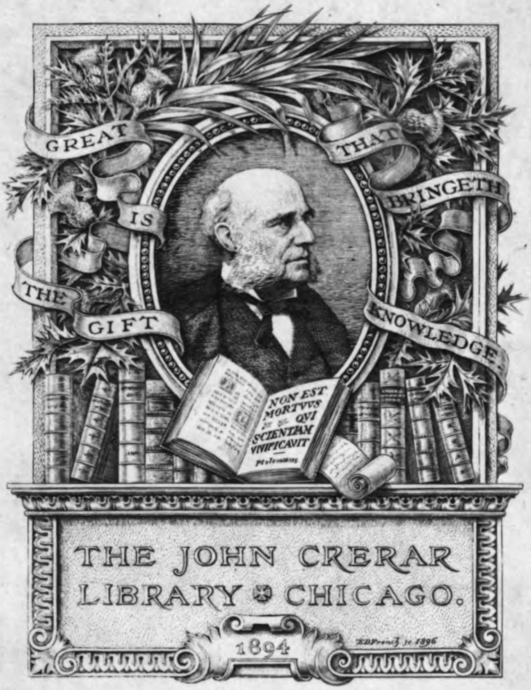
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DEPARTMENT OF THE INTERIOR.

UNITED STATES GEOLOGICAL SURVEY OF THE TERRITORIES.

F. V. HAYDEN, U. S. GEOLOGIST-IN-CHARGE.

REPORT

ON THE

VERTEBRATE PALEONTOLOGY

OF

COLORADO.

BY

E. D. COPE, A. M.

[EXTRACTED FROM THE ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES FOR 1873.—F. V. HAYDEN, GEOLOGIST-IN-CHARGE.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1875.

REPORT ON THE VERTEBRATE PALEONTOLOGY OF COLORADO.

BY EDWARD D. COPE, A. M.

PHILADELPHIA, *July* 12, 1874.

SIR: I send herewith a report on the stratigraphical relations and vertebrate paleontology of the formations which represent the Cretaceous, Eocene, Miocene, and Pliocene periods in Colorado, with a few species from other localities added. This essay is based on material collected by myself during a part of the summer and autumn of the year 1873, under the auspices of the geological survey of which you are director. This represents the following numbers of species from the respective formations, to which I have added the number from each which is believed to have been first introduced to the knowledge of paleontologists:

Formation.	Total.	New.
Pliocene	21	9
Miocene	75	59
Eocene	15	7
Cretaceous	38	19
Total	149	94

Hoping that the report will subserve the objects of the survey, I remain, with respect,

EDWARD D. COPE,
Paleontologist.

Dr. F. V. HAYDEN,
Geologist in Charge, &c

CHAPTER I.

INTRODUCTION.

The water-shed between the South Platte River and Lodge Pole Creek is composed superficially of formations of the Pliocene epoch as defined by Hayden. The latter stream flows eastwardly through the southern parts of Wyoming and Nebraska, and empties into the South Platte near Julesburgh, Nebr. The territorial and state boundaries traverse this water-shed from west to east. The springs on its southern slope, which form the sources of the northern tributaries of the South Platte, issue from beneath the beds of the formation above named. At or near this point is an abrupt descent in the level of the country, which generally presents the character of a line of bluffs varying from two to nine hundred feet in height. This line forms the eastern border of the valley of Crow Creek until it bends to the eastward, when it extends in a nearly east and west direction for at least sixty miles.* At various points along it, portions have become isolated through the action of erosion, forming "buttes." Two of these, at the head of Middle Pawnee Creek, are especially conspicuous landmarks, forming truncate cones of about 900 feet in elevation, as Mr. Stevenson, of the survey, informs me. They are called the Pawnee or sometimes the White Buttes; near them stand two others, the Castle and Court-House Buttes.

The upper portion of this line of bluffs and buttes is composed of the Pliocene sandstone in alternating strata of harder and softer consistence. It is usually of medium hardness, and such beds, where exposed on both the Lodge Pole and South Platte slopes of the water-shed, appear to be penetrated by innumerable tortuous, friable, siliceous rods and stem-like bodies. They resemble the roots of the vegetation of a swamp, and such they may have been, as the stratum is frequently filled with remains of animals which have been buried while it was in a soft state. No better-preserved remains of plants were seen. The depth of the entire formation is not more than 75 feet, of which the softer beds are the lower, and vary in depth from 1 foot to 20. The superior strata are either sandstone conglomerate or a coarse sand, of varying thickness and alternating relations; the conglomerate contains white pebbles and rolled Pliocene mammalian remains.

This formation rests on a stratum of white, friable, argillaceous rock of Miocene age, probably of the White River epoch, as I believe, from the presence of the following species, which I detected in it: *Hyænodon horridus*, *H. crucians*, *Oreodon culbertsonii*, *O. gracilis*, *Pœbrotherium wilsonii*, *Aceratherium occidentale*, *Hyracodon nebrascensis*, *Anchitherium bairdii*, *Palæolagus haydenii*, *Ischromys typus*, *Mus elegans*, &c. The formation extends to a depth of several hundred feet, and rests on a stratum of a fine-grained, hard, argillaceous rock of a dark-brown color. Some of its strata are carbonaceous, and contain vegetable remains badly preserved; others are filled with immense numbers of fresh and brackish water shells, including oysters. I do not know the depth of this bed, but followed it to the southward until it disappeared beneath the Loess of the South Platte. The age of this formation is identical with that which underlies the fresh-water basins of Dakota and Wyoming according to Hayden, and concerning which difference of opinion

* See Berthoud, Proceed. Acad. Nat. Sci. Phila., 1872, p. 48, where the bluffs are mentioned.

exists among geologists. I, however, succeeded in procuring a number of fossil vertebrates from it, which not only prove conclusively its Mesozoic age, but its horizontal identity with the reptile-bearing Fort Union beds of the Upper Missouri. This formation, which has been usually regarded as Tertiary, I determined to be Cretaceous in 1869, and the present discoveries establish that view as correct. The fossils which are described in the following pages represent *Dinosauria* of three species, a crocodile, and several tortoises, identical specifically with those obtained by Dr. Hayden on the Missouri, Big Horn Rivers, &c. Some of the shells I submitted to Mr. Conrad, and he pronounces them to be *Cyrenas*.

South of the South Fork of the Platte, the Cretaceous beds have an extensive development, and south of the Kansas Pacific Railroad contain some beds of pretty good coal. The high tract of land which extends east from the Rocky Mountains, and constitutes the "divide" between the waters of the Platte and Arkansas, is composed of Tertiary strata lying nearly horizontal. A few days' exploration among them revealed chiefly hard, coarse sandstones and conglomerates, which belong to the Monument Creek group of Hayden. The more elevated hills nearest the mountains are capped by a light-colored trachytic rock, believed to be of volcanic origin. While it overlies the Monument Creek formation, the sandstone of the latter not infrequently incloses angular fragments of a similar rock, showing that the outflow commenced prior to the period of its deposit, and continued subsequently. The age of the Monument Creek formation in relation to the other Tertiaries not having been definitely determined, I sought for vertebrate fossils. The most characteristic one which I procured was the hind leg and foot of an *Artiodactyle* of the *Oreodon* type, which indicated conclusively that the formation is newer than the Eocene. From the same neighborhood and stratum, as I have every reason for believing, the fragment of the *Megaceratops coloradoensis* was obtained. This fossil is equally conclusive against the Pliocene age of the formation, so that it may be referred to the Miocene until further discoveries enable us to be more exact.

Fresh-water strata of probable Eocene age were, however, detected by both Dr. Hayden's party and my own in the South Park. These consist of laminated argillaceous shales of soft consistency, in which great numbers of fishes and plant impressions are preserved. The fishes are referable to only two species, *Amyzon commune* and *Rhineastes pectinatus*, and are described in chapter II. They are nearly related to species of the Elko shales and Bridger formation, and I suspect that their age is Eocene.

From Trout Creek, near Fairplay, we procured a number of invertebrate fossils of Lower Cretaceous age, a few of which are described by Mr. Conrad in chapter II.

Thus it appears that, in Colorado as in Dakota, the formations of the Loup Fork, White River, and Fort Union epochs are present, and display a similar succession of life, and that the corresponding horizons display identity in the generic and often specific forms of life. They also exhibit the same marked faunal distinctness from each other in Colorado as in Dakota, and the Colorado fauna displays the same strong diversity from the Eocene fauna of Wyoming in respect to the genera, families, and orders which can be compared.

CHAPTER II.

THE CRETACEOUS PERIOD.

SECTION I.—ON THE MUTUAL RELATIONS OF THE CRETACEOUS AND TERTIARY FORMATIONS OF THE WEST.

The subject which it is proposed here briefly to discuss is one which has excited considerable interest for several reasons. One of these is, that there exists some discrepancy in the evidences as to the true age of beds at the summit of the Cretaceous period and base of the Tertiary in the Missouri and Rocky Mountain regions, and hence a difference of opinion. Another is, that the question of continuity in topographical, and hence of faunal and floral, relations, will be largely elucidated by a proper determination of the beds in question, both geologically and paleontologically. I have endeavored to attain some results in the latter field in the department of *Vertebrata*, which are here presented, with some stratigraphical observations made at localities either little or not previously studied.

Messrs. Meek and Hayden have classified the vast thickness of the Cretaceous system, recognizing five epochs as quite distinctly defined. These are as follows:

I. THE DAKOTA GROUP, (No. 1.)—The present list does not include any species as discovered in this formation. Developed on the Missouri and on the Rio Grande, New Mexico.

II. THE BENTON GROUP.—Seen on the Missouri River by Hayden, and stated by him to extend to the Smoky Hill River, in Kansas, and to Texas. I have determined only three species from it, namely: *Hyposaurus vebbii*, a crocodile; *Apsopelix sauriformis*, a clupeoid; and *Pelecorapis varians*, a ctenoid fish. Other species of fishes occur in the same formation in Kansas.

III. THE NIOBRARA GROUP.—From the Missouri, Kansas, and Texas, according to Hayden. Confirmatory of the last locality are remains of *Pythonomorpha* from that State, discovered and sent to me by Mr. A. R. Roessler. I have also described a species of that order as common to Eastern New Mexico and Western Kansas; and Hayden and Leconte state that it appears north of the Arkansas in Southern Colorado. Vertebrate remains are abundant in this formation, and it has furnished a majority of those investigated by paleontologists. They are distributed as follows, among the orders of *Vertebrata*:

Aves:	
Natatores	2
(?) *Saururæ*	2
Reptilia:	
Dinosauria	1
Pterosauria	4
Sauropterygia	3
Testudinata	3
Pythonomorpha	27

Pisces:
Isospondyli 31
Selachii 10

IV. THE PIERRE GROUP.—In Nebraska and Dakota, and Middle Colorado south of the divide between the waters of the Arkansas and Platte Rivers. Also the lower bed of Greensand of New Jersey. Besides the numerous remains of reptiles and fishes found in New Jersey, this formation contains saurian (mosasauroid) remains in Colorado. Weber River, Wyoming,* below the coal.

V. THE FOX HILLS GROUP.—Extended in Central Dakota; on the Arkansas and tributaries in Southern Colorado; and as the second Greensand bed in New Jersey.†

VI. THE FORT UNION OR LIGNITE GROUP.

With this epoch we enter debatable ground, and begin to consider strata deposited in brackish or fresh waters, which were more or less inclosed by the elevation of parts of the Rocky Mountains and other western regions, and which are therefore more interrupted in their outlines than the marine formations which underlie them. Dr. Hayden has recognized and located a number of formations of this character, to some of which he has applied the name of "transition-beds." That the period of their deposit was one of transition from marine to lacustrine conditions is evident, and that a succession of conformities in position of beds may be traced from the lowest to the highest of them, and with the Tertiary strata above them at distinct localities, beginning at the south and extending to the north, is also proved by Hayden and others. It appears impossible, therefore, to draw the line satisfactorily without the aid of paleontology; but here, while evidence of interruption is clear, from the relations of the plants and vertebrate animals, it is not identical in the two cases, but discrepant. I therefore append a synopsis of the views expressed by authors, with a presentation of the evidence which is accessible in my department. I am aware that the combination I shall make is of a highly inflammable character, because it not only relates to the most combustible deposits of the West, but also to the "*partie honteuse*" of contemporary geologists and paleontologists. But should any inflammation ensue, I hope it will be attributed to the nature of the materials employed, rather than to any inattention on the part of the author to the just claims of his friends.

Hayden has named the following as distinct epochs of transitional character, all of which he originally referred to the Tertiary period. I give them in the order of age which he has assigned to them.‡ (1.) Placer Mountain; locality, New Mexico. (2.) Cañon City coals, Southern Central Colorado. (3.) Fort Union, or Lignite group; Dakota, Montana, and Wyoming. (4.) The Bitter Creek series; embracing the Bitter Creek coals, Wyoming. (5.) Bear River group, Western Wyoming. To these may be added the Judith River beds of Montana, which Dr. Hayden has placed with reservation below the Fort Union series, leaving their final location for future discoveries.

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* Hayden's Annual Report, 1870, p. 167.

† For a review of the extinct reptiles of this epoch, see the author's Extinct Batrachia, Reptilia, &c., N. Am., 1870.

‡ Geological Survey of Colorado, 1869, p. 90.

No vertebrate remains having come under the author's notice from the Placer Mountain and Cañon City formations, no further notice can be here taken of them beyond the statement that they are, as Meek indicates, of Cretaceous age, not far removed from the horizon of the coals of Weber River, Utah. The presence of ammonites and baculites above and below them has indicated such a conclusion to Leconte,* as it has in the case of the Weber River beds to Dr. Hayden.† To near the same horizon is perhaps to be referred the coal observed by Professor Marsh‡ on the south side of the Uintah Mountains in Utah, which were overlaid by strata containing *Ostrea congesta.* This may, indeed, be referred to a still older period, as that oyster is characteristic of No. 3, according to Meek and Hayden. The Placer Mountain and Cañon City groups are nearer to No. 5, but the precise relation to it has not yet been determined. I therefore proceed to the Fort Union group as No. 6.

This extended deposit is stated by Hayden§ to extend from the Missouri Valley to Colorado, passing under Tertiary beds by the way. That this is the case has been confirmed by the researches conducted in the northern and eastern portions of Colorado during the season of 1873 by the writer.‖ I present comparative lists of the vertebrate species known from the Platte and Missouri Valleys in the respective Territories:

COLORADO.	DAKOTA.
Compsemys victus.	*Compsemys victus.*
Adocus lineolatus.	*Adocus lineolatus.*
Plastomenus punctulatus.	*Plastomenus punctulatus.*
Plastomenus insignis.	* *
Trionyx vagans.	*Trionyx vagans.*
* *	*Ischyrosaurus antiquus.*
* *	*Plesiosaurus occiduus.*
Bottosaurus perrugosus.	* *
Polyonax mortuarius.	* *
Cionodon arctatus.	* *
? *Hadrosaurus occidentalis.*	*Hadrosaurus occidentalis.*

The identity and correspondence of the species indicate that these remote localities contain the remains of the same fauna. Further, the presence of the orders *Sauropterygia* and *Dinosauria* establishes conclusively the Cretaceous and Mesozoic character of that fauna.¶ This reference was made by the writer in 1869, and was at that time opposed to the views extant, both geological and paleontological. The following exhibits the state of opinion on this point at that time:

1856. Meek and Hayden, Proceedings Academy Philadelphia, p. 63, referred them to the Tertiary.

1856. Meek and Hayden, *loc. cit.*, p. 255; Lignite referred to the Miocene.

* Report on the Geology of the Smoky Hill Pacific Railroad Route, 1868, p. 66.
† Annual Report, 1870, p. 168.
‡ See an interesting article by Prof. O. C. Marsh on the Geology of the Eastern Uintah Mountains; Amer. Jour. Sci. Arts, March, 1871.
§ Annual Report, Colorado, 1869, p. 89.
‖ See Bulletin of the United States Geological Survey, 1874, p. 10.
¶ Two species are provisionally referred to the Tertiary genus *Plastomenus*, but are too fragmentary for final determination.

1856. Meek and Hayden, *loc. cit.*, 113; referred to Lower Tertiary.

1856. Leidy, *loc. cit.*, p. 312; *Thespesius occidentalis*, (*Hadrosaurus*,) referred to the Mammalia and regarded as perhaps *Dinosaurian*.

1856. Leidy, *loc. cit.*, 1856, p. 89; *Ischyrosaurus* referred to the Mammalia as a *Sirenian*.

1860. Hayden, Transac. American Philosoph. Society, repeats former conclusions, and Leidy refers *Thespesius* more decidedly to the *Sauria*.

1868. Hayden, Amer. Journal Science Arts, 1868, p. 204; Lignites, regarded as Tertiary, from both vegetable and *animal remains* from the Missouri and the Laramie Plains.

1868. Leconte, Exploration of the Smoky Hill R. R. Route, p. 65; the Colorado beds are "older than those of the Missouri or Great Lignite bed of Hayden, which are probably Miocene," &c.

1869. Cope, Trans. Amer. Philos. Soc., pp. 40, 98, 243; supposed mammalian remains proved to be reptilian, and the formation referred to the Cretaceous.

