges have been preserved, so that we cannot learn whether they confirm this indication by resembling those of the *Cynœlurus jubatus* or the still less specialized forms of other families.

History.—This species was the first of the Oregon felines of which bones were obtained. It was first sent here by Mr. C. H. Sternberg, from the Miocene bad lands of the John Day Valley, Oregon.

HOPLOPHONEUS Cope.

Annual Report U. S. Geol. Survey Territories, F. V. Hayden, 1873 (1874), p. 509. Proceedings Academy Philadelphia, 1879, p. 170.

Dental formula: I. $\frac{3}{3}$; C. $\frac{1}{1}$; Pm. $\frac{3-2}{2}$; M. $\frac{1}{1}$. Inferior border of mandible flared downwards in front for the protection of the large double-edged superior canine tooth. Lateral and anterior faces of ramus sharply distinguished. Incisors with wedge-shaped or conic crowns. Superior sectorial without anterior basal lobe; inferior sectorial with a heel. No inferior tubercular molar.

The original diagnosis of this genus includes the ascription of a tubercular molar to the inferior dental series, which is an error due to the reference of a specimen to the *H. oreodontis* which does not belong to it.

In this genus we reach the dental formula of *Drepanodon* and the true cats, while at the same time the primitive form of the sectorials of the lower jaw remains. I have not been able to examine the skull of a *Drepanodon* (*Machœrodus*), but from the silence of European authors it may be presumed that the foramina which characterize the *Nimravidæ* are absent, as in the true cats. The fact that the species have been derived from the

Pliocene and Upper Miocene formations increases the probability of the correctness of this supposition. I have ascertained that the American Pliocene saber-tooths of the genus *Smilodon* possess the characters of the *Felidæ* rather than those of the *Nimravidæ*.

Four or five species only of *Hoplophoneus* are known as yet, all from North America. We may expect, however, to find the genus in various parts of the world, wherever the beds occur which represent the time immediately preceding the epoch of the true saber-tooths. The longest known species is the *Hoplophoneus primævus* Leidy, from the White River bad lands of Dakota and Nebraska. It is about as large as the Canada lynx, and has long and slender superior canines. A larger species, the *H. occidentalis* Leidy, from the same horizon and locality, is known from two jaw fragments as large as the corresponding parts of the *Nimravus gomphodus*. Although the oldest members of the *Nimravidæ* yet known from North America, the *Drepanodon* characters of the mandible and of the superior canine tooth are well developed, much more so than in the false saber-tooth group of the later John Day epoch. In Europe, however, it must be remembered that the latter division commences still earlier; *i. e.*, in the Upper Eocene, in the genus *Ælurogale* Filhol.

As I have not obtained any parts of the *H. primævus* and *H. occidentalis* not already described by Leidy, I confine myself at present to a description of the *H. oreodontis* and *H. cerebralis*.

HOPLOPHONEUS OREODONTIS Cope.

Annual Report F. V. Hayden, U. S. Geol. Survey Terrs., 1872 (1873), p. 509. *Machærodus oreodontis*, Synopsis of New Vertebrata Colorado, Misc. Pub. U. S. G. S. Terrs., 1873, p. 9.

Plate LXVII *a*, fig. 17; LXXV *a*, figs. 1, 2.

This saber-tooth was described from the fragment of a mandibular ramus supporting the temporary dentition. Subsequently I obtained at the same locality a large part of the skull, with portions of some of the limb bones of a fully grown specimen. The permanent dentition is in place, and is but little worn, while the epiphyses are not yet attached to the long bones. This specimen enables me to give a much fuller account of the species than heretofore.