1871. Newberry, in Hayden's Annual Report, pp. 95, 96; Lignite flora regarded as Miocene.

1874. Cope, *loc. supra cit.*; Lignite of Northern Colorado referred to the same horizon.

The Judith River beds may be noticed in this connection. They have yielded but few vertebrate remains, namely, six species of *Reptilia*. Four of these are *Dinosauria*, and hence diagnostic of the Mesozoic age of the formation. The presence of a species, *Hadrosaurus mirabilis*, Leidy, closely allied generically and *specifically* to a species (*H. foulkei*) of Cretaceous Nos. 4 and 5 of New Jersey, induces me to believe that the formation is Cretaceous, and such would appear to have been the suspicion of Messrs. Meek and Hayden when they originally described the deposit and its invertebrate fossils. Leidy suspected that the species "indicate the existence of a a formation like that of the *Wealden* in Europe."* Meek and Hayden † remarked, "We are inclined to think with Professor Leidy that there may be at the base of the Cretaceous system a fresh-water formation like the *Wealden*. Inasmuch, however, as there are some outliers of fresh-water Tertiary in these lowlands, we would suggest that it is barely possible these remains may belong to that epoch." From the stand-point of the writer, these beds would be at the top of the Cretaceous, and more or less related to the Fort Union epoch. Mr. Meek expresses himself ‡ cautiously with reference to the age of the Fort Union and Judith River formations, as follows: "The occurrence of" fossils specified "at the Judith River localities would certainly strongly favor the conclusion not only that this Judith formation, the age of which has so long been in doubt, is also Cretaceous, but that even the higher fresh-water Lignite formation at Fort Clark and other Upper Missouri localities may also be Upper Cretaceous instead of Lower Tertiary. That the Judith River beds may be Cretaceous, I am, in the light of all now known of this region of the continent, rather inclined to believe. But it would take very strong evidence to convince me that the higher fresh-water Lignite series of the Upper Missouri is more ancient than the Lower Eocene. That they are not is certainly strongly indicated not only by the modern affinities of their molluscan remains, but also by the state of preservation of the latter," &c. It is thus evident that the paleontologists as well as stratigraphers have continued to regard the

* Proceedings Academy Philadelphia, 1856, p. 73.
† *Loc. cit.*, 1856, p. 114.
‡ Hayden's Annual Report, 1872, p. 450.

Lignite series as Eocene and not Cretaceous, as is and has been maintained by the writer since 1868.

VII. THE BITTER CREEK SERIES, mentioned by the writer as a distinct group in the Proceedings of the American Philosophical Society, 1872, (published on August 12,) is apparently regarded by Mr. Meek also as representing a distinct epoch.* He says, "The invertebrate fossils yet known from this formation are in their specific relations, with possibly two or three exceptions, new to science and different from those yet found either at Bear River, Coalville, or, indeed, elsewhere in any established horizon, so that we can scarcely more than conjecture from their specific affinities to known forms as to the probable age of the rocks in which we find them." On this account, and because of the great stratigraphical differences exhibited by the Bear River and Evanston coal-strata, I have followed Hayden in regarding the Bear River group on the west side of the Bridger basin as representing a distinct series of rocks, with present knowledge. On this account I omit, as heretofore, allusion to determinations of age of the latter formation as irrelevant in discussing the age of the Bitter Creek epoch.†

My own observations on the relations of these rocks, made during the summer of 1872, have been in measure anticipated by the detailed reports of Messrs. Meek and Bannister,‡ which, with the older observations of Dr. Hayden and Mr. Emmons, (of King's survey,) leave little to be added. However, as none of these gentlemen paid especial attention to the vertebrate paleontology, the bearing of this department in relation to the stratigraphy remains to be explained.

As Dr. Hayden remarks, the Union Pacific Railroad, at Black Butte station, passes through a monoclinal valley, the rocks on both sides having a gentle dip to the southeast. This dip continues to the eastward to near Creston, where the beds pass under the newer Tertiary strata. Following the railroad westward from Black Butte, the same dip continues to near Salt Wells, where we cross an anticlinal axis, the dip of the strata being gentle to the northwest. There are minor variations in the dip, but the general result is as stated. They disappear five miles east of Rock Spring station, beneath the latter beds of the Green River Tertiary, which at this point presents a line of strike extending northeast and southwest across the railroad in the form of a range of bluffs of considerable elevation. They are composed of lighter-colored and softer material than the Bitter Creek strata. The latter consists of alternating beds of hard and soft sandstone, with argillaceous and carbonaceous strata. The upper part of the series contains eleven coal-strata; at Rock Spring I was informed that the upper was ten feet in thickness, and the next four feet. Returning eastward, the heavier bedded sandstone is low in the series at Point of Rocks, in consequence of the southeast dip; and the upper beds are softer and abound in fossil shells. At Black Butte station, the heavy sandstone bed disappears from view toward the east, and the eleven coal-strata appear above it. About twenty feet above the sandstone, between two of the thinner beds of coal, the bones of the *Agathaumas sylvestris* were found imbedded in leaves and sticks of dicotyledonous plants, cemented together by sand and clay. Where the heavy sandstone bed disappears below the level of the track of the railroad, in the course of its eastern dip, a thin

* Hayden's Annual Report, 1872, pp. 459, 461, published April, 1873.

† This course has been misunderstood by Mr. Meek and others as implying a design to ignore those determinations. Both Mr. Emmons and Mr. Meek are clear in the expression of their conclusions as to the age of the Bear River epoch.

‡ See Hayden's Annual Report, 1872, pp. 457, 525.

bed of coal just above it soon follows; then a bed of shells containing oysters, more and less numerous at different points, may be traced for some distance before it also disappears. Near the latter point, a bed of melanian and other fresh-water shells is seen a few feet above them.

A section, carried for eight miles south of Black Butte station, exhibits the relation of the Bitter Creek series to the superincumbent Tertiaries very instructively. The whole series rises slightly to the southward, and more distinctly to the westward, so as to form an escarpment as the eastern border of an open valley, which extends south from the railroad just west of the station. The heavy bed of sand-rock is here as elsewhere the landmark and stratigraphical base-line. Moving south from the railroad, we keep along the strike of the lower coal-beds. Just above the sandstone bed the softer stratum thickens, and six miles from the station is covered with the *débris* of immense numbers of *Leptesthes crassatelliformis*. Passing over the edges of the strata toward the southeast, I counted eight beds of coal, separated by various short intervals, the eighth being the heaviest, and five or six feet thick. Above this one, three thin beds of lignite were crossed in succession, each accompanied with an abundance of leaves of chiefly dicotyledonous plants. Then came the ninth bed of coal, and then in order three more beds of lignite, with abundant leaves. During this time the ascent became less steep, and a number of level tracts were passed before reaching the upper bed of lignite. Beyond this I passed another short flat, which was marked by a number of worn banks of the light ash-color that distinguishes the material of the bluffs of the Green River Tertiary which overlie the coal-series near Rock Springs. I had not ridden a quarter of a mile before reaching a low line from which one of my men picked up a jaw of a small mammalian allied to the Bridger *Hyopsodus*, or *Hyracotherium* of the Eocene of France and Switzerland, and a number of *Paludina*-like shells. I had thus reached the summit of the Bitter Creek formation, which did not appear to be much more than three hundred and fifty feet above its base at the railroad. In full view, a mile or two to the south, rose the first of the benches which constitute the levels of the Green River formation. Between this and the first mammal-producing bed rose three banks, one beyond the other, measuring altogether one hundred and twenty feet; perhaps the lowest was ten feet above the first bank, and this one not more elevated above the last lignite and leaf bed. In all of these, I found bones of Green River *Vertebrata* exceedingly abundant, but all dislocated and scattered, so as to be rarely in juxtaposition. These consisted of the following species:

FISHES:

Clastes (?) *glaber*.

REPTILES:

Emys megaulax.
Emys pachylomus.
Emys euthnetus.
Trionyx scutumantiquum.
Alligator heterodon.

MAMMALS:

Orotherium vasacciense, and fragments of others too imperfect for determination.

In the third bank, in immediate juxtaposition with the remains just enumerated, I found another thin bed of lignite, but this time without any visible leaves. In a fourth line of low bluffs, a little beyond, I found that remarkable mammal *Metalophodon armatus*, with its dentition nearly complete, in connection with fragments of other mammals and reptiles.

Behind these rises the first line of white bluffs, already described, which extends away to the east; to the west it soon terminates in a high escarpment, in north and south line with that of the Bitter Creek beds, already mentioned as bounding a north and south valley. This and the superjacent strata, which we pass over in going south, *appear* to be conformable to those of the Bitter Creek series beneath them. I say "appear," for slight differences of dip are not readily measured by the eye; yet I suspect that the conformability is very close, if not exact, and similar to that mentioned by Meek and Bannister as exhibited by the beds of the Washakie group, which lie upon the coal-series east of Creston. The white bluffs add perhaps one hundred feet to the elevation. On their summit is a thin bed of buff clay and sand rock, similar to the upper strata of the Bitter Creek series, and containing numerous shells and some scattered teeth and scales of fishes. I called Mr. Meek's attention to the specimens of these shells which I sent him, and his reply was that most were of identical species with those of the coal-series, Cretaceous, and that they presented no general peculiarity.

At a short distance to the southward, another line of white bluffs extends across the line of travel. This is not more elevated than the preceding one; I only found remains of tortoises on it. Several miles to the south we reach another bench, whose bluffy face rises four or five hundred feet in buttress-like masses, interrupted at regular intervals by narrow terraces. This line is distinguished for its brilliantly-colored strata, extending in horizontal bands along the escarpment. They are brilliant cherry-red, white, true purple, with a bloom-shade, yellow, and pea-green, forming one of the most beautiful displays I ever beheld. The lower portions are bright-red, which color predominates toward the west, where the bluffs descend to a lower elevation. I found on them remains of a turtle, (*Emys euthnetus*, Cope,) and some borings of a worm in a hard layer. On top of these are clay and slate rocks of a muddy-yellow color, with their various ledges rising to perhaps two hundred feet. Continuing now to the southeastward along the old stage-road, we cross South Bitter Creek at the old Laclede station. Some miles south and east of this point we cross a band of buff sandstones, forming a bluff of fifty or more feet in elevation. Below it lie more white or ashen beds, which contain remains of mammals and turtles rather decayed. A short distance beyond these, and forty miles from Black Butte station, we reach the base of the enormous pile of sediment which I have called the Mammoth Buttes. These form a horseshoe-shaped mass, the concavity presenting south and eastwardly, the summit narrow, serrate, and most elevated to the east, and desending and widening toward the south. I estimated the height of the eastern end to be at least one thousand feet above the plain surrounding it. Numerous mammalian remains* demonstrated that this mass is a part of the Bridger Eocene, although, as Mr. Emmons, of King's survey, informs me, no continuous connection with the principal area west of Green River can be traced. The total thickness of the Green River and Bridger formations on this section cannot be far from twenty-five hundred feet, at a very rough estimate.

The point of transition from the Cretaceous to the Tertiary deposits, as indicated by the vertebrate remains, is then in the interval between the last plant-bed at the summit of the buff mud-rocks and the mammal-bone deposit in the lowest of the ash-gray beds. Below this line

* See The Monster of Mammoth Buttes, Penn Monthly Magazine, 1873, August.

the formation must be accounted as Cretaceous, on account of the presence of the Dinosaurian *Agathaumas sylvestris;* and those above it, as I have already pointed out, Eocene,* on account of the types of *Mammalia* contained in them.

The authorities on the Bitter Creek formation have presented views more or less at variance with those entertained by the writer, or of such dubious character as to fall very far short of the requirements of evidence. Dr. Hayden has regarded them as Tertiary and as transitional from Cretaceous to Tertiary. Mr. King, in his very full article on the Green River basin, definitely refers the lower part of the series to the Cretaceous, in the following language: † "We have, then, here the uppermost members of the Cretaceous series laid down in the period of the oceanic sway, and quite freely charged with the fossil relics of marine life; then an uninterrupted passage of conformable beds through the brackish period up till the whole Green River basin became a single sheet of fresh water." He regards the line of the upper bed of oysters as the summit of the Cretaceous, and the superimposed beds as Tertiary, in the following language, (p. 453:) "while the fresh-water species, which are found in connection with the uppermost coal-beds, seem to belong to the early Tertiary period." He thus places the line some distance within what I have regarded as the Cretaceous boundary; what the significance of this conclusion is will be subsequently considered.

Mr. Lesquereaux, as is known, regards these beds as Tertiary, not only on account of their vegetable fossils, but also on account of the stratigraphic relations of the formation. His conclusion to this effect is consistent throughout, and is a fact of the highest importance in this connection.

Mr. Meek has fully discussed the age of this series in his interesting article in Hayden's Annual Report for 1872, the general tenor of which is indicated by the passage I have quoted from the opening of his remarks in the beginning of the present notice of the Bitter Creek beds. His opinions may be cited as follows: In the Annual Report for 1870, he determined the beds visible at Hallville as Tertiary; in that of 1871, three species of oysters from other parts of the Bitter Creek beds are placed in the Cretaceous list, each one with question as to the identification of species, a point, it is to be noticed, equivalent in the case of oysters to question of the age of deposit. The remarks in his report, as well as those in Mr. King's report, refer either to the much lower Weber River coal or to the different area of the Bear River group, and are consequently noticed under that head.

In a paper on the age of these beds, published August 12, 1872, the writer asserted the Cretaceous age of the series. On this Dr. Bannister, the companion of Mr. Meek, writes‡ that "Mr. Meek, and, I believe, Mr. Emmons also, had considered that these beds might be Cretaceous, but this was rather on account of the change in the fossil fauna from purely fresh-water, as in the characteristic Tertiary of this region, to brackish-water marine, and the specific affinities of a few of the fossils to California Cretaceous species, than from any very positive evidence. As far as I know, the only evidence of this kind is the identification by Professor Cope of the saurian remains found by us at Black Butte."

It only remains to observe that the strata and coal of the Bitter Creek group of the Cretaceous are either wanting on the western and southern

* On *Bathmodon*, an extinct genus of ungulates, Feb. 16, 1872, Hayden's Annual Report, 1870, p. 431; Annual Report, 1872, p. 645.

† Exploration of the Fortieth Parallel, p. 458.

‡ Annual Report, 1872, p. 534.

borders of the Green River basin, or are concealed by the superincumbent Tertiaries. Instead of these, a comparatively thin bed of apparently unfossiliferous quartzite or sandstone lies at a high angle against the bases of the Uintah* and Ham's Fork Mountains respectively, on beds of Jurassic age, which are probably Cretaceous No. 1, (Dakota.) The beds observed by Professor Marsh on the south side of the Uintah Mountains, on Brush Creek, belong neither to the Dakota nor Bitter Creek epochs, but perhaps to No 3, if, as Professor Marsh asserts, the oyster found in a superjacent stratum is *Ostrea congesta*, Con.; it is in any case of no later date than the Canyon City or Weber River coals. Hence the assumption of some writers that this discovery determined the age of the Bitter Creek series to be Cretaceous is without foundation in fact.

VIII. THE BEAR RIVER GROUP of Hayden occupies, according to him, a distinct basin, to the west of an anticlinal axis, which separates it from that of Green River. It is buried under Tertiary beds, the age of which has been a question of interest, and will be hereafter considered. In order to determine the relations of the two basins, a section was carried across the rim of the eastern, starting from the Fontanelle Creek, eighty miles north of the Union Pacific Railroad, and continuing toward the upper waters of Ham's Fork of the Green River to the westward. My notes are as follows:

The beds of the Green River epoch dip gently from the point where my last notes left them near the Rock Spring station, toward the northwest all the way to Green River. The upper strata become slaty in character, and descend to the water-level at the river, where they form a high bluff. In these slates occur the fish-beds discovered by Dr. Hayden, as well as the insect-beds noticed by Messrs. Denton and Richardson. They are worn into towers and other picturesque forms at Green River City. (See Hayden's Annual Report, 1870.) Passing north from the railroad, up the valley of Green River, the slates display a gentle dip to the north, and eighteen miles beyond have disappeared from view. On both sides of the river, huge mesas of the Bridger formation come into view; those on the east extending to the Big Sandy River, and those on the West to Ham's Fork. At Slate Creek, farther to the north twenty miles, a yellowish-brown sandstone rises into view, and continues to increase in importance toward the north. At the mouth of Fontanelle Creek, it rises on the east side of the river to a height of perhaps two hundred and fifty feet, but sinks toward the north and east from near the mouth of Labarge Creek, fifteen miles up the river. North of Labarge, a similar bed of sandstone rises again, and is immediately overlaid by white shales resembling those of the Green River epoch, which have here a great thickness. Opposite the mouth of the Labarge, their lower strata are bright-red, but on the west side of the river the sandstone only is visible. All the beds rise to the north, the red beds forming the summits of the cliffs in that direction.

In passing up Fontanelle Creek to the westward, the heavy beds of buff sandstone gradually descend, and the white shales come into view. I examined the former for lignite and coal, but found none. There are several thin beds of a tough carbonaceous material in the white shales, (which I take to be of the Green River epoch.) In the lower strata, in this locality as well as on the east side of Green River, above the mouth of Labarge Creek, are numerous remains of fishes similar to those of Green River City, with insects and their larvæ, shells like *Pupa*

* See Hayden's Annual Report, 1870; Marsh, American Journal of Science and Arts, March, 1871.

and *Cyrena*, and millions of *Cypris*. The larvæ are dipterous, some nearly an inch long, and others minute, and in prodigious numbers. With them are found stems of plants, but no leaves. These beds rise with a very gently dip, and twenty miles from the mouth of the creek terminate against steeply-inclined strata of earlier age. At this point the lower beds exhibit the bright-red colors that are so often seen in the lower parts of the formation at other points. The uplifted beds form a ridge of high hills having a north by east and south by west trend, through which the Fontanelle cuts its way in a deep cañon. This range is monoclinal, the strata dipping 45° east, and their outcrop on the summit and eastern face. The first bed which forms the surface of the incline is rather thin, and is composed of a reddish quartzite without fossils, no doubt of Cretaceous age. Below it is a stratum of highly fossiliferous bluish limestone of Jurassic age, containing *Pentacrinus asteriscus*, M. and H.; *Trigonia*, &c. Below this a reddish sandstone presented a similar thickness, which may represent the Trias, which rests on a bluish-shale formation. We have now reached the base of the western side of the hills; from their summit we have had a beautiful and interesting view of geological structure. The valley, of three or four miles in width, is bounded on the west side by a range of low mountains, whose summits are well-timbered. The valley is excavated at an acute angle to the strike of the strata, so that as far as the eye can reach to north and south successive hog-backs issue *en échelon* from the western side, and run diagonally, striking the eastern side many miles to the southward. At the cañon of the Fontanelle, six of these hog-backs occupy the valley, and the number varies as we proceed down the valley. The structure changes from the same cause as we explore in either direction. The dip of all these hog-back strata is to the west and slightly north, less steep at the eastern side, but reaching 45° and a still higher angle at the middle and west side of the valley. There appears to be an anticlinal near the base of the eastern range, which has been deeply excavated; from its western slope (in the valley) the upper beds, even in the eastern range, have been carried away, leaving only probable Triassic and Carboniferous strata exposed. In one of these latter I found a well-marked horizon of carbonaceous shales extending as far as I explored them. Toward the western side of the valley, the descending strata are sandstones, but whether identical with that of the eastern hills of Cretaceous age I could not ascertain. Lower down the valley (to the south) similar beds form a high vertical wall of very light color, the scenery resembling that of the Garden of the Gods in Colorado. I suspect that the existence of more than one fold can be demonstrated in these hog-backs and mountains.

The result which bears on the history of the Bear River group is, that on this side of the Green River basin the Bitter Creek epoch is either wanting or represented by a thin layer of red quartzite, (or perhaps Cretaceous No. 1,) and that no coal of Cretaceous age exists along its western rim. After following the valley to Ham's Fork River, and proceeding a short distance along it toward the southeast, I crossed a thin bed of coal in the upturned edges of the same beds crossed in the valley above. The discovery of the extension of the fish and insect beds sixty miles north of the principal localities is a point of interest in Tertiary geology.

The Ham's Fork Mountains form the divide between the waters of Green and Bear Rivers respectively, and are passed by the Union Pacific Railroad at and west of Aspen station, as is described by Dr. Hayden, (Annual Report for 1870, p. 149.) He here points out that the distinctness of the two basins was marked during the Tertiary period, and hence names the deposits of the western area the Wahsatch group, regarding it at the same time as synchronous with those of the Green River epoch. The writer has attained the same opinion on paleontological grounds, and has hence employed the same name for both areas, namely, the Green River epoch.*

As already stated,† the upper or red-banded Tertiary beds of this locality yielded the following species:

Perissodactyle bones, two species.
Orotherium vasacciense.
Crocodilus, sp.
Alligator heterodon.
Trionyx scutumantiquum.
Emys testudineus.
  gravis.
Clastes (?) *glaber.*
Unio, two species.

The lower sandstone beds yielded the following mammals:

Bathmodon radians.
  semicinctus.
  latipes.
Orotherium index.‡
Phenacodus primævus.

West of the contact of Bear River with the Tertiary bluffs, the strata consist of sandstone and conglomerates, and dip at about 30° to the northeast. Five hundred feet vertically below the *Bathmodon* bed, a stratum of impure limestone crops out, forming the slope and apex of a portion of the bluff. In this I found the following vertebrates:

Reptiles:	*Trionyx scutumantiquum.*	Fishes:	*Rhineastes calvus.*
	Emys ? euthnetus.		*Clastes glaber.*

In comparing this list with that given for the lower beds of the Green River epoch, where they overlie the Bitter Creek coal, such resemblance may be observed as is sufficient to indentify the two series.

This is the nearest to a determination of the age of the Evanston coal-bed, which Hayden regards as the most important west of the Missouri River, that I have been able to reach. From the limestone just described to the coal-bed, two miles to the west, the strata are very similar in character, and apparently conformable, so that they appear to belong to the same series. Dr. Hayden confesses his inability to correlate them with those of Bear River City and Weber River, but discovered remains of plants which were identified with some of those known to occur in the Fort Union beds, on the Laramie Plains, and the Upper Missouri. If this be the case to a sufficient extent, the Evanston coal must be referred to that division of the Cretaceous period. This conclusion is, however, only provisional, and Dr. Bannister's remarks* are much to the point. He says, "In the upper beds northeast of Evanston," (the ones I describe above,) "there seems to have been a considerable disturbance besides the mere tilting of the beds, and from the altered direction of the strike § we were led to suspect considerable lateral dis-

* Proceedings Acad. of Nat. Sciences, 1872, p. 279.
† Proceedings American Philosophical Society, 1872, p. 473.
‡ Cope, Paleontological Bulletin, No. 17, 1873.
§ Hayden's Annual Report, 1872, p. 541.

placement with faulting, which might very possibly cause the appearance of the same beds both here and at the coal-mines, although at first sight these would appear much higher in geological position. * * * I do not know the grounds of Professor Cope's reference of the coal at this point to the Cretaceous, while he admits the Tertiary age at least of some of the overlying sandstones; but as we found no break nor line of demarkation in the whole 2,000 feet or more which we examined, and found our fossils in coal-bearing beds immediately above and conformable to the main coal, the facts, so far as they are known to me, do not seem sufficient for such identification."* This point offers, therefore, a more complete continuity in stratification and mineral character from the Cretaceous to Tertiary deposits than any other which I have had the opportunity of examining.

CONCLUSION.†

Having traced the transition-series of the coal-bearing formations of the Rocky Mountain region from the lowest marine to the highest fresh-water epochs, it remains to indicate conclusions. I have alluded but cursorily to the opinions of Mr. Lesquereux and Dr. Newberry as based upon the study of the extinct flora. They have, as is well known, pronounced this whole series of formations as of Tertiary age, and some of the beds to be as high as Miocene. The material on which this determination is based is abundant, and the latter must be accepted as demonstrated beyond all doubt. I regard the evidence derived from the mollusks in the lower beds and the vertebrates in the higher as equally conclusive that the beds are of Cretaceous age. There is, then, no alternative but to accept the result *that a Tertiary flora was contemporaneous with a Cretaceous fauna,*‡ *establishing an uninterrupted succession of life* across what is generally regarded as one of the greatest breaks in geologic time. The appearance of mammalia and sudden disappearance of the large Mesozoic types of reptiles may be regarded as *evidence of migration, and not of creation.* It is to be remembered that the smaller types of lizards and tortoises continue, like the crocodiles, from Mesozoic to Tertiary time without extraordinary modification of structure. It is the *Dinosauria* which disappeared from the land, driven out or killed by the more active and intelligent mammal. Herbivorous reptiles like *Agathaumas* and *Cionodon* would have little chance of successful competition with beasts like the well-armed *Bathmodon* and *Metalophodon.* There is good reason for believing that this incursion of mammalia came from the south.

It then appears that the transition-series of Hayden is such not only in name but in fact, and that paleontology confirms, in a highly satisfactory manner, his conclusion, "already shown many times, that there is no real physical break in the deposition of the sediments between the well-marked Cretaceous and Tertiary groups." §

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* Hayden's Annual Report, 1872, p. 541.

† See Bulletin U. S. Geol. Survey Terrs., No. 2, p. 16.

‡ The circumstance of the discovery of a mesozoic dinosaur, *Agathaumas sylvestris,* with the cavities of and between his bones stuffed full of leaves of Eocene plants, (Lesquereux,) would prove this proposition to be true, had no other fossils of either kind ever been discovered elsewhere.

§ Annual report, 1870, p. 166. For instance, Geol. Surv. Colorado, 1869, p. 197, Dr. Hayden observes, "There is no proof, so far as I have observed in all the Western country, of true non-conformity between the Cretaceous and Lower Tertiary beds, and no evidence of any change in sediments or any catastrophe sufficient to account for the sudden and apparently complete destruction of organic life at the close of the Cretaceous period."

Since the above was written, a paper * by Prof. J. S. Newberry has appeared, in which he gives full expression of his views as to the ages of the different extinct floras of the West. He points out clearly that the flora of the Fort Union beds is part of that which is extensively distributed over the northern hemisphere, and which is believed to characterize the Miocene period in Europe. He states that characteristic structural parallelism between American and European plants does not obtain in the preceding periods of the Eocene and Cretaceous, and that the flora found in the lower part of our Cretaceous formations, as determined by animal remains, is "somewhat more closely allied to the Tertiary flora than are the plants found in the Cretaceous of Europe." He does not make any botanical determination of the age of the fossil plants of the Bitter Creek series, nor of the lignite beds of Colorado. He, however, objects to regarding any of the floras found below the Fort Union formation as Tertiary in the following language, (p. 402:) "The lignites and plant-beds of New Mexico, which I have called Cretaceous, but which are referred by Mr. Lesquereux to the Tertiary, are, for the most part, derived from the lower portions of our Cretaceous series, and are overlaid by many hundred feet of strata unquestionably Cretaceous, in which all the typical forms of Cretaceous *animal life* are abundantly represented. Whether the great lignite deposits of Colorado should be considered Tertiary or Cretaceous, it is perhaps not yet possible to decide; but in the absence of any distinctive or unmistakable Eocene plants, if the strata which contain them shall be found to include vertebrates or mollusks which have a decidedly Mesozoic character, we shall be compelled to include them in the Cretaceous system. Mr. Lesquereux has met the statements of Professors Meek, Cope, and Marsh by pointing to his two hundred and fifty species of fossil plants, claiming that they far outweigh the testimony of the animal remains. In fact, however, these fossil plants have very little bearing on the question. They are probably all distinct from European Cretaceous and Eocene species, and the genera to which they are supposed to belong afford only negative evidence of the strata that contain them."

Thus it is evident that Professor Newberry appeals to the evidence furnished by the animal remains as basis of determination of the epochal type of the contemporary vegetable life. In further illustration of his view he says, (p. 404:) "Whatever plants are found with *Zeuglodon cetoides*, *Cardita planicosta*, *Orbitoides mantellii*, &c., we must accept as Eocene, even should they have no intrinsic Eocene characteristic. So in regard to our Cretaceous flora. While it is altogether new, its varied character and *modern aspect* simply give us a new revelation in regard to the vegetation of the Cretaceous world; for, while the fauna of that world contains *Ammonites*, *Baculites*, *Inoceramus*, &c., we are forced to call it Cretaceous."

It certainly appears to me to be introducing a new element into paleontological reasoning to estimate the age of one class of fossils by reference to the structural characters of another. Every flora and fauna, and every genus in them, offers its own intrinsic evidence as to age or relation to other genera of preceding, contemporary, and succeeding time; and all that we can affirm of the relations of the life of any given deposit or age are the sums or results of the various parts of such flora and fauna. In the present case, the evidence brought forward by Dr. Newberry from his own stand-point as a distinguished student of extinct vegetation, and upon which I necessarily rely, is: (1.) That the floras of the

* American Journal of Science and Arts, 1874, p. 399.

European Eocene and Cretaceous are not represented on this continent so far as known. (2.) That the flora found below the remains of a Cretaceous fauna more nearly resembles the Tertiary flora than it does that of the European Cretaceous. (3.) That the flora of the Fort Union beds is undoubtedly Miocene.

These facts are confirmatory of my previous conclusion, "that a Tertiary flora was contemporary with a Cretaceous fauna in the transition-period of the Rocky Mountains." If a flora below the Cretaceous of New Mexico resembles a Tertiary one, how much more probable is it that the floras of the Lignites of Colorado and Wyoming are such, as they are known to be of later age than those of New Mexico, and to be at the summit of the Cretaceous series, as indicated by animal remains. And if the flora of the Fort Union beds be Miocene, that of the identical horizon in Colorado must be Miocene also; and if the vegetation below this flora be so distinct from it, what is more probable, according to the evidence adduced by Dr. Newberry, than that they are Eocene, as maintained by Mr. Lesquereux? That such should be the case is in harmoney rather than in conflict with the facts presented by the existing life of the earth, where we have the modern fauna of the northern hemisphere contemporary with a partly Eocene and partly Mesozoic fauna in the southern.

Prof. J. W. Dawson, in his late interesting annual address before the Natural History Society of Montreal, thus comments on the above conclusion.* He says that the mixture of Mesozoic animals with Tertiary plants "depends on the general law that in times of continental elevation newer productions of the land are mixed with more antique inhabitants of the sea." * * "Thus it must have happened that the marine Cretaceous animals disappeared first from the high lands and lingered longest in the valleys, while the life of the Tertiary came on first in the hills, and was more tardily introduced on the plains." Were the Mesozoic reptiles of the Fort Union and Bitter Creek beds marine or even aquatic in their character, their co-existence with a Tertiary flora would, indeed, be quite explicable on Professor Dawson's view. But they are in the most important and diagnostic species—the *Dinosauria*—terrestrial in their habits, and in several cases vegetable feeders, browsing on the very foliage in which their bones were found enwrapped.

SECTION II.—THE VERTEBRATA OF THE FORT UNION CRETACEOUS OF COLORADO.

DINOSAURIA.

AGATHAUMAS, Cope.

Proceedings of the American Philosophical Society, 1872, p. 482.

The characters of this genus are derived from the typical species *A. sylvestris*, which is represented by dorsal and lumbar vertebræ, and an entire sacrum, with the ilia—one nearly entire—ribs, and a number of bones, the character of which has not yet been positively ascertained. One of these resembles the proximal part of the pubis; others, portions of the sternum, &c.

On eight, and perhaps nine, vertebræ anterior to the sacrum, there is no indication of the capitular articular face for the rib. This facet is found, as in *Crocodilia*, at or near the base of the elongate diapophyses. The centra are slightly concave posteriorly, and still less so on the anterior face, with gently convex margins. The neural canal is very small,

* May, 1874, p. 9.

and the neural arch short and quite distinct from the centrum, having scarcely any suture. The neural arch has a subcubical form, partly truncated above by the anterior zygapophyses. In like manner, the bases of the combined neural spine and diapophyses are truncate below by the square-cut posterior zygapophyses. The diapophyses are long and directed upward; they are triangular in section.

There are eight, and perhaps nine, sacral vertebræ, which exhibit a considerable diminution in the diameter of the centra. The diapophyses and neural arches are shared by two centra; the anterior part of the latter bearing the larger portion of both. The diapophyses are united distally in pairs, each pair inclosing a large foramen; the anterior is the most massive; rest on the ilium; the posterior pair the most expanded; the superior margins of its posterior edge form an open V, with the apex forward on the neural arch of the fifth vertebra. On the last sacrals, the diapophyses rise to the neural arch again. The exits of the sacral spinal nerves are behind the middles of the centra, and continue into grooves of the sides in all but the last vertebræ. The reduced and rather elongate form of the last sacral vertebræ induces me to believe that this animal did not possess such large and short caudal vertebræ as are found in the genus *Hadrosaurus*, and that the tail was a less massive organ.

The ilium is much more elongate than the corresponding element in *Hadrosaurus*, *Cetiosaurus*, or *Megalosaurus*. Its upper edge is turned and thickened inward above the anterior margin of the acetabulum, and here the middle of the conjoined diapophyses of the second and third sacral vertebræ was applied when in place. In front of this point, the ilium is produced in a straight line, in a stout, flattened form, with obtuse end. Posterior to it, its inner face is concave, to receive the second transverse rest of the sacrum, and the superior margin is produced horizontally toward the median line like the corresponding bone in a bird. The posterior part of the bone is the widest, for it is expanded into a thin plate and produced to a considerable length. From one of the margins, (my sketch made on the ground represents it as the upper,) a cylindric rod is produced still farther backward. The base of the ischium is co-ossified with the ilium, and is separated from the iliac portion of the acetabulum. There is no facet nor suture for the pubis at the front of the acetabulum. The ribs are compressed. There are no bones certainly referable to the ;imbs. The form of the ilia distinguishes this genus from those known heretofore. It is also highly probable that it differs from some other genera, in which the ilium is not known, *e. g.*, *Thespesius*, in the smaller and differently formed tail.

AGATHAUMAS SYLVESTRIS, Cope, Proceed. American Philos. Soc., 1872, 482.

The last nine dorsal vertebræ have rather short centra, the most posterior the shortest. They are higher than wide; the sides are concave; the inferior face somewhat flattened. The neural arch is keeled behind from the canal to between the posterior zygapophyses, and a similar keel extends from the base of the neural spine to between the anterior zygapophyses. The neural spine is elevated, broad, and compressed; the diapophysis is convex above and concave along the two inferior faces, most so on the posterior. The articular face of the first sacral vertebra is wider than deep. The eight sacral vertebræ are flattened below in all except the first by a plane, which is separated from the sides by a longitudinal angle. The neural spines of the anterior five sacral vertebræ are mere tuberosities. A large sutural surface for attachment of a transverse process is seen in the posterior third of the eighth sacral vertebra, which descends nearly as low as the plane of the inferior surface. On the tenth sacral, there is no such process, but its neural arch and that of the ninth support transverse processes. These are more like those of the dorsals in having three strong basal supporting ribs, the anterior and posterior extending for some distance along the arch.

Whether naturally or in consequence of distortion, the plate of the ilium is at a strong angle to the vertical axis of the acetabulum; and at the posterior part of it, the margin of the plate is free on the outside as well as the inside of the femoral articulation.

Measurements.

	M.
Length of nine posterior dorsal vertebræ	.880
Length of nine sacral vertebræ, (36$\frac{5}{8}$ inches)	.930
Length of right ilium, (two pieces, 0.84 +0.22, 41 inches)	1.060
Length of eighth dorsal from sacrum	.090
Length of base of neurapophysis	.085
Depth of articular face	.153
Width of articular face	.123
Length of second from sacrum	.070
Depth of articular face	.155
Width of articular face	.137
Elevation of neural canal	.045
Width of neural canal	.028
Elevation to face of zygapophysis	.104
Elevation to base of neural spine	.150
Length of diapophysis from lower base	.200
Length from capitular articulation	.125
Antero-posterior width above	.050
Antero-posterior base of neural spine	.075
Antero-posterior width at zygapophysis	.070
Length of neural spine, (fragment)	.208
Width of centrum of first sacral	.160
Depth of centrum of first sacral, (to neurapophysis)	.140
Length of centrum of first sacral	.105
Length of centrum of seventh sacral	.100
Depth of centrum of seventh sacral, (behind)	.080
Width of centrum of seventh sacral, (behind)	.103
Expanse of second sacral transverse support, (22 inches)	.560
Length of ilium anterior to acetabulum	.470
Length of acetabulum	.200
Length of posterior to acetabulum	.390
Width of ilium at anterior extremity	.140
Width of ilium at front of acetabulum	.210
Width of ilium at posterior expansion	.250
Thickness above acetabulum	.060
Width of acetabulum	.100
Width of basis of ischium	.085
Width of shaft of a rib	.062

Other bones not yet determined will be included in the description in the final report.