The profile is convex. The face is flat in front of the orbit, but is strongly convex for the alveolus of the superior canine in front of the infra-orbital foramen. The premaxillary border is moderately produced, and the palate is generally flat. The anterior border of the posterior nares is concave on each side of the median suture, which terminates at the apex of a projecting angle. The sagittal crest is not much elevated anteriorly, but rises steeply to the inion. The lateral occipital crests are prominent and nearly parallel. The occiput is not narrowed, and it is divided by a keel on the median line. There are no lateral keels or fossæ. The suprameatal crest is thin, and the postglenoid process is not much extended transversely. The mandibular ramus is shallow, and of nearly equal depth below the molar teeth. The inferior flare is quite prominent, and the alveolar margin rises to the inferior canine. The symphysis is very deep, and the front of the chin is strongly convex at its superior part, and less so below, having a form quite different from that seen in the species of *Felidæ* already described, where it is flat and transverse. The symphyseal suture is longer above than below, and the two parts are separated by a deep sinus without contact, which almost reaches the external surface. The angle of the ramus is not as much produced as in the species above described, and it is widened horizontally inwards. The masseteric fossa is profound, and its inferior and supero-anterior borders are prominent. There is a peculiar rough, flat tuberosity on the inner side of the superior border of the ramus, opposite the posterior part of the sectorial, which I do not find in the existing cats nor in the species of *Nimravus*, and of which a trace is seen in the *Dinictis cyclops*.

Sutures.—The *frontomaxillary* is almost vertical from the orbit, and turns downwards to join the lateral nasal suture for a very short distance only. It is there widely separated from the premaxillo-maxillary. The lachrymal bone is pear-shaped, with the narrow end directed downwards and backwards, and joining the orbital plate of the palatine by a short suture. Its bounding sutures are not dentate. The anterior part of the orbitosphenoid is separated from the lachrymal by about the length of the inferior border of the latter bone. The palatal plate of the palatine bone extends as far forwards as the anterior border of the superior sectorials, and is broadly

truncate anteriorly. The frontoparietal suture crosses the apex of the frontal space.

Foramina.—The infraorbital foramen is large and subtriangular. Its posterior border is directly above the middle of the anterior root of the superior sectorial. The lachrymal is small. There are two nasoörbitals perforating the orbital plate of the palatine, of which the superior is the larger. The incisive foramina are large, and the palatals are small and opposite the anterior border of the (first) third premolar. The postparietal is well below the sagittal crest. The postglenoid is small. The dental foramen is large, and its center is below the middle line of the ramus, and below the anterior border of the base of the coronoid process. There are three external mental foramina on both rami; one below the front of the fourth premolar, one anterior to the front of the third premolar, and a larger one below the middle of the surface to which the superior canine tooth is applied. There are two anterior mental foramina which mark about the thirds of the depth of the chin.

Dentition.—The width of the premaxillary region gives space for a full development of the incisors, which have robust bases. The canines, like the incisors, are broken off. Their bases show them to have been of large size, and of more compressed form than those of any of the species already described. Their long diameter considerably exceeds the length of the diastema which separates them from the third (first) premolar. There is no indication of the existence of a second premolar. As the outlines of the maxillary bones diverge strongly, the base of the third premolar is oblique. Its crown is broken off, but it was evidently not as large a tooth as in the species of *Nimravidæ* above described. Its base is one-half the length of that of the sectorial. The sectorial has its principal cusp prominent and acute, while its heel is low, but compressed and sharp. There is a rudiment of an anterior basal lobe, as is figured by Leidy in the *H. primævus.* This tooth is characterized also by the very small size of its internal heel, which is continued downwards as a perfectly straight ridge, without interruption, to near the apex of the principal cusp. The edges of the tooth are little worn, and they show at several points anterior and posterior to the principal cusp a beautiful denticulate structure. The tubercular molar is large, but not

equal to that of *Pogonodon platycopis* or *Dinictis cyclops*. It has but two roots, and its crown is partly concealed from the side view by the posterior extremity of the sectorial.