This species was no doubt equal in dimensions to the largest known terrestrial saurians or mammals.

HADROSAURUS, Leidy.

[Cretaceous Reptiles of the United States, 1865, 76; Proceedings of the Academy of Natural Sciences, Philadelphia, 1856, 218.]

HADROSAURUS OCCIDENTALIS, Cope, Extinct Batrachia, &c., p. 98; *Thespesius occidentalis*, Leidy, Proceedings of the Academy, Philadelphia, 1856, 311; Transactions of the American Philosophical Society, 1860, 151.

From the lowest member of the lignite formation at Grand River, Nebraska.

Referred, by Professor Leidy, to a distinct genus under the name of *Thespesius*, on account of the slightly opisthocœlian character of the large caudal vertebra. Teeth unknown.

Fragments of a large dinosaur from Colorado were found associated with species of tortoises identical with those found in Dakota in the horizon which contains the *H. occidentalis*, (see under head of *Cionodon arctatus*,) and may possibly belong to it. I have no identical parts in the two for comparison.

Char. specif.—The largest fragment of a long bone is probably from the proximal end of the tibia; it includes the curved inner border of the side, and the inner posterior tuberosity, with five inches of the inner head side of the shaft. The superficial layer is marked with numerous closely-placed longitudinal grooves, which are replaced by a few coarser and deeper ones, which interrupt the angle with the articular surface, giving it a lobate margin. There was probably a prominent cnemial crest. Another fragment exhibits one flat plane and a concave posterior face. It comes from near the extremity of the humerus or the femur; it was found near the fragment of the tibia. The sacral vertebra is probably that of an animal not fully grown, as it was not co-ossified with those adjacent. The articular extremities are expanded, and present distinct faces for articulation for the large diapophyses. The one extremity is more expanded and less thickened; the other more thickened and less dilated; on this rests the greater part of the base of the neural arch. Just at the extremity of this base, the large sacral nervous foramen issues, which is continued in a wide groove downward between the transverse expansions. Inferior surface convex. As compared with the fourth sacral vertebra of *Agathaumas sylvestris*, Cope, which it nearly resembles in size, it is to be observed that the anterior extremity is less expanded transversely as compared with the posterior; that the bases of support for the anterior diapophyses are not produced downward so far; that the sides of the centrum are nearly vertical and not sloping obliquely toward the middle line; and that there is no inferior plane separated from the lateral by a longitudinal angle as in *A. sylvestris*. It differs in like manner from the third and second sacral vertebræ, and still more from the first of the latter saurian.

Measurements.

		M.
Length of centrum of fourth sacral vertebra		.092
Transverse diameter	in front	.103
	at middle	.072
	posteriorly	.121
Vertical diameter posteriorly		.092
Diameter of head of tibia antero-posteriorly		.250

CIONODON, Cope.

Bulletin of the United States Geological Survey of the Territories, 1874, 10.*

Remains of species of *Dinosauria* were obtained at two localities in Colorado not many miles apart—the greater number at one of them, from which also all the crocodilian and turtle remains were derived. Those from the other deposit consist of portions of limb-bones apparently of a single individual of gigantic size. The more abundant fragments are referable to three species. A fragment of limb-bone is very similar to portions from the other locality, and associated is a sacral vertebra of appropriate size and characters. All of these were therefore referred

* Where the proof-reader made it *Cinodon*.

provisionally to a single species under the name of *Agathaumas milo*, but are here described under *Hadrosaurus occidentalis*. The remaining specimens fall into two series. In the one, the bones are occupied by a heavy mineral and the surfaces covered by a white layer, which is marked by irregular ridges, as though produced by deposit along the lines of small adherent foreign bodies. In the other set, the bones are lighter, more spongy, and not covered with the white layer; some of them are stained by the sesquioxide of iron. Both present vertebræ and limb-bones, which are related appropriately as to size and structure; that is, the larger limb-bones have the same mineral character as the larger vertebræ, and the smaller as the smaller. These limb-bones represent corresponding parts in the two, and, differing widely, confirm the belief in the existence of two species indicated by the different types of vertebræ. In these fossils, then, I see evidence for the existence of two species of two genera, which I name, the larger *Polyonax mortuarius*, the smaller *Cionodon arctatus*. Both genera present a solid cancellous filling of femora, tibiæ, and other long bones, and hence differ from such genera as *Hadrosaurus*, *Hypsibema*, *Lælaps*, and others. *Cionodon* differs in dentition from all *Dinosauria* where that part of the structure is known, but it remains to compare *Polyonax* with *Troödon* and *Palæoscincus* of Leidy, which are known from the teeth only, while no portions of dentition are preserved with the specimens at my disposal.

Char. gen.—Established primarily on a portion of the right maxillary bone, with numerous teeth in place. The posterior portion exhibits a suture, probably for union with the palatine bone, while the rest of the interior margin is free. It is removed some distance from the tooth-line in consequence of the horizontal expanse of the bone, while the outer face is vertical.

The teeth are rod-like, the upper portion subcylindric in section, with the inner face flattened from apex to base, while the lower half is flattened externally by an abrupt excavation to the middle for the accommodation of the crown of the successional tooth. The inner face of the tooth, from apex to base, is shielded by a plate of enamel, which is somewhat elevated at the margins, and supports a keel in the middle, thus giving rise to two shallow longitudinal troughs. The remainder of the tooth is covered with a layer of some dense substance, possibly cementum, which overlaps the vanishing margins of the enamel. The outer inferior excavation of the shaft presents a median longitudinal groove, to accommodate the keel of the closely-appressed crown of the successional tooth. The apex of the tooth being obtusely wedge-shaped, the functional tooth is pushed downward and transversely toward the inner side of the jaw. The tooth slides downward in a closely-fitting vertical groove of the outer alveolar wall. The inner wall is oblique, its section forming, with that of the outer, a V; it is furrowed with grooves similar and opposite to those of the outer wall, but entirely disconnected from them. The base of the shank of the functional tooth, on being displaced by the successional, slides downward and inward along the groove of the inner side, each lateral movement being accompanied by a corresponding protrusion. At the most, three teeth form a transverse line, namely, one new apex external, one half-worn crown median, and the stump or basis of a shank on the inner. The new crowns are, however, protruded successively in series of three, in the longitudinal direction also. Thus, when an apex is freshly protruded, the shank in front of it is a little more prominent, and the third stands beyond the alveolar border. As each shank increases somewhat in diameter downward in the *C. arctatus*, the section increases in size with protrusion; hence, before the appearance of a new crown outside of it, there are but two new functional teeth in a cross-row. Thus, in the outer longitudinal row, only every third tooth is in functional use at one time; in the middle series, all are in use; while in the inner, every third one is simultaneously thrown out in the form of a minute stump of the shank, if not entirely ground up.

The dorsal vertebræ are opisthocœlian, the anterior more compressed than the posterior; capitular articular faces, if existing, are slightly marked. The zygapophyses are but little prominent beyond the arch. A caudal vertebra is plano-concave, with rather depressed centrum, a little longer than broad. The condyles of the femur have a short arc and chord; the head of the tibia displays a large cnemial crest, but is not emarginate behind.

The type of dentition exhibited by this genus is perhaps the most complex known among reptiles, and is well adapted for the comminution of vegetable food. While the mechanical effect is quite similar to that obtained by the structure of the molars of ruminating mammals, the mode of construction is entirely altered by the materials at hand. Thus, the peculiarly simple form and rapid replacement of the reptilian dentition is, by a system of complication by repetition of parts, made to subserve an end identical with that secured by duplication of the crown of the more specialized molar of the mammal.

Cionodon is evidently allied to *Hadrosaurus*, but displays greater dental complication. In that genus, according to Leidy, the successional crowns appear on the *front* side of the shank of the tooth, not behind, and below the base of the enamel area, so that the tooth is distinguished into crown and shaft. It also follows from this arrangement that the successional tooth does not appear until its predecessor has been worn to the root, in which case there can be only one functional tooth in a transverse direction instead of two or three.

CIONODON ARCTATUS, Cope, Bulletin, *loc. cit.*, 10.

Char. specif.—The enamel-plate of the tooth extends from apex to near the base of the shaft. Its margins are thickened and without serration, while the surface generally is nearly smooth. The dense layer over the remainder of the tooth is much roughened by a great number of short, serrate, and somewhat irregular longitudinal ridges.

Measurements.

	M.
Width of alveolar groove	.0120
Length of a triad of teeth on alveolus	.0140
Length of an unworn tooth	.0250
Diameter of surface of attrition of a tooth of the middle row, (longitudinal)	.0063
Diameter of surface of attrition of a tooth of the middle row, (transverse)	.0072
Width of maxillary bone	.0350
Depth of maxillary at inner margin	.0140

What I suppose to be the posterior end of the maxillary bone exhibits the grooves to near its apex, as well as a considerable surface of articulation for the malar.

Two dorsal vertebræ are preserved, whose neural arches are co-ossified, with trace of suture remaining. Both articular faces exhibit a transverse fossa for ligamentous or bursary attachment. Round these, on the convex face, there are transverse rugosities, while oblique-ridged lines descend on each side from the floor of the neural canal. The centra are shorter than deep, and subquadrate in a horizontal section. The sides are concave; the anterior are compressed with lenticular vertical section, with angle below. The more posterior is less compressed, and the surface is smooth; in the anterior, it is thrown into weak longitudinal ridges near the edges of the articular extremities. There are large nutritious foramina on the sides. The neurapophyses are excavated vertically on their posterior edges. Neural arch on the anterior dorsal, a broad, vertical oval. A caudal vertebra is rather elongate and depressed; as it has no diapophysis, it is not from the anterior part of the series. There is no prominent lateral angle, but the two inferior angles connecting the chevron facets are well marked; neurapophysis only measuring half the length of the centrum. The articular faces exhibit the same transverse fossa as is seen in the dorsals; the anterior is plane, the posterior uniformly concave.

Measurements.

	M.
Anterior dorsal, length of centrum	.074
Anterior elevation of articular face	.073
Anterior width of articular face	.070
Anterior vertical diameter of neural canal	.027
Anterior elevation of anterior zygapophyses	.122
Middle dorsal, length of centrum	.068
Middle elevation of articular face	.085
Middle width of articular face	.080
Middle caudal, length of centrum	.062
Middle elevation of articular face, (at canal)	.047
Middle width of articular face	.068
Middle width between inferior angles	.024
Middle width of neural canal	.013

The femur is only represented by the distal end, with the condyles perfectly preserved. The latter form a single trochlear surface, whose borders form arcs of circles. It is slightly hour-glass-shaped, chiefly by excavation of the posterior face, which is, however, shallow; the deep fossæ seen in *Hadrosaurus* and other genera being absent. The area of the articular cartilage is clearly marked out, and the dense surface of the shaft is marked with delicate striæ, which terminate at the edge of the former. One side of the end of the bone is nearly plane, the other is longitudinally excavated; some shallow grooves furrow the angle with the trochlear face. The section of the shaft, three inches from the end, is a wide, transverse parallelogram. This bone looks no little like the distal end of a metapodial bone, but there are various reasons why it is more probably femur or humerus. The form of the tibia especially determines it to be the former element.

The head and distal end of the tibia, with six inches of the shaft, are preserved. The former relates with the end of the femur, resembling it both in size, simplicity of contour, and details of surface. The form is crescentoid, one horn being the cnemial crest, the other posterior and replaced by a short truncation. The inner (convex) face is rendered angular by a median tuberosity, and all round this margin shallow grooves cut the solid angle at irregular distances. The articular face displays the smooth area, and the shaft the delicate striæ, seen in the femur. The distal end is unsymmetrically lenticular in section, one side being more convex; the articular face is rugose, showing a fixed ligamentous articulation for the astragalus. The convex face of the shaft is coarsely striate-grooved near the extremity; on the other side, the intervening ridges are represented by exostoses or rugosities. The flatter side becomes the more convex on the lower part of the shaft.

Measurements.

		M.
Transverse diameter of condyles of femur		.082
Transverse diameter of shaft of femur		.053
Diameter fore and aft	of middle of condyles	.054
	of side of condyles	.069
	of shaft	.038
Diameter of head of tibia	greatest	.102
	fore and aft	.096
	transverse	.060
Diameter of shaft of tibia proximally	transverse	.050
	fore and aft	.045
Diameter of distal end of tibia	transversely	.115
	fore and aft	.060

Remarks.—If the bones above described as pertaining to the hind limb are really such, they are smaller as compared with the dorsal vertebræ than in *Hadrosaurus foulkei*, and indicate an animal the size of a horse.

POLYONAX, Cope.

Char. gen.—A species considerably larger than the last, represented by vertebræ and numerous fragments of limb-bones. The most characteristic of the former are two probably from the posterior dorsal region, which are somewhat distorted by pressure. The more anterior is shorter than the other, and exhibits both articular faces slightly concave, the one more so than the other. They are higher than wide, and the border is scolloped above for the capitular articulation for the rib. There are numerous nutritious foramina, and some ligamentous pits on the articular surfaces. The inferior face is rounded. In the longer vertebra, both faces are more strongly concave, and at each end of the lower side there is an obtuse hypopophysial tuberosity. The sides of the centra of both vertebræ are concave. The neural canals are relatively small, and the neurapophyses co-ossified. A third vertebra without arches is similar in specific gravity, though without the white surface-layer of the others. It is appropriate in size and form to this species, and is peculiar in its flat form, resembling the anterior dorsals of the *Hadrosaurus*. In this respect it is related to the shorter vertebra of the two above described as the latter is to the longer. The surface of the posterior articular face is damaged; it was not concave, and is now slightly convex; the anterior is preserved, and is concave.

POLYONAX MORTUARIUS, Cope.

The articular faces are deeper than wide in the vertebræ; the sides are smooth; the lower faces narrowed and probably keeled.

Measurements.

	M.
Anterior dorsal, length of centrum	.048
Anterior dorsal, elevation to neural canal	.094
Anterior dorsal, width	.094
Median dorsal, length of centrum	.057
Median dorsal, elevation to neural canal	.117
Median dorsal, width	.083
Posterior dorsal, length of centrum	.092
Posterior dorsal, elevation	.104
Posterior dorsal, width	.083
Posterior dorsal, diameter of neural canal	.015

The measurement of the neural canal is made near the base of the neurapophyses, and is probably a little affected by pressure.

The limb-bones embrace portions of tibia, fibula, and some others not yet determined. The portion of tibia is from the base of the cnemial crest, so that one extremity is trilobate, the other transverse oval. The former outline indicates two posterior tuberosities. The bone is solid, and the superficial layer, for three millimeters or less, is so dense and glistening as to resemble cementum. Portions referred to fibulæ have a subcrescentic section, with narrowed width in one direction. Two fragments of shafts of long bones I cannot determine either as belonging to the limbs or pelvis. They belong to opposite sides; each is oval in section, and the diameter regularly contracts to one end. One side is slightly convex in both directions; the other is less convex transversely, and gently convex longitudinally. A peculiarity consists of a central cavity present in both at the fractured large end, which is bordered by a layer of dense bone like the outside.

Measurements.

	M.
Transverse diameter of tibia fragment below cnemial crest	.125
Antero-posterior diameter of tibia fragment at base of crest	.095
Width of fragment of fibula	.073
Thickness of fragment of fibula	.035
Length of fragment of unknown bone	.145
Proximal diameter of unknown bone	.088
Distal diameter of unknown bone	.065

The above measurements indicate a larger animal than the *Cionodon arctatus*, and one not very different in size from the *Lælaps aquilunguis.*

CROCODILIA.

BOTTOSAURUS, Agass.

Cope, Proceed. Amer. Philos. Soc., 1871, 48.

BOTTOSAURUS PERRUGOSUS, sp. nov.

Represented by numerous fragments, with vertebræ and portions of skull which accompanied the dinosaurian and turtle remains from Eastern Colorado, already alluded to.

A portion of the left dentary bone containing alveoli for ten teeth shows that this species is not a gavial. The dental series passes in a curve from the inner to the outer sides of the bones, one or two alveoli behind being probably bounded on the inner side by the splenial only, as in *B. macrorhynchus*, when that bone is in place. The dentary is compressed at this point; in front it is depressed. There is a slight difference in the sizes of the alveoli, but not such as is usual in Tertiary crocodiles. The external face of the bone exhibits deep pits in longitudinal lines. The angle of the mandible is depressed; the cotylus of articulation is partially concealed on the outer side by the elevation of the surangular, whose upper border is parallel with the inferior margin of the ramus for two inches to where it is broken off. The outer face of this region is marked by irregular coarse ridges more or less inosculating, separated by deep pits. The lower posterior half of the angular bone is smooth.

A posterior dorsal or lumbar vertebra has a depressed cordate articular cup. The zygapophyses are large and widely spread, and strengthened by obtuse ridges running from the base of the neural spine to the posterior margin of the anterior and the posterior outer angle of the posterior. One pit at basis of neural spine in front; two before. Ball prominent; sides of centrum concave.

Measurements.

	M.
Length of fragment of ramus	.100
Width in front	.034
Depth behind	.032
Length of eight alveoli	.069
Diameter of largest alveolus	.012
Diameter of smallest	.007
Width of base of angle of ramus	.048
Depth at surangular	.034
Length of centrum of vertebra	.045
Width of articular cup	.031
Vertical diameter of cup	.025
Vertical diameter of neural arch	.011
Expanse of anterior zygapophyses	.056

The specimen is adult, and indicates an animal about the size of the alligator of the Southern States. Its reference to the present genus is provisional only.

TESTUDINATA.

TRIONYX, Geoffr.

TRIONYX VAGANS, sp. nov.; *Trionyx? foveatus*, Leidy; Proceed. Acad. Nat. Sci. Philadelphia, 1856, 312.

Represented by a number of fragments of costal bones and perhaps of sternals also. The former are rather light or thin for their width, and are marked with a honey-comb pattern of sculpture, in which the ridges are thin and much narrower than the intervening pits. They incline to longitudinal confluence at and near the lateral sutures. Several areæ are not infrequently confluent in a transverse direction near the middle of the bone.

Measurements.

	M.
Width of costal bone	.0370
Thickness of costal bone	.0045

Four and five areæ in $0^{m}.010$.

This species differs from the *T. foveatus*, Leidy, in the much narrower interareolar ridges, and larger areæ, and in their longitudinal confluence at the margins, characters exhibited by numerous specimens.

Lignite Cretaceous of Colorado; near the mouth of the Big Horn River, Montana; Long Lake, Nebraska; found at the last two localities by Dr. Hayden.

PLASTOMENUS, Cope.

Annual Report U. S. Geol. Survey, 1872, 617.

PLASTOMENUS (?) PUNCTULATUS, sp. nov.

Established on a costal bone found in association with the preceding species, and referred to the genus *Plastomenus* provisionally, and with a probability that it will be found not to pertain to it when fully known. That genus has so far only been found in the Eocene formation. The bone is rather thin and sufficiently curved to indicate a convex carapace of moderate thickness. The surface is marked with closely-packed shallow pits without material variation of form on the proximal half of the bone. The result is an obsolete sculpture quite similar to that seen in some species of the genus to which it is at present referred.

Measurements.

	M.
Width of costal bone	.0230
Thickness of costal bone	.0033

Number of pits in $0^m.010$, 6.

Lignite Cretaceous of Colorado; also several fragments from Long Lake, Nebraska, from Dr. Hayden.

PLASTOMENUS (?) INSIGNIS, sp. nov.

Represented by a portion of the right hyposternal bone of a tortoise about the size of the last species, and from the same locality. The specimen resembles in its sculpture such species as the *Plastomenus trionychoides*, and in structural character the species of *Anostira*, but it is scarcely probable that it belongs to either genus. It is flat, and has a narrow, straight, inguinal margin at right angles to the fine suture with the hyosternal. The suture with the postabdomial is partially gomphosial. Surface dense, polished, marked externally with a reticulate sculpture of narrow ridges separating larger and smaller areas wider than themselves. Marginal edge thinner.

Measurements.

	M.
Length of hyposternal fore and aft	.025
Thickness of hyposternal at front	.004

Pits in $0^m.010$, 6.

Lignite Cretaceous of Colorado.

ADOCUS, Cope.

Proceedings Academy of Natural Sciences, Philadelphia, 1868, 235; Proceedings American Philosophical Society, 1870, November.

ADOCUS (?) LINEOLATUS, sp. nov.

Established on a number of fragments from different exposures of the lignite beds—primarily on a vertebral and sternal bone from the same locality as the preceding specimen. As the diagnostic portions of this specimen are wanting, it is referred to this genus provisionally, and because the structure and sculpture of the parts resemble most nearly known species of it from the Cretaceous greensand of New Jersey.

The sternal bone is flat, and presents the wide and transverse sutures forming the usual right angle, and of a rather coarse character of a medium serrate keel, with pits on each side for the reception of corresponding ribs. The vertebral bone is rather thick, and is shallowly emarginate in front. The sculpture consists of delicate, obscure, parallel lines, which are more or less interrupted and occasionally joined, so as to inclose faintly-marked areolæ.

Measurements.

	M.
Width of vertebral bone in front	.0135
Greatest of vertebral bone	.0280
Thickness of vertebral bone	.0070
Thickness of sternal bone	.0080

From lignite of Colorado, and mouth of Big Horn River, Montana.

COMPSEMYS, Leidy.

COMPSEMYS VICTUS, Leidy, Proceedings Academy Natural Sciences, Philadelphia, 1856, 312.

Lignite of Long Lake, Nebraska; Cretaceous of Colorado.

APPENDIX.

Descriptions of new mollusks from Cretaceous beds of Colorado, by T. A. Conrad.

I add here some determinations, by T. A. Conrad, of mollusks of Cretaceous age obtained near Denver and in the South Park.

HELICOCERAS, d'Orb.

H. VESPERTINUS.—Sinistral, gradually tapering; ribs prominent, often placed irregularly as regards distance from each other, gradually thickening toward the back, which has two rows of tubercles; back flattened on the large part of the shell, and gradually rounding on the smaller.

Locality.—Seven miles south-southeast of Fairplay.

In the small specimen of rock containing this fossil are two specimens of the same and two of *Ptychoceras.*

ANCHURA, Conrad.

A. BELLA.—Subfusiform; spire elevated; volutions convex, with oblique, subacute, curved, longitudinal ribs, crossed by regular, fine striæ; suture deeply impressed; last volution with two distant, angular, revolving ridges, the upper one largest and extending to the end of the projecting lip; above this angle, the ribs are less prominent and distinct than on the spine, and disappear at the lower revolving angle; lip upturned toward the extremity and acute at the end; lower margin entire; beak short, narrow, acute.

MEEKIA, Gabb.

M. BULLATA.—Subglobose, inequilateral; anterior side short, compressed, acute at the end; summits very prominent; umbo inflated. This smooth little species is proportionally much shorter and the umbones more inflated than in *M. sella*, Gabb. The anterior side is shorter and more acute.

Locality.—Trout Creek, near Fairplay.

PTYCHOCERAS, d'Orb.

P. ARATUS.—Larger branch having prominent, slightly oblique, subundulated, compressed ribs, subacute on the margin; body slightly swelling on the back toward the base, where the ribs become fine and close; smaller branch ribbed obliquely in a downward direction.

Locality.—Trout Creek, near Fairplay.

There are two rows of very small tubercles on the flattened back of this species.

HAPLOSCAPHIDÆ.

The genus *Haploscapha*, described in a former volume of these reports, is not, as I thought at the time, a member of the family *Rudistæ*, but probably belongs to no recognized family. I have every reason to believe that *Inoceramus involutus*, Sowerby, is a species of this or a nearly allied genus. It has the singular character of being very thin on the disk and gradually thickening to the margin, in which it agrees with the American shells, and also in the character of the dorsal margin, which appears to be rolled over. This rolling-over, however, does not exhibit the hinge-character, which has no resemblance whatever to that of *Inoceramus*, and the ridged surface at the top of the hinge is on the outside of the valve, as represented in Sowerby's figure, Table 583, Fig. 2. The typical specimen of one valve of the genus has a broad or thick tooth near the anterior margin, and a thick, rounded ridge forming the rest of the hinge. These singular shells were developed in the Upper Chalk of England and America, and, like the *Rudistæ*, came suddenly and disappeared forever with the last deposit of chalk.

H. CAPAX.—Left valve inflated, subrotund, incurved toward the ventral margin; undulations or concentric ridges profound, distant, extending to the posterior hinge-margin, though becoming almost obsolete very near the margin; interstices regularly and strongly striated. Length and height equal, five inches. Found by Dr. Leconte near Denver. *Inoceramus*, Fig. 2, Frémont's expedition represents, I think, this species.

CHAPTER III.

THE EOCENE PERIOD.

A few species from beds of this period were obtained in Wyoming and Colorado, of which the following are new to science.

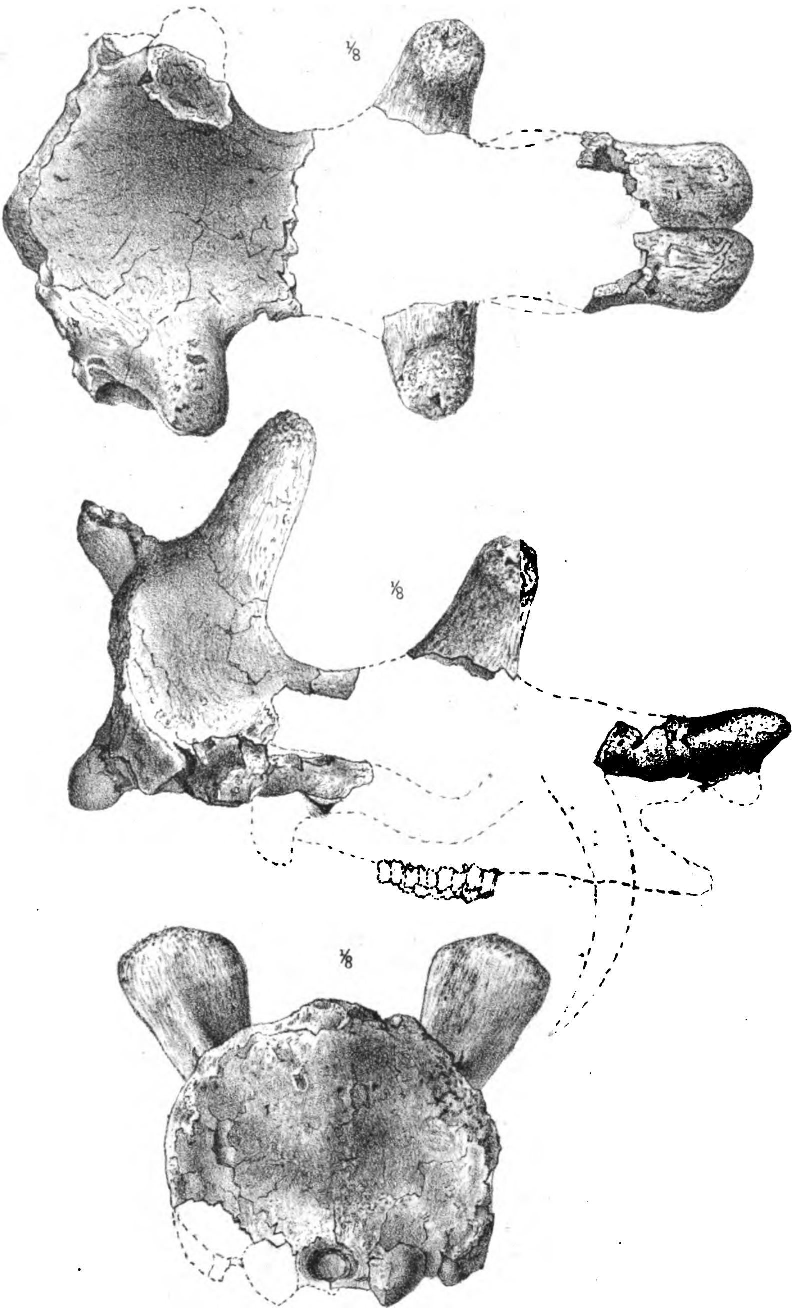
MAMMALIA.

EOBASILEUS, Cope.

EOBASILEUS GALEATUS, sp. nov.

Represented by the greater portion of a cranium of an individual of the size of the *Loxolophodon cornutus*. It possesses a greatly-elevated occipital crest, whose superior border presents a median angle upward. A short distance in front of it, and connected by a very stout, lateral ridge, there arises, on each side, a large, erect horn-core. The base is very massive, subquadrate in section, and flattened in front. Posteriorly, it presents a very shallow groove, which is bounded on the outside by a low ridge. The shaft expands gradually, and is proportionally flattened from behind forward. The posterior face is flat; the anterior gently convex. The extremity is transverse-convex, and pitted for cartilaginous or corneous attachment. These horns stand on the parietal bones. The frontals extend to their bases, and send a laminar expansion backward to the margins of the lateral and posterior crests, covering the parietal in the fundus of the basin, which the former inclose.*

* Marsh originally stated that these horn-cores in *Uintatherium mirabile* stand on the frontal; but later, that it was doubtful whether the frontal supported horns.



Thos Sinclair & Son lith. Phila

LOXOLOPHODON GALEATUS COPE.

The median horns are very stout, and are connected with the posterior by an acute supratemporal ridge. Their inner face is composed to near the apex of the nasal bones. Where they terminate, the apex contracts, and is composed of a cylindric production from the maxillary. The section of these cores at the middle is subquadrangular, and longitudinally oval at the base.

The extremity of the nasal bones is small and contracted, and is extensively overhung by the cornice-like, flat cores above them. Thus the end of the snout has a bilobate outline when viewed from above.

The occipital face is concave in vertical section and presents a V-shaped depression, with the angle downward, and a low ridge on the middle line to the transverse superior border.

Measurements.

	M.
Width of the foramen magnum and occipital condyles	0.2100
Elevation of occiput, (8 inches)	.2500
Width of basin between lateral crests	.3250
Height of posterior horn-core, (7 inches)	.2300
Width, base of posterior horn-core antero-posteriorly	.1300
Width, base of posterior horn-core transversely	.0900
Width at summit	.1230
Height of median horn-core	.1750
Diameter of base antero-posteriorly	.1060
Diameter of base transversely	.0800
Diameter of summit	.0650
Projection of nasal cornices beyond apex	.0630
Length of posterior molar, crown	.0450
Width of posterior molar, crown	.0550

This species is equal in size to the largest known from the Bridger formation. It differs from *E.* (*Loxolophodon*) *cornutus* in the posteriorly-truncate base of the posterior horn-cores, the quadrate instead of triangular section, and the stoutness of the median cores, and extent of their inner face covered by the nasal bones. It more nearly resembles the *E. pressicornis*, Cope, and may possibly prove to represent an old male of that animal. There is, however, a considerable disparity in their sizes; the horns differ in the greater stoutness, having twice the diameter, with little greater height. They differ also in form, in the abrupt contraction just below the apex. The cornice-like cores of the nasal bones represent the tubercles of the *E. pressicornis*. The posterior horns differ in many ways from those of the *E. furcatus*, and are alone sufficient to indicate a different species.

From the bad lands of South Bitter Creek.

ACHÆNODON, Cope.

Paleontological Bulletin, No. 17, p. 2.

ACHÆNODON INSOLENS, gen. et sp. nov.

Char. gen.—Dentition of mandible, In., 3; C., 1; P. m., 3 (?4); M., 3; forming an uninterrupted series throughout. Molars consisting of two pairs of obtuse tubercles, those of each pair fused transversely by a lower yoke; last molar with a large posterior fifth tubercle; last premolar enlarged, and with a posterior heel; penultimate with a simple conic crown and two roots. It is uncertain whether one or two teeth intervene between this one and the canine. The alveoli are round, and look as through designed for two single-rooted premolars.

This genus presents many points of resemblance to *Elotherium*, but the continuous dental series is characteristic of many genera of the Eocene. In the only known species, there are no osseous tuberosities on the rami. The symphyseal suture is persistent.

Char. specif.—Last premolar with longer basis than first molar; its posterior heel tubercularly plicate. The crown of the penultimate premolar is a slightly-compressed cone with elongate base, but little shorter than that of the first molar. Molars with smooth enamel; an anterior cingulum on the second and third; a small posterior median tubercle on the second molar; and a short cingulum, from the base of the posterior cone forward, on the third. Canines very large, suberect; enamel smooth. Ramus of mandible very stout.

Measurements.

	M.
Length of molar series	0.180
Diameter of canine tooth	.033
Length of premolars	.093
Length of premolars No. 3	.035
Length of molar No. 1	.024
Length of molar No. 2	.027
Width of molar No. 2	.022
Length of molar No. 3	.041
Width of molar No. 3	.024
Depth of ramus at molar No. 2	.073

This species betrays more of suilline character than any yet discovered in the Bridger series; but that it has any such affinity has yet to be shown. It was about as large as a fully-grown cow.

PHENACODUS, Cope.

Paleontological Bulletin, No. 17, p. 3.

PHENACODUS PRIMÆVUS, Cope.

Char. gen., as expressed by a posterior superior molar tooth. Crown transverse, a little narrower and more strongly convex at the inner than the outer extremity. It supports five rather low and obtuse tubercles, two exterior and three on the inner side. Outer tubercles well inside the outer margin of the crown; the one subtriangular in section; the other more nearly conical; the two connected by a low ridge, which incloses a concavity with the outer margin of the crown. Three inner tubercles, arranged on the segment of a circle, subequal; the lateral of one side connected with the exterior tubercle of the opposite side by a low ridge, which incloses a basin with the inner tubercles.

Char. specif.—Median of the three inner tubercles stouter than the others. No noticeable basal cingulum. Two compressed roots, with axes at right angles to each other, and very large pulp-cavities and thin walls.

Measurements.

	M.
Width of crown	0.0140
Length of crown	.0093
Elevation of outer cones above shoulder	.0050
Width between apices of outer cones	.0060
Width between apices of median cones	.0050

This tooth more nearly resembles the last tubercular molar of a canine carnivore than any other with which I can compare it, though it presents some differences. It would represent an animal rather larger than a wolf.

OROTHERIUM, Marsh.

Amer. Journ. Sci. Arts, 1872, p. 217.

OROTHERIUM INDEX, sp. nov.

Represented by both mandibular ramis, with many of the molars in good preservation. These number P. m., 3; M., 3. The last premolar is somewhat like the first molar, but has but one posterior tubercle, and adds a cingular projection in front of the anterior pair. The first premolar has two roots; the second is compressed and with a broad heel behind. In the molars, the anterior tubercles are connected by a cross-ridge; the posterior are a little more distinct from each other. The inner anterior tubercle is obtuse, but not bifid, and its base is connected with the apex of the posterior outer by a diagonal ridge. There is a small median posterior tubercle on the M. 2, and a large heel on the last molar. It supports a conic tubercle, which is connected by sharp ridges with the tubercles preceding it. There is a cingulum on the outer face of the true molars, which does not extend on the base of the tubercle of the posterior pair.

Measurements.