The mandibular incisors are well developed, and the canine is not much larger than the external incisor. Of the molars, the first is very small, though two-rooted, and has anterior and posterior basal lobes, although the former is minute. The fourth premolar is intermediate in size between the third and the sectorial, and has anterior and posterior basal lobes, the posterior being the longer. The main cusp is not high, and its acute edges are crenulate. The sectorial has its principal cusp elevated; the heel is short, and the internal tubercle stands on the posterior edge of the main cusp two-fifths the distance from the base of the crown. The enamel of the external sides of the last two molars is slightly wrinkled.

Measurements.

	M.
Axial length from premaxillary edge to orbit	.041
Axial length from premaxillary edge to extremity of maxillary bone	.061
Axial length to middle of posterior border of palate	.060
Width of palate behind sectorials	.054
Length from premaxillary border to frontoparietal suture on profile	.095
Width of occiput at superior part	.030
Length of base of third premolar	.009
Length of base of sectorial	.020
Width of base of tubercular molar	.011
Length of mandible to angle	.101
Length of dental series from I. i	.067
Length of canine and incisor series (oblique)	.015
Length of diastema	.019
Length of base of Pm. iii	.006
Length of base of Pm. iv	.012
Length of base of sectorial	.018
Depth of chin at symphysis	.031
Depth of chin at flange	.032
Depth of ramus at M. i	.017

The mandibular ramus of the young animal already mentioned supports the temporary sectorial, and displays two of the permanent incisors inclosed in the jaw in an unworn condition (Plate LXVIIa, fig. 17). The latter have slightly recurved conic crowns, with denticulate cutting edges. The sectorial has the character of that of most *Felidæ;* there is a short acute heel, and an elevated compressed internal tubercle, which is as high as the anterior lobe of the crown. Its position is behind and a little within the median cusp of the tooth.

Remarks.—This species is nearly allied to the *Hoplophoneus primævus*, of which it may be only a regional variety. It is distinguished by its shorter and wider face and palate, a character especially seen in the shortness of the diastema, which is considerably less than in the Nebraska species. With this animal it compares much as the bull-dog does with the ordinary varieties of the genus *Canis*.

The two specimens I have described were found by myself on a denuded portion of the White River formation in Northeastern Colorado. At the same locality were multitudes of bones, mostly jaws, of fifty species of various orders of *Mammalia* and *Reptilia*, on many of which it doubtless preyed.

HOPLOPHONEUS CEREBRALIS Cope.

American Naturalist, 1880, Dec., p. 850. *Machærodus cerebralis* Cope, American Naturalist, 1880, p. 143 (January 31).

Plate LXXV a; figs. 3, 4, 5.

Probably the smallest species of the genus, and one that presents peculiar characters.

This peculiar species, the smallest of the genus, approaches nearest in dentition to the true saber-tooths (*Drepanodon*), and is represented by a skull, from which the basioccipital region, a good deal of the right side, and the lower jaw, are absent.

It differs in many respects from all the members of this family of cats heretofore discovered in North America. In almost every point in the osteology of the skull it is peculiar. There is not as much space for the temporal muscle as in most of the extinct species described, or as in the large recent *Unciæ*, but the points of origin of the muscle indicate that it was relatively stronger than in the domestic cat and the lynxes. Its single premolar is very small, so that the dentition for practical use is reduced, in the upper jaw, to the canine and sectorial. Both have been most effective instruments in the performance of their respective functions. The sectorial has a distinct anterior basal lobe. The space for the accommodation of the brain is relatively more ample than in any other feline of the formation, and the inner wall indicates that the convolutions of the hemispheres were well developed. This species, if the cranium were of usual proportions, was about the size of the red lynx (*Lynx rufus*).