	M.
Length of molar series	0.0350
Length of first premolar	.0032
Length of third premolar	.0055
Width of third premolar	.0040
Length of second molar	.0065
Width of second molar	.0045
Length of last molar	.0098
Depth of ramus at first premolar	.0021
Depth of ramus at second molar	.0023

PISCES.

RHINEASTES, Cope.

Hayden's Annual Report, 1872, p. 638.

RHINEASTES PECTINATUS, Cope, Bullet. U. S. Geol. Surv., No. 2, 1874, p. 49.

This catfish is represented by a single specimen, which includes only the inferior view of the head and body anterior to the ventral fins. These exhibit characters similar in many respects to those of *Amiurus*, Raf., but the interoperculum, the only lateral cranial bone visible, displays the dermo-ossified or sculptured surface of the Eocene genus, to which I now refer it. Other characters are those of the same genus. Thus, the teeth are brush-like, and there is an inferior limb of the post-temporal bone, reaching the basi-occipital. The modified vertebral mass is deeply grooved below, and gives off the enlarged diapophysis that extends outward and forward to the upper extremity of the clavicle. The patches of teeth on the premaxillary are separated by a slight notch at the middle of the front margin The teeth are minute. The four basihyals and the elongate anterior axial hyal are distinct; also, the ceratohyal with its interlocking median suture. The number of branchiostegal radii is not determinable; three large ones are visible. The mutual sutures of the clavicles and coracoids are interlocking, and their inferior surface displays grooves extending from the notches. The pectoral spine is rather small, and bears a row of recurved hooks on its posterior face; there are none on the anterior face.

The head is broad, short, and rounded in front, which, with the uncinate character of the serration of the pectoral spine, reminds one of the existing genus *Noturus*. As compared with the five species of *Rhineastes* described from the Bridger Eocene, the present species is distinguished by the small size and uncini of the pectoral spine.

Measurements.

	M.
Length of head to clavicle, (below)	0.018
Width of head, (below)	.036
Width of scapular arch, (below)	.011
Expanse modified diapophyses	.020
Length of modified vertebræ	.0115
Length of pectoral spine	.021

From the Tertiary shale of the South Park, Colorado.

AMYZON, Cope.

Hayden's Annual Report, 1872, p. 642.

AMYZON COMMUNE, Cope, Bullet. U. S. Geol. Survey, No. 2, 1874, p. 50.

In describing this species, the following additions to our knowledge of the generic characters may be made. There is an open fronto-parietal fontanelle; the premaxillary forms the entire superior arch of the mouth; the pharyngeal bones are expanded behind; there are 12–13 rays of the ventral fin; there is a lateral line of pores, which divides the scales it pierces to the margin.

The greatest depth of the body is just anterior to the dorsal fin, and enters the length 2.66 times to the base of the caudal fin, or a little more than three times, including the caudal fin. The length of the head enters the former distance a little over 3.25 times. The general form is thus stout and the head short; the front is gently convex and the mouth terminal. There are fifteen or sixteen rows of scales between the bases of the dorsal and ventral fins. They are marked by close concentric lines, which are interrupted by the radii, of which eight to fifteen cross them on the exposed surface, forming an elegant pattern. At the center of the scale, the interrupted lines inclose an areolation. The extended pectoral fin reaches the ventral, or nearly so; the latter originates beneath the anterior rays of the dorsal, or in some specimens a litttle behind that point. They do not reach the anal when appressed. The anal is rather short and has long anterior radii. The dorsal is elevated in front; the first ray is a little nearer the basis of the caudal fin than the end of the muzzle. Its median and posterior rays are much shortened; the latter are continued to near the base of the anal fin. Radii, D., 33; P., 14; V., 13; A., 12. The caudal is strongly emarginate, and displays equal lobes.

Measurements.

	M.
Length of a large specimen, (10.25 inches)	0.250
Length of a medium specimen	.182
Depth at occiput	.043
Depth at dorsal fin	.057
Depth at caudal peduncle	.023
Length of head, axial	.044
Length to D. 1, axial	.075
Length to end of dorsal, axial	.131
Length to basis of caudal fin	.146
Length of basis of anal fin	.023

There are thirty-eight or thirty-nine vertebræ, of which nine are anterior to the first interneural spine, and fourteen between that point and the first caudal vertebra.

A very large number of specimens was obtained by Dr. Hayden and myself from the Tertiary shales of the Middle and South Parks, Colorado. They display but insignificant variations in all respects, and furnish a good basis of determination. They all differ from the *A. mentale*, Cope, (Proceed. Amer. Philos. Soc., 1872, p. 481,) in the larger numbers of vertebræ and dorsal and anal fin radii, and greater prolongation of the dorsal fin. It is, however, nearly allied to the species of the Osino shales. The only fish found associated with this one is the small nematognath just described. The predominance of these types and exclusion of the brackish-water genera *Asineops*, *Erismatopterus*, and *Clupea*, so abundant in the shales of the Green River epoch, indicate a more lacustrine, and hence, perhaps, though not necessarily, later deposit.

CLUPEA, Linn.

CLUPEA THETA, Cope, Bullet. U. S. Geol. Surv., No. 2, 1874, p. 51.

Represented by a specimen from the Green River shales, near the mouth of Labarge Creek, in the upper valley of Green River. It is a larger species than the *C. pusilla*, Leidy, which is also found at the same locality, and has a much longer anal fin. Its radii number twenty-six, possibly a few more, as the end appears to have been injured. The dorsal fin is short; the last ray in advance of the line of the first of the anal. The body is deep. Number of vertebræ from the first interneural spine to the last interhæmal, twenty-nine. Depth at first dorsal ray, 0.0485; depth at last anal ray, 0.0170; length of twenty-nine vertebræ, 0.0780.

CHAPTER IV.

THE MIOCENE PERIOD.

The fauna of the White River epoch is well known to be entirely distinct from that which preceded it, which is preserved in the beds of the Bridger formation; no species or genus of mammal is common to the two, and but a proportion of the families. This difference is similar to that which distinguishes the Lower Eocene from the Miocene fauna of Europe. The parallelism of the Wyoming fauna with that of the Eocene of France and Switzerland is very full, although not without exceptions. Both are characterized by the absence of equine perissodactyles and ruminant artiodactyles, of *Elephantidæ*, *Rhinoceridæ*, and extreme poverty in feline and musteline, or the higher carnivora. Both are characterized by the presence of lemurs and generalized quadrumana, and by the great predominance of *Perissodactyla* allied to the tapirs. Parallel genera of the respective groups may be thus exhibited:

	WYOMING.	FRANCE.
Carnivora,	*Mesonyx.*	*Hyænodon.*
Quadrumana,	*Anaptomorphus.*	*Adapis.*
Perissodactyla,	*Palæosyops.*	*Palæotherium.*
	Hyrachyus.	*Lophiodon.*
	Hyopsodus.	*Hyracotherium.*
Artiodactyla,	*Achænodon.*	*Anthracotherium.*

The important differences are the presence of *Artiodactyla* with selenodont molar teeth in the French Eocene; I allude to the *Anoplotheriidæ* and *Hyopotamidæ*, which are entirely wanting in the Wyoming beds. On the part of the latter, the presence of the *Eobasiliidæ*, *Bathmodontidæ*, and *Anchippodontidæ* constitute a marked peculiarity. On the whole, the evidence is in favor of ascribing the priority of age to the Wyoming Eocene.

The appearance of selenodont artiodactyles, including great numbers of *Tragulidæ*, with horses and rhinoceroses in the White River beds, clearly mark the advent of the Miocene, while the presence of *Hyopotamus* and *Elotherium* indicate a nearer relation to the Lower than to the Upper Miocene of Europe. The family of *Oreodontidæ* is the peculiar feature which distinguishes the American from the European beds, while the latter contain numerous viverrine carnivora not known from America. The Loup Fork beds, from the greater proportion of existing genera which they contain, display a resemblance to the European Pliocene; but they differ strikingly in the greater number of horses and camels which they contain. The smaller percentage of existing genera in the Loup Fork beds, with the persistence of an oreodont, (*Merychyus*,) indicates that these also should be placed anterior to the Pliocene of France.

The species enumerated in the following pages are distributed in their orders as follows. I add a list of the species enumerated by Dr. Leidy, as occurring in the White River beds of Dakota and Nebraska, with the number common to them and the Colorado beds. I add also a column indicating the number not yet identified out of Colorado.

	Species above enumerated.	Species of Dakota, &c.	Species common to the two.	Species only known from Colorado.
Insectivora	11	2	0	11
Rodentia	10	5	4	6
Perissodactyla	16	6	4	11
Artiodactyla	10	20	4	6
Carnivora	10	8	3	7
Quadrumana	1	(?) 1	0	1
Testudinata	5	1	1	4
Lacertilia	8	0	0	8
Ophidia	5	0	0	5
Total	75	43	16	59

The difference between the Dakota and Colorado faunas is more apparent than real. The presence of numerous small reptiles and insectivorous and rodent mammals in the latter is chiefly due to local advantages for preservation and subsequent discovery. This is indicated partly by the fact that the more abundant rodents of Colorado are those which have been already discovered in Dakota. Other differences are not so readily accounted for. Thus, the poverty in species of *Oreodontidæ* in the midst of most abundant individual remains is a peculiarity of the Colorado formation, while the *Tragulidæ* of the latter are more abundant in both individuals and species than in the Dakota fauna. While there is but one species in the latter, there are five species of four genera in Colorado. The *Poëbrotherium*, rather rare in Dakota, is quite abundant in Colorado. On the other hand, no trace of the *Titanotherium* of the former has yet been announced from the latter locality, and it is probable, indeed, as remarked by Professor Marsh, that that genus is characteristic of another horizon of the Tertiary from the one under consideration. If, as I believe, the Colorado Miocene is the true White River epoch, then the *Titanotherium* is derived from another.* Comparatively few traces of the *Symborodons* have yet been brought from Dakota, but this may be due to the fragility of these fossils and local causes. The differences in the carnivora are not strikingly great; the only genus not in some degree representative in the two faunas being the *Bunælurus* of the present paper.

The most important result obtained by the expedition of 1873 was the discovery of an abundant fauna of *Lacertilia* and *Ophidia* and of the smaller mammalia of the insectivorous and rodent orders. A genus of supposed *Quadrumana* was discovered, and an elucidation of the structure of the genus of gigantic, horned perissodactyles, which I called *Symborodon*, was rendered possible by the large amount of material obtained. While the pre-eminently horned type of the present fauna is the order of *Ruminantia*, and it has been found that those of the Eocene period were an aberrant type of proboscidians, those of the Miocene are now shown to be perissodactyles.

The predecessors or ancestors of the hog, *Babirussa*, and similar existing animals, are being gradually brought to light by modern paleontological studies. One of those nearest the domesticated form has been found in the Miocene of France, and is referred to the genus *Palæochœrus*. It is also related to the peccaries, which appear to have existed during the same early period in North America in considerable abundance. Their existence in South America at the present time is one of many indications that that region has not advanced in respect to its fauna as rapidly as our own and the old continents. Another Miocene genus of hogs is the *Elotherium*, which has left remains in France and in North America. The common species of the Nebraska beds is the *E. mortonii* of Leidy, which was as large as a pig. Its front teeth are much developed at the expense of the hinder ones; and it had bony tuberosities on the under jaw in the positions now supporting wattles in the hog. I discovered during the past season much the largest species of *Elotherium* yet known. The skull was longer than that of the Indian rhinoceros, and the tuberosities of the lower jaw were greatly developed. The front pair formed divergent branches on the lower front of the chin, so that it appeared to bear a horn on each side, which the animal, doubtless, found useful in rooting in the earth. The species was semi-aquatic in its habits, like the *Hippopotamus* and *Dinotherium;* but while these are furnished with extraordinary developments of the lower incisor-teeth for tearing up their food, the *Elotherium ramosum* is the only animal known which possessed horns in the same position and for the same purpose.

A still older type of hogs—which may claim to be the predecessor in structure as well as in time of all known genera—is the *Achænodon*, Cope, from the Eocene of Wyoming, described a few pages back. The *A. insolens* was a powerful beast, larger than a boar, with a compara-

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* I formerly supposed, following Dr. Leidy, that *Titanotherium* is characteristic of the horizon of *Oreodon*, &c., and therefore quoted Professor Marsh as assigning a different age to the Colorado beds. On re-examination of his remarks, (Amer. Journ. Sci. Arts, 1870, p. 292,) while they bear this interpretation, I believe that he did not intend to make any direct assertion to this effect.

tively short head, and with the uninterrupted series of teeth which belongs to all the oldest forms of the mammals and to the higher quadrumana.

The early relations of the camels is a question, heretofore very obscure, which has been greatly elucidated by the researches in Colorado during the present season. These ruminants differ from all of their order of quadrupeds in having one incisor-tooth in the upper jaw on each side, and in a remarkable structure of the neck-vertebræ. In the latter, the artery that conveys blood to the brain in part occupies the vertebral canal with the nervous cord. In other ruminants, as in most mammalia, it is carried by the lateral process of the vertebræ in a tube at their bases.

Camels and llamas have a limited number of premolar teeth of the permanent series, and a larger number in the milk-series; the excess not being replaced when shed. They have, at a very early stage of development, indications of a full series of upper incisors, which are early absorbed. The extinct camels (*Procamelus*) of the latest of our Western Tertiary formations, supposed to be the Pliocene, have been shown by Leidy to retain, in their permanent dentition, the full number present in the milk-series, thus resembling the younger stage of the modern camels and llamas rather than the adult. I have also found that these early camels possessed a full development of the character seen in the fœtus of various ruminants. In this respect, the *Procamelus* resembled their still earlier predecessors. It is also evident that the change from *Procamelus* to *Camelus* may be explained by a process of retardation of the growth of the teeth.

The ruminants called *Tragulidæ* are now confined to the warm regions of Asia and Africa, but they were formerly widely distributed over the earth, especially during the Miocene period. They embraced then, as they do now, some of the smallest and most elegant of the cloven-footed *Ungulata*. In France, three genera have been discovered, which embrace numerous species. The most numerously-represented genus is the *Amphitragulus*. In North America, four genera have been found in corresponding formations, representing five species. Two of them belong to *Hypertragulus;* while *Hypisodus* includes the smallest of the known species, the *H. minimus*, Cope, which was not heavier than a cat-squirrel. In these musks, the first premolar teeth have a peculiar position, being more or less approximated to the incisor-teeth. The *Leptomeryx evansii*, Leidy, is a species of medium size, which has the permanent premolar teeth of the same form as the milk-premolars; while in *Hypertragulus*, the permanent premolars take on quite a different form, thus making a step in advance not attained by the former. It has been ascertained by me that *Poëbrotherium* has the peculiar neck-vertebræ that belong to the camels, and also similar resemblances in the forefoot, differing in both respects from *Tragulidæ*. Like the camels, it has only two toes, while *Tragulidæ* have four; but then it is like the latter in having these toes entirely separate, as in a hog, and not united into the common bone of ruminants. The conclusion is that *Poëbrotherium* is the prototype of the camels, and that it is near the common ancestor from which *Tragulidæ* seem to have branched off. This ancestor undoubtedly was nearly related to certain fossil ungulates found in the Eocene of France.

INSECTIVORA.

Numerous species of this order were discovered during the exploration of the Colorado Miocene. Two species only had been previously known in the formation, namely, the *Leptictis haydenii* and *Ictops dako-*

tensis of Leidy, from the bad lands of Dakota, obtained by Dr. Hayden in 1866. These species are allied to both the hedgehogs and the tenrecs of Madagascar, and represent the larger forms of the order. A third species of the same group was found by the writer, viz, the *Isacis caniculus*. But the greater number of species discovered are of smaller size, and belong to families of which no representatives had been previously known in the American Miocene. *Herpetotherium*, Cope, embracing the greatest number of species and individuals, is possibly a member of the *Talpidæ*, and presents affinities to the European genus *Talpa*, or the true moles. *Domnina*, Cope, and probably *Embassis*, Cope, present affinities to the *Soricidæ*, so far as known. As elsewhere, the species are most frequently represented by rami of the mandible, often with beautifully-preserved dentition; but portions of crania are occasionally found. Those of the latter in my possession are referable to three species. One of them fortunately supports both mandibular rami, and furnishes the entire dentition of the *Herpetotherium fugax*, the superior incisors only being wanting. Another consists of a very elongate and compressed muzzle, with which a cranium with base of muzzle may be associated. They are described provisionally under the head of *Domnina*.

The generic types differ as follows:

* Inferior molars (except rarely the posterior) similarly composed:

Herpetotherium, Cope. Dentition: I., $\frac{?}{4}$; C., $\frac{1}{1}$; P. m., $\frac{3}{3}$; M., $\frac{4}{4}$. Last inferior molars nearly similar to the others, which have the posterior pair of tubercles and the anterior one distinct; inferior canine large, followed immediately by premolars.

Embassis, Cope. Inferior molars without anterior cone; the anterior lobe elevated, triangular in section; posterior tubercles conic; last molar similar.

Domnina, Cope. Inferior molars three, with the outer posterior tubercle a crescent, like the outer anterior; the inner posterior a cone; anterior forming a sectorial edge with outer; last molar smaller, consisting of one crescent and a heel; molars increasing in size anteriorly with anterior cone.

** Inferior molars dissimilar, tubercular, and sectorial:

Isacis, Cope. Last three molars with cross-crests; the one preceding with an anterior conic cusp and two median ones, with a broad heel, which supports a cusp.

The total number of the species of *Insectivora* obtained by the expedition of 1873 is as follows, all of them being at the time new to science:

Herpetotherium, Cope	5
Embassis, Cope	2
Domnina, Cope	3
Isacis, Cope	1
	11

HERPETOTHERIUM, Cope.

Paleontological Bulletin, No. 16, 1873, p. 1.—Synopsis of New Vertebrata from the Tertiary of Colorado, p. 4.