The facies is quite different from that of the species heretofore described, the profile more nearly resembling that of some of the smaller species which belong to the genus *Felis*. It is much less convex than usual, for though the nasal bones descend, the sagittal crest is horizontal and the occiput vertical, when the sphenoid bone is held in a horizontal position. The side of the face is slightly concave in front of the orbit, and plane in front of the infraorbital foramen as far as the gentle curvature to the nareal border. There is a low protuberance on each frontal bone, near the maxillary suture, a little nearer the median suture than the superciliary border. From it the surface descends rapidly to the superciliary border. The postorbital process is longer and more recurved than in any of the species of the White River period, resembling more nearly that of the recent *Felidæ*. The orbit has less vertical and more lateral presentation than in many of the species, owing to the less prominence of the anterior part of the zygoma It is of a vertically oval form, owing largely to the shortness of its superciliary border. The parts of the zygoma remaining are slender, and the malar portion turns inwards below. The sagittal crest is long, but is quite narrow and low. The brain-case is relatively large, and the parietal surface of the temporal fossa is regularly convex. The occiput is quite wide, and does not project backwards as in the larger and many of the smaller cats The lateral crests are not prominent, and are quite obsolete above the mastoid region. The posterior face is impressed by a uumber of small fossæ and foramina. Though the occiput is somewhat imperfect, there is evidence that there was no paroccipital process; even less than the rudiment found in most of the recent *Felidæ*. Above its position, forming the external expansion of the exoccipital bone, is a low tuberosity. The posttympanic process is quite long, and is subcylindric and truncate. It does not touch the postglenoid. The lateral occipital crest is continued as a delicate ridge which divides it lengthwise externally. It does not give off the suprameatal crest, which is low, but expands into the thin posterior superior edge of the squamosal part of the zygoma. The latter is more expanded posteriorly than anteriorly. The anterior part of the basioccipital has a median groove, which is continued on the basisphenoid. The pterygoid processes of the palatine bone have rounded infe-

rior edges. The nareal border of the palatines consists of two pronounced concavities separated by a prominent point. The border of each concavity supports two contiguous obtuse tubercles well separated from each other. The external one of these is separated from the acute deflected posterior border of the maxillary bone by a concavity of the horizontal surface. The posterior front of the palate is slightly concave on each side of the median line, and presents a deep excavation on the inner side of the sectorial, to receive the crown of a large inferior sectorial. This fossa has a straight inner border. The palate is concave between the canines; behind them on each side, a shallow groove enters the palatine foramen.

The characters of the palate described are quite peculiar among cats.

Sutures.—The premaxillomaxillary suture joins the nasal suture well above the nareal border of the nasal bones, but does not probably meet the frontomaxillary. The latter is arched upwards to a point above the anterior third of the orbit. Its nasal terminus is lost from both sides. The fronto-parietal suture crosses the sagittal crest well behind the junction of the temporal ridges. The parietosphenoid suture is quite long. The squamosal bone is not much longer than it is deep to the *meatus auditorius.* The maxillo-palatine suture extends along the inner border of the fossa for the inferior sectorial.

Foramina.—The external nares are rather small, partly curving to the prolongation of the nasal bones. The infraorbital foramen is round and small for a cat; owing to the lack of prominence of the malar bone it has a partially external opening. The lachrymal is normal and well inside the orbit. The optic is close to the sphenoörbital and is of usual size. The sphenoörbital and round foramina are united into a single large anteriorly directed opening; whether the internal perforations are united or not, the state of the specimen does not allow me to see. There is an alisphenoid canal, which connects the external opening with a common foramen with the *f. ovale.* Its diameter is small. The *f. ovale* is large, and is not widely separated from the *meatus auditorius internus.* The *f. postglenoideum* is moderate, and terminates in a groove in the anterior wall of the *meatus auditorius.* The basioccipital bone being absent, the relations of various foramina cannot be ascertained. There are two postparietals, both penetrating the

inferior part of the bone, the posterior near the lateral occipital crest. The palatine foramen is rather large. It is much nearer the alveolar border than to the median suture, and is opposite the anterior border of the third premolar tooth.