This genus is more nearly allied to the existing genus *Talpa* of the Palearctic region than to any existing North American form, so far as dental characters are conclusive. The number of molar teeth is greater; thus $\frac{3\,4}{3\,4}$ in the extinct to $\frac{2\,2}{2\,2}$ in the recent genus.* If the inferior cani-

* The dental formula given for this genus (Synopsis New Vertebrata, &c., p. 4) embraces the figures, incisors $\frac{8}{4}$. This is a typographical error for $\frac{?}{4}$. I did not have opportunity of reading the proofs.

niform tooth be regarded with F. Cuvier as a premolar, the numbers of the latter teeth must be read in these genera $\frac{3}{4}$ and $\frac{4}{4}$ respectively. Since it is situated in advance of the foramen mentale and closes in front of the superior canine, it is probably not a premolar, but a true canine, and the number of inferior incisors is correctly stated as four on each side. In the typical species, *H. fugax*, the superior molars are composed of two external triangles, and an internal cingulum-like cresent, near the base of the crown; last molar with only one external triangle; premolars compressed, simple; canines large, simple, subvertical; inferior incisors slender.

The homologies of the cusps of the upper molars appear to be that the apices of the external triangles represent a median series of cusps, while the longitudinal ridge forming their bases represents the cusps of the external row. When in an unworn state, their apices are probably more distinct. At present, in the typical specimen, the ridge is not less elevated than the apices of the triangles. This genus differs from the *Talpidæ* and resembles the *Isacidæ* in the fact that the cusps of the premolars are homologous with the external one of the true molars, and not with those of the median series, as in the former family. But it agrees with the *Talpidæ* in the presence of two triangles and a well-developed internal lobe. All of the teeth, and especially the canines, are more robust than in *Talpa* and *Scalops*.

The known species differ as follows:

I. Anterior cusp of molars well separated; several molars with three cusps on the heel:
  Size, medium .... *H. tricuspis.*
  Size, very small .... *H. huntii.*

II. Anterior cusp well separated; heel (except of the last) with two cusps:
  Heel of M. 4 narrow; middle cusps moderate:
    Very small .... *H. stevensonii.*
    Large .... *H. fugax.*
  Heel of M. 4 narrow; middle cusps elevated much above heel:
    Medium .... *H. scalare.*

HERPETOTHERIUM TRICUSPIS, Cope., Synopsis New Vertebrata Col., 1873, (October 16,) p. 5.

Represented by portions of five mandibular rami. Posterior tubercle low, on the inner side, visible in all the molars. A hiatus between the first and second premolars; foramina below P. m. 1 and M. 1; canine well developed.

Measurements.

	M.
Length of dental series from canine, omitting M. 4	0.0110
Length of first true molar	.0020
Elevation of first true molar	.0018
Depth of ramus at third true molar	.0027

HERPETOTHERIUM HUNTII, Cope, Synopsis, loc. cit., p. 5.

The least species of the genus, represented by portions of three mandibular rami with all of the molar teeth.

All the cusps low, the median unequal, the anterior and posterior divergent, the latter concealed by the former when in place, although well developed. Foramina below P. m. 2 and M. 1.

Measurements.

	M.
Length of dental series, omitting canine and P. m. 1	0.0072
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

Dedicated to my friend Prof. T. Sterry Hunt, of Boston.

HERPETOTHERIUM STEVENSONII, Cope, Synopsis, loc. cit., p. 6.

A very small species. Median cusps of molars unequal; the external much elevated, and separated by a deep notch from the anterior. Heel of M. 4 contracted.

Measurements.

	M.
Length of last two molars	0.0029
Length of third true molar	.0015
Elevation of third true molar	.0012
Depth of ramus at third true molar	.0020

Abundant. Dedicated to my friend James Stevenson, of the United States Geological Survey, the discoverer of the deposit from which the fossils here described were procured.

HERPETOTHERIUM FUGAX, Cope, Paleontological Bulletin, No. 16, p. 1; Synopsis New Vert. Colorado, p. 6.

Cranium wide; interorbital region flat; muzzle narrowed, but still wide and plane above. Mandibular rami long and slender; mental foramina below the first premolar and the first molar. The *foramen infraorbitale anterius* is situated above the third premolar. There is a short diastema behind the first premolar in both jaws. There are rudimental basal tubercles fore and aft on the second superior premolar. The superior canine issues a short distance behind the maxillo-premaxillary suture. In the inferior molars, all of the five cusps are distinct to the base, except the median pair, which are connected by a deeply-notched yoke. Enamel smooth; no cingula. The nasal bones are expanded behind and their posterior suture is medially emarginate.

Measurements.

	M.
Width of cranium at front orbit	0.0160
Width of muzzle at canines	.0050
Length of bases of crowns of four true molars of upper jaw	.0070
Length of bases of five inferior molars	.0100
Length of basis of crown of last molar	.0020
Length of basis of crown of penultimate molar	.0020
Height of crown of penultimate molar	.0017
Depth of jaw at penultimate molar	.0036

Established on jaws of many individuals and a nearly complete cranium. These indicate a species of about the size of our common *Scalops aquaticus*.

HERPETOTHERIUM SCALARE, Cope, Synopsis, Vert. Col., 1873, p. 7.

Readily distinguished by the increased disparity in the elevations of the anterior and posterior portions of the molar teeth, resembling in this respect the *Embassis 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.

Measurements.

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

EMBASSIS, Cope.

Synopsis New Vertebrata Colorado, 1873, p. 4.

This genus was instituted to receive a single species supposed to be allied to those of the preceding genus. Its prominent character consists in the development of the anterior three cusps at the expense of the posterior two; the former forming a trihedral mass, to which the latter form but a basal appendage. In the typical species, the last inferior molar exhibits the same reduction in size seen in *Domnina*, and, as I find that a second species agrees with it in all important respects, characters derived from it induce me to refer *Embassis* to a nearer relation with that genus than I have heretofore indicated. This I formerly described as *Herpetotherium marginale*, but it evidently pertains to a distinct genus, characterized by the presence of only three true molars of the inferior series. These present the general characters of those of *Embassis alternans*, and, like it, differ from those of *Domnina gradata* in having the outer posterior cusp a cone instead of a crescent. The last premolar is composed of two conic cusps, the inner the smaller, and separated from the outer by a deep notch. The other premolars are wanting in the specimen; but the characters observed indicate affinity with the *Soricidæ* rather than the *Talpidæ*, and probably a smaller number of teeth than in *Herpetotherium.*

EMBASSIS ALTERNANS, Cope, Synopsis, Vert. Colorado, 1873, p. 7.

Heel of molars with two low tubercles; the last tooth smaller than the penultimate. An antero-external cingulum.

Measurements.

	M.
Length of two last molars	0.0038
Length of third molar	.0020
Elevation of third molar	.0018

EMBASSIS MARGINALIS, Cope. *Herpetotherium marginale*, Cope, *loc. cit.*, 1873, p. 6.

Anterior cusp close-pressed to the median pair, and united with them above the base, forming a triquetrous mass elevated above the heel. The cusps of the heel two, more than usually elevated, and acute. A cingulum descending from the anterior and posterior cusps to the base of the median on the outer side. Only two cusps on the heel of the last molar. Cusps of the last premolar acute, smooth, and recurved.

This species is about as large as the *Domnina gradata*, but differs from it in many respects besides those already noted. The first true molar, though larger than the third, is not so much so as in the *D. gradata;* the anterior crescents are less open, the heel more contracted, &c.

Measurements.

	M.
Length of last three molars	0.0052
Length of third true molar	.0024
Elevation of third true molar	.0018
Depth of ramus at third true molar	.0023

Two specimens.

DOMNINA, Cope.

Paleontological Bulletin, No. 16, (August 20, 1873,) p. 1.—Synopsis Vertebrata Colorado p. 4, (?); *Miothen*, Cope, *loc. cit.*, pp. 4–8.

Three true molars, the last reduced in size; first molar large, with the *foramen mentale posterius* below it, and a small alveolus for the root of a premolar in front of it. In front of this a considerable alveolus-like cavity rises toward the border, but is interrupted by fracture. These characters are derived from the specimen of *D. gradata*. In *D. crassigenis*, the last molar is still more reduced. In none of the species is the premolar series preserved.

Portions of two crania already mentioned are described here provisionally and without final reference. The form is narrower across the frontal region than in *Herpetotherium fugax* and plane above. The muzzle is abruptly contracted at the base, and maintains a narrow, compressed form to the end; the nasal bones are convex in section, and narrow to their posterior extremity. There are three premaxillary teeth on each side, the anterior of which is enlarged and directed downward and a little forward; base of crown an antero-posterior oval; of last, round. The numbers of molars and premolars is probably 3–3; but the alveoli of the last true molars are obscured, so as to leave some slight question as to the presence or absence of a fourth. The first "premolar" is in the position of the canine of *Herpetotherium*, and probably represents that tooth, as there is no caniniform tooth in the present species. It is two-rooted, compressed, and with triangular profile. It is both preceded and followed by a short diastema. The other premolars are two-rooted.

Measurements.

	M.
Length of premolar series of No. 1	0.0054
Length to M. 1 of No. 1	.0090
Width at P. m. 2 of No. 1	.0027

DOMNINA GRADATA, Cope, *loc. cit.*, p. 1.

Crowns of the molars composed of two rows of alternating tubercles, with an odd one in front. The inner tubercles are much the more elevated, and form the apices of V's, of which the inner commence the limbs.

Three rows of acute tubercles on the inner, two on the outer side of each dental crown, the last pair of the last crown fused into a heel; the middle outer and anterior inner forming together a notched, sectorial yoke. A low cingulum on outer, none on inner basis of tooth-crown; enamel smooth.

Measurements.

	M.
Length of basis of three molars	0.0055
Length of basis of first molar	.0023
Length of basis of last molar	.0015
Depth of ramus at first molar	.0026
Width of first molar	.0015

As compared with the *Herpetotherium fugax*, this species has a shallower mandibular bone and a larger anterior true molar. The sectorial character of the oblique yoke connecting the anterior inner and outer tubercles and the crescentic character of the posterior outer are not nearly so well marked in the *H. fugax*.

One specimen.

DOMNINA CRASSIGENIS, Cope. *Miothen crassigenis*, Synopsis New Vertebrata Colorado, p. 8.

This species is less robust than the last, and the last molar still more reduced. The cusps of the latter, though not well pronounced in the specimens, are homologous with those in *D. gradata*.

Represented by two imperfect mandibular rami, with the posterior molars preserved. Last molar longitudinal and diamoned-shaped, half the size of the penultimate. The latter composed of two exterior crescents; the cusps of the inner side worn down in both specimens, if they have existed. Ramus of the mandible deep.

Measurements.

	M.
Length of last two molars	0.0022
Length of third molar	.0018
Depth of ramus at third molar	.0030

DOMNINA GRACILIS, Cope. *Miothen gracile*, Cope, Synopsis Vert. Col., 1873, p. 8.

This species is quite distinct from those that precede, and may, in future, require the use of the generic name I formerly applied to it. It is represented by a portion of a mandibular ramus, which is of slender proportions. The posterior external cusps have the crescentic form characteristic of this genus.

Last molar nearly as large as penultimate, with a low cusp at each extremity and an emarginate cross-crest at the middle. Penultimate molar with three inner cusps and two outer crescents. Ramus of mandible slender.

Measurements.

	M.
Length of last two molars	0.0025
Length of penultimate molar	.0012
Elevation of penultimate molar	.0009
Depth of ramus at penultimate molar	.0021

ISACIS, Cope.

Paleontological Bulletin, (August, 1873,) No. 16, p. 3.—Bulletin U. S. Geol. Survey Terrs., No. 1, 1874, p. 23.

This genus embraces at present but a single species, which is known from numerous specimens discovered by the writer in the Miocene formation of Colorado. From these it appears that *Isacis* is closely allied to the *Leptictis* and *Ictops* of Leidy, occupying a position between them 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 *Isacis*, 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 generally 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 sectorial 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.

Portions of the *cranium* preserved present general characters of *Leptictis*. There is a strong postglenoid process giving support to a thin zygomatic process. Behind the base of the latter, the squamosal is pierced by three large foramina, the inferior bounded by a ridge above and one below. The mastoid and paramastoid processes are rudimental, and the occiput is transverse and bounded by a well-marked inion. The petrous bone is large, and there is space for a large bulla, but its existence is uncertain. There is a longitudinal crest directed forward and inward in advance of the postglenoid process, which is probably in line with the external pterygoid ala.

The *cervical vertebræ* are short and transverse, and have well-developed laterial 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 obtuse *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 neurapophysis is almost entirely occupied by the basis 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 clavicles, and are of considerable size. 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 large deltoid crest rises as high as the head parallel to it. Distally, the condyles are continuous, nearly concave, and supplemented by a huge inner and a smaller outer tuberosity. 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 wanting, but were clearly attached at the extremity of the hemispheres. 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.

In determining the affinities of this and the two allied genera already named, it is first necessary to ascertain the homologies of the cusps of the molar teeth. *Insectivora* and some genera of *Marsupialia* are characterized by the presence of three longitudinal series of tubercles on the molar teeth. With the exception of the posterior molars of some *Carnivora*, the arrangement usual among *Mammalia* is in two longitudinal series, with frequently but two in each row. In most *Insectivora*, the cusp or cusps of the median series are the most prominent, and those of the outer series sometimes entirely wanting. Hence, Mivart* homologizes the middle pair with those of the external series of the other *Mammalia*, the inner with the internal, and the outer are regarded as representing cusps of a basal cingulum. Now, in the *Isacidæ*, (including *Leptictis* and *Ictops*,) the external cusps very are largely developed; there is one well-developed median and a rudimental internal cusp. Are the external cusps only cingular, or homologous with those that occupy the same position in other *Mammalia*; and what are their relations to the corresponding ones of the premolars?

In the true molars of the opossum and tubercular molars of the dog, there are three rows of tubercles. In both, it is evident that the two of the outer series correspond with the outer tubercles of the teeth which precede them in the jaw, and in which the inner tubercles are reduced in size and number. This is notably clear in comparison with the sectorial molar of the dog. It might, however, be asserted that the single outer tubercle of the last premolar in *Isacis* (and *Leptictis*) is homologous with that of the middle series of the true molars instead of the outer, and some color is given to this view from the internal position of the last premolar in *Leptictis*, so that its outer cusps range with the median of the true molars. This opinion is, however, readily corrected by a consideration of the arrangement in *Ictops dakotensis*,† where the last premolar exhibits both the median and internal cusps, so that the homology of the outer pair with those of the true molars is assured.

In *Didelphys*, in passing to the anterior molar, where the three series of cusps are not well defined, we observe that it is the middle tubercles are the ones which disappear, the internal remaining. In the same manner, in tracing the series of forms from the horse to the tapir, we find the cusps of the middle series disappear, leaving the internal and external to represent those of the original quadritubercular molar. In *Ictops* and probably *Isacis*, the median cusp is preserved at the interval of the last premolar. The case is quite different in *Talpa* and *Scalops*, where it is evident that, as we advance along the dental series forward, the cusps of the outer row disappear, and the external ones remaining represent those of the middle series of the true molars. As already indicated, the arrangement in *Herpetotherium* is as in *Isacis*, and the premolars have, therefore, an entirely distinct structure from that observed in the *Talpidæ*.

From the above considerations, it appears that the external, often minute, cusps of the teeth of *Insectivora* are the homologues of those of

* See his valuable Memoir on Osteology of Insectivora, Journ. Anatomy and Physiology, vol. ii, p. 138.

† See Leidy's Extinct Fauna of Dakota and Nebraska, p. 351, Pl. xxvi, Fig. 29.

true external series, and do not represent merely a cingulum. Comparisons of the molars of the extinct and recent forms are thus facilitated.

In *Chrysochloris* and *Centetes*, according to Mivart, the external cusps are wanting. In the genera in which they are present, as *Tupaia*, *Talpa*, *Sorex*, &c., there are two of the middle series, as in *Herpetotherium*, and these add a strong internal lobe also. In *Erinaceus*, they are quadrituberculate; but which pair represents the median, I am not yet sure. The closest approximation is made by the genera *Potamogale* 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 *Isacis* thus resemble most closely those of *Solenodon*, (Brandt,) but the external cusps are more developed than in that genus. If, as is probable, the superior molars of *Erinaceus* possess only the outer and median pairs of tubercles, a resemblance between the two may be traced; the existing genus differing from *Isacis* in its two median cusps. The single one of *Isacis* is connected with the external ones by oblique ridges, as in *Erinaceus;* and on one of these is a rudimental tubercle, representing the second median cusp.

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 *Potamogalidæ*. Both of these lack the zygoma, which is present in *Isacidæ*, and have the nasals co-ossified, while they are distinct in these Tertiary forms; *Potamogale* 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.

Thus the affinities of *Isacis* are quite complex, and abundantly indicate its position and that of the two allied genera to be in a family distinct from any now in existence.

ISACIS CANICULUS, Cope, *loc. citat.*

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 basi-occipital is three-keeled below, and the petrous bone with a longitudinal concavity below. 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

Size of a skunk.

RODENTIA.

Species of this order are numerous in the Tertiary of Colorado, and the individuals were more abundant than those of any other type of mammalia. Hundreds of specimens of some of the species were found, which range from the size of a marmot to even less than the domestic mouse. The relationships of these are as follows:

Muridæ:	
Eumys, Leidy	1
Sciuridæ:	
Sciurus, Linn	1
Gymnoptychus, Cope	2
Incertæ sedis:	
Heliscomys, Cope	1
Ischyromys, Leidy	1
Leporidæ:	
Palæolagus, Leidy	4
	10

EUMYS, Leidy.

Mus (*Eumys*), Leidy.