Dentition.—The bases of two incisors, and both canines, are preserved with the crowns of the molars of one side. The base of the external incisor is not so much larger than that of the second, as in the cats already described. It is separated from the canine by a diastema half as long as that posterior to the canine. The latter is two-thirds as long as the long diameter of the canine. The base of the canine is of a compressed oval form, with a slight concavity on the inner side. It is much like that of the *Hoplophoneus oreodontis*, but is relatively larger. In fact, it is relatively larger than in any other American saber-tooth, excepting the *Pogonodon platycopis*. There are but three molars. The first or third premolar is quite small, but has, as usual, two roots. The crown has a low compressed anterior basal tubercle, and a small median cusp. The heel is rather long, equaling the long diameter of the base of the cusp, and is compressed. The sectorial is relatively large. It is somewhat worn by use, but its form is characteristic. Its cutting heel is very long, while the base of the principal cusp is small. There is a distinct anterior basal cutting lobe, as in the true *Drepanodontes*. The external face of the crown is concave before and behind the median cusp. The tubercular or true molar has been lost; there are alveoli for two roots, rather close together. The position of the external alveolus shows that the crown extended externally to the plane of the jaw.

Measurements.

	M.
Length from premaxillary border to inion	.117
Probable width of zygomata posteriorly	.082
Axial length from premaxillary border to orbit	.040
Axial length from premaxillary border to nares	.057
Axial length from premaxillary border to postglenoid process	.025
Width between superior canines	.020
Width between sectorials behind	.043
Width of posterior nares	.012
Width of occiput above middle	.037
Width between orbits (horizontally)	.047
Length of sagittal crest	.038
Length of postglenoid from roof of meatus	.018
Length of posttympanic (total)	.011

	M.
Length of glenoid cavity (transversely)	.017
Vertical diameter of orbit	.025
Length of base of canine	.016
Width of base of canine	.017
Length of diastema	.011
Length of molar teeth on base	.025
Length of Pm. iii	.006
Length of sectorial	.017

The unique specimen of this species was found by Mr. J. L. Wortman in the bad lands of Camp Creek, one of the head tributaries of the Crooked River, in Central Oregon.

HOPLOPHONEUS STRIGIDENS Cope.

American Naturalist, 1880, December, p. 851. *Machærodus strigidens* Cope, Paleontological Bulletin, No. 30, p. 9 (Dec. 3, 1878). Proceed. Amer. Philos. Soc., 1878, p. 71.

Plate LXXV*a*; fig. 6.

This obviously distinct species is only represented by the crown of a superior canine tooth, from which the apex has been broken. Its characters are so peculiar that I have recorded it under the above name, not knowing whether I shall have better specimens.

The tooth is long and very much compressed, much more so than in any species of the genus known to me. Its anterior and posterior edges are finely and very perfectly denticulate, without lateral flexure near the base. The center of each side of the tooth is occupied by a wide open gutter, so that the greatest transverse diameter of the crown is not at its middle. These gutters become planes towards the apex, giving an elongated hexagonal section. The size indicates an animal of the proportions of the *H. cerebralis*.

As compared with the superior canine of the *Dinictis squalidens*, which the present specimen resembles in its compression and fine denticulation, it differs in its greater relative length and in the presence of the lateral open sulci.

Measurements.

			M.
Diameters at base	anteroposterior		.0120
	transverse	greatest	.0036
		median	.0032
Length of a denticle on base			.000143

Remarks.—This tooth belonged to an animal of about the size of the *H. cerebralis*, and perhaps to that species. If so, it indicates for it a longer canine than usual, as its extremely compressed form points to a position at a considerable distance beyond the base of the crown. The probabilities are against reference to the *D. cerebralis.*

The tooth is the most elegant in form and perfect in its details yet found. As a cutting instrument it is superior to anything of human manufacture which I have seen.

Found by C. H. Sternberg, on the John Day River, Oregon, in the Truckee beds.

(The White River and John Day Faunæ are continued in Vol. IV.)

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