The single species embraced in this genus is nearly allied in dental and the known portions of its cranial characters to those of the existing genus *Mus*. The only distinctive feature which I can discover is that the supraorbital ridges rise from the lachrymal bones, and unite, forming a median keel between the orbits as in the *Fiber*. Whether it is found in any of the numerous existing species of *Mus*, I cannot state; but the frontis plane and the superciliary ridges are well separated in *Mus decumanus*. The *foramen infraorbitale anterius* is much as in *Mus decumanus*, being large and continued into a fissure below. The dentition is also similar, including the composition of the molars. These support two rows of obtuse tubercles, the number increasing with the size of the teeth from behind forward. Formula: I., $\frac{1}{1}$; C., $\frac{0}{0}$; M., $\frac{3}{3}$.

EUMYS ELEGANS, Leidy, Ext. Fauna Dakota and Nebraska, p. 342, Pl. xxvi, Figs. 12–13.

This species is exceedingly abundant in the Colorado Miocene, and many specimens were obtained. These display considerable variation in size and robustness; some, perhaps males, having the muzzles stouter in proportion to the length than others; some more decurved than others.

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

HELISCOMYS, Cope.

Synopsis New Vert. Colorado, 1873, p. 3.

Char. gen.—Inferior molars four; the crowns supporting four isolated cones in pairs. This genus is only known from mandibular rami. These resemble in their dental structure some of the *Muridæ*, but the number of molars is more, as in *Sciuridæ*. In *Myops*, Leidy, of the Bridger Eocene, the dental cusps are connected by cross-yokes.

HELISCOMYS VETUS, Cope, *loc. cit.*, p. 4.

Char. specif.—First molar with only three cones; all the molars except the first with a broad contiguous cingulum on the external side. Ramus rather stout; incisor-teeth very slender, elongate, slightly compressed, with parallel sides and convex anterior face.

Measurements.

	M.
Length of molar series	0.0030
Length of third molar	.0008
Elevation of third molar	.0005
Depth of ramus at third molar	.0023
Length of ramus to end of molars	.0010

The least mammal of the fauna to which it pertains.

SCIURUS, Linn.

SCIURUS RELICTUS, Cope. *Paramys relictus*, Cope, Synopsis New Vert. Colorado, 1873, p. 3.

This species is established on two left mandibular rami, with all the teeth complete. It was referred to the genus *Paramys*, because I found no difference between the corresponding parts in the respective species; but as the characters of the latter are chiefly observable in the maxillary teeth, the reference was not final. As it does not differ in any degree from corresponding parts of the existing squirrels, I place it for the present in the same genus with them, as the safer course.

The teeth 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 buttress, 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	0.0120
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

Size that of the chickaree, (*Sciurus hudsonius.*)

GYMNOPTYCHUS, Cope.

Paleontological Bulletin, No. 16, p. 6.

This genus is allied to the squirrels, differing as to cranial characters in the structure of the molar teeth. These exhibit in the superior series two crescents on the inner side, connected by transverse yokes with two cusps on the outer; in the lower jaw the crescents are on the outer, and the cusps on the inner side. The yokes are separated by deep valleys without cementum, which do not wear out so readily as in *Sciurus* and marmots. It differs from both these genera in its two well-defined crescents in both dental series. It agrees with them in the position of the *foramen infraorbitale anterius*, which is small, inferior, and situated in advance of the dental series. There are four molars, which do not differ materially in structure in both jaws. Two species are known, a larger and a smaller.

GYMNOPTYCHUS TRILOPHUS, Cope, Pal. Bulletin, No. 16, p. 6. *G. nasutus*, Cope, *loc. cit.*

Inferior molars with two cross-crests and two cingula from the external cones; each posterior crest of a pair terminating in an interior cone. The inner apices of the crescents unite and give origin to a short median cross-crest. First molar narrower; the anterior part of a ranium probably belongs to the same species. The first molar has a subround crown, with four tubercles; the second is constructed like the corresponding inferior. Muzzle much compressed; nasal bones flat, extending to beyond above incisors.

Measurements.

No. 1.

	M.
Length of interior three molars	0.0045
Length of first molar	.0015
Diameter of inferior incisor	.0008
Depth of ramus at second molar	.0036
Length of diastema above	.0080
Width of a pre-orbital region	.0073
Width of end of muzzle	.0030

No. 2.

Length of four molars	0.0070
Length of second molar	.0017
Width of second molar	.0015
Depth of ramus at second molar	.0035
Width of lower incisor	.0010

GYMNOPTYCHUS MINUTUS, Cope, Pal. Bull., No. 16, p. 6.

A very small species. Middle pair of molars with the anterior and posterior cross-crests bifurcate, and a short median cross-crest; only three cross-crests on the fourth, and four tubercles on the first. Ramus deep.

Measurements.

	M.
Length of inferior molars	0.0040
Length of second molar	.0010
Width of second molar	.0010
Transverse diameter of incisor	.0008
Depth of ramus at second molar	.0030

Scarcely larger than the house-mouse.

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 have a reversed relation. No cementum.

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, there is a large *foramen infraorbitale anterius*, which occupies the elevated position at the origin of the zygomatic arch seen in the *Fiber*, the porcupines, and cavies. There is no superciliary ridge nor postorbital 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 *Pseudotomus*, Cope. 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.

ICHSYROMYS TYPUS, Leidy, *loc. cit.* *Colotaxis cristatus*, Cope, Pal. Bull., No. 15, p. 1. *Gymnoptychus chrysodon*, Cope, *loc. cit.*, No. 16, p. 5.

First upper molar a simple cone. Incisors quite compressed. First inferior molar a broad oblong; the cusps opposite, the anterior close together. The two posterior cross-crests do not form a V; the anterior being interrupted at the cusp. There is a delicate tubercle between the outer cusps of the three last molars. The incisor is compressed; the anterior and outer faces being separated by an angle.

Measurements.

	M.
Length of 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 skull is broad and stout but not depressed; muzzle broad above, short; front moderately contracted; no postorbital processes.

This species varies considerably in the form of the premolar teeth, and I believe the above names refer to varieties, not to species.

PALÆOLAGUS, Leidy.

Proceed. Acad. Nat. Sci. Philad., 1856, p. 89.—Extinct Mamm. Dakota and Nebraska, p. 331.

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 that 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 are explained under the head of the *P. haydenii*, the most abundantly represented in the collections. It may be mentioned here that in neither *P. haydenii* nor *P. turgidus* is there any evidence that more than two anterior molars are preceded by deciduous teeth, while the latter are present in many specimens.

PALÆOLAGUS AGAPETILLUS, Cope, Paleontological Bulletin, No. 15, p. 1.

Established on a mandibular ramus with the first and last permanent molars just protruding. Size the least in the genus, not exceeding the *P. haydenii* in the milk-dentition, but more robust and with larger incisor-tooth. Form of the ramus wedge-shaped, contracted, and convex on the outer side forward. Molars all composed of two columns, the anterior the more elevated, the fore portion surrounded by its distinct enamel sheath, with a narrow intervening band of cementum. Posterior molar much reduced in size; posterior column of molars with a median posterior rib, which forms a loop in section. Anterior column much more elevated than posterior. The section of the slender incisor is nearly a right-angled spherical triangle.

Measurements.

	M.
Length of molar series	0.0100
Length of penultimate molar	.0020
Depth at penultimate molar	.0070
Depth at first molar	.0050
Transverse thickness at first molar	.0037

PALÆOLAGUS HAYDENII, Leidy.

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.

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.

Ths measurements of a medium-sized adult are—

Measurements.

	M.
Length of inferior molar series	0.012
Length from M. 1 to end of incisor	.012
Length of diastema	.008
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

Several hundreds of specimens of this species were observed.

PALÆOLAGUS TURGIDUS, Cope, Pal. Bull., No. 16, p. 4. *Tricium paniense*, Cope, *loc. cit.*, p. 5.

The largest species of the genus. Molars with two simple columns, the first and fifth grooved on the outer side only; the interior grooves of the others weaker. A porous enlargement on the inner inferior part of the ramus just behind the symphysis. Diastema obtuse.

Measurements.

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

The deciduous molars present much the same character as in *P. haydenii*, 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

PALÆOLAGUS TRIPLEX, Cope, Paleontological Bulletin, No. 16, p. 4.

This species rests on characters which I have observed to be transitional in the *P. haydenii*, 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 considerable attrition of the teeth has been reached; size of the last; first and last molars deeply grooved on both sides, as well as all the rest; first molar with a trifolium-lobate crown. Median three molars with a narrow posterior column, as in *P. agapetillus*. Punctate patch on inner face of ramus extensive.

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 and the last are rather larger than the prairie-marmot, (*Cynomys ludvicianus.*)

PERISSODACTYLA.

SYMBORODON, Cope.

Paleontological Bulletin, No. 15, p. 2, (August 20, 1873.)—Synopsis Vertebrata Colorado, 1873, p. 14.—Proceed. Amer. Assoc. Adv. Sci., 1873, p. 109.

A genus embracing species, so far as known, of large size, allied to *Titanotherium*, Leidy, and belonging to the same family. Its affinities are indicated by the following description:

Dental formula: I., $\frac{2}{0}$; C., $\frac{1}{1}$; P. m. $\frac{4}{3}$; M., $\frac{3}{3}$. Teeth reduced in size anteriorly; no diastema behind the canine. Molars consisting of two external and confluent crescents, and one or two internal cones. In the larger premolars, there are two, sometimes confluent, cones; in the molars, the posterior cone is sometimes much reduced, especially on the third, while on the second and third a small third one is sometimes added in front. The mandibular teeth are constructed like those of *Palæotherium*, *i. e.*, of two crescents with the horns directed inward, the middle two united, and the third molar with a third posterior one. The superior incisors are very small and with obtuse crowns, and are separated by a median interval; the inferior canines are separated by a short edentulous space, with thin alveolar margin openly emarginate.

The *cranium* is remarkably elongate in proportion to its width, excepting in those species where the zygomas are so expanded as to modify the proportions. The top of the skull is flat or convex in transverse direction, and the well-separated temporal fossæ are overhung by the angular or produced borders. The temporal fossæ are well produced posteriorly, in some species remarkably so, and, with the supraoccipital border or horizontal crest, inclose a deep occipital fossa. The inferior border of the fossa is continued to the zygoma. The zygomatic fossa is rather narrow, but the squamosal process is sometimes horizontally expanded to a great mass. There are no postorbital processes, and in all the species the orbits are small. The *foramen infraorbitale* is very large, and is a simple perforation of the thin wall bounding the orbit in front. A narrow column separates it from the orbit exteriorly, and a stouter one from the external nasal meatus. The latter is large and very little incised behind the premaxillary border. Hence the fore portion of the nasal bones is very short. The lateral walls, anterior to the orbits, are directed somewhat anteriorly, so that, viewed from the front, there is a considerable border on each side of the nasal meatus, bounded by a lateral vertical angle, and pierced below by the *foramen infraorbitale*. The borders of the nasal bones are thickened, and often ridged below. The premaxillaries are small and fragile.

The *maxillaries* rise above the level of the orbit in a solid support for a stout horn-core, which is principally composed of a production of the nasal bone. The distance to which these supporting elements rise differs in the species. The horn-cores are a striking feature of the genus, and vary in shape and proportions in the species. In one, they are rudimental; in others, short and stout; in another, long, slender, and curved. The nature of their investing membrane remains unknown, but the extremities in several of them (*S. acer*, *S. bucco*) are so rugose with coarse exostoses as to suggest strongly a cartilaginous or corneous appendage or continuation representing the deciduous horn of the deer. The nasal bones are co-ossified in most of the species, and present various forms in the different species. In all the specimens, the sutures on the upper face of the skull are obliterated, so that it is difficult to determine the true structure. The orbits being far anterior and but little behind the line of the bases of the horn-cores, it is evident that the frontal bones are produced well forward. The nasals are, however, produced broadly between the anterior portions of the frontals.

The *basioccipital* and basisphenoid are narrowed and bounded by a large confluent *foramen lacerum anterius et posterius*. The petrous bone is small and deeply set. There is a transverse paramastoid process, and a very large transverse postglenoid process. The mastoid process is thickened and recurved so as to be nearly in contact with the postglenoid, and to inclose the external auricular meatus. The side-walls of the posterior nasal meatus are prolonged, and form an abrupt obtuse angle posteriorly where the border rises to the basisphenoid. The pyramidal process of the palatine, the pterygoid, and the pterygoid ala of the sphenoid, which compose each, are closely co-ossified. The external side of this plate is deeply longitudinally grooved, which terminates posteriorly in a foramen, the spheno-orbital. The posterior base of the plate is longitudinally perforated, and in line with this short tube is a large foramen opposite the glenoid cavity. The *foramen ovale* is probably confluent with the *f. lacerum anterius* as in *Eobasileus* and *Rhinocerus*. The palate is incised to the front of the last molar. In outline, it is quite narrow when compared with the large molars; the diameters of the two being about equal.

The *mandible* is small when compared with the cranium, and contracts rapidly forward. The condyle is large and transverse, and the coronoid process small, narrow, and close to the condyle. The angular region is strongly convex both backward and downward. The inferior margin of the ramus is without tuberosities, and the symphysis co-ossified, shallow, and oblique.

The *cranial chamber* is elongate, and is divided into three departments for corresponding segments of the brain. The posterior is elongate-oval, for the reception of the cerebellum. It is separated from the median division by a thin tentorium, whose union with the superior walls indicates that the cerebral hemispheres did not overhang the cerebellum. The anterior border of the hemispheres is indicated by a thickened, arch-like contraction of the lateral and superior cranial walls within, and is situated much behind the orbits, as in perissodactyles and some carnivora. This chamber is divided longitudinally by a thin falx, and each posterior lobe is again divided vertically by a thin osseous septum, thus accommodating two convolutions. The external of these is supported underneath by a thin septum from the outer wall. The falx divides or forks at its anterior extremity into two vertical laminæ, which continue parallel to each other to the inner bases of the nasal horns. They are here continuous with the external wall, forming the posterior boundary of the anterior narial opening. They form the lateral walls of the long nasal fossa, and inclose a large chamber on each side with the lateral cranial walls. This sinus appears to be separated by a thin osseous septum from the brain-case proper; the septum extending from above obliquely forward and downward, altogether behind the arch-like projection of the frontal bone above described. As it is not perforated, it gave no exit for the olfactory nerves. I cannot detect the proper boundary separating the hemispheres from the olfactory lobes, as their usual position, both in front of and behind the frontal arch, is included in the large sinus above described. The nasal fossa is divided by the usual septum, and each half communicates with the large fossæ above mentioned by a large longitudinal oval foramen. In one specimen of *Symborodon acer*, in which this lateral septum is almost entirely preserved, there is no indication of attachment of turbinal bones, but the surface is smooth. On these and the median septum, the olfactory nerve was, no doubt, distributed. The olfactory lobes were contracted in dimensions, and the large lateral sinuses in front of them are doubtless the frontal sinuses of the mammalian skull. Their length is double that of the brain-case, and they extend far posterior to the orbits and above and behind the olfactory lobes. They do not appear to have been divided by septa, excepting a small one springing from the outer wall near the posterior fourth in *S. acer*, and near the same place from the inner wall in *S. trigonoceras*. This huge cavity was doubtless an air-chamber, which gave a lightness to the skull not otherwise attainable consistently with its great length, and which has rendered the use of the nasal horns entirely practicable. They explain the elongation of the skull in the Eocene genera *Eobasileus* and *Uintatherium*, and prove that the sinus at the base of the horns of the middle pair is the frontal sinus and not the alveolus of the canine tooth, as supposed by Marsh.

The cervical vertebræ in all the species are concavo-convex, and much deeper than long; they are longer than in *Eobasileus*. The odontoid process is a solid cone; the coracoid process is a tubercle; there is no acromion; and the spine of the scapula rises gradually from its base. The ilium is strongly pedunculate.

In *S. bucco*, the femur has a third trochanter, and is relatively longer than in *Rhinocerus*. There is a fossa for the round ligament, and the condyles are expanded. The fibula is enlarged distally, and is distinct. The phalanges, including the ungueal, are very short. The carpals interlock; and the ulna is much reduced, giving the carpal articulation to the radius.

The *S. acer* is the smallest species described, and has the longest horns. Its astragalus resembles that of *Rhinocerus*, having a deeply-grooved trochlea and well-defined head and neck. The cuboid facet is rather larger than in that genus, but is considerably smaller than the navicular, and extends with an acuminate outline behind it, as in *Eobasileus;* otherwise it has no resemblance to that element in that genus. The metatarsals have much the form of those of *Rhinocerus*.

The palate is deeply incised, as in *Rhinocerus*, and other cranial peculiarities resemble those of that genus. In no case are any traces of inferior incisors present in the numerous under-jaws at my disposal.

In estimating the ordinal affinities of the genus, the greater number at once assign it to the *Perissodactyla*. The teeth,* the incised palate, the distribution of the cranial foramina, including the perforation of the pterygoid, the postglenoid and paramastoid processes, are all characters

* See the Structure and Homologies of Molar Teeth of Mammalia, by E. D. Cope, Journ. Acad. Sci., Philad., 1874.

of that order. The scapular and pelvic arches have the same significance in the gradually-descending spine of the former and pedunculate ilium of the latter. The limbs testify to the same effect, and in the third trochanter of the femur, (small, it is true,) the digitigrade hindfoot, with attendant modifications of the structure of the calcaneum and astragalus. Its only indications of other affinity are a few toward the *Eobasileidæ*, seen in the enlarged cuboid facet of the astragalus, the elongate femur with reduced third trochanter, and the paired horns on the anterior part of the cranium. They present no special marks of affinity to the artiodactyles, and show that the paired horns of the *Eobasileidæ* have no significance in the same direction, as has been supposed by a recent writer on this group.

As compared with the *Rhinoceridæ*, the principal distinctions are to be observed in the feet, in which the median pair of toes are less unequal in proportions. The cranium is still more abbreviated in front and the orbits more anterior, while the bilateral arrangement of horns belongs exclusively to the extinct. The structure of the molar teeth is distinct, but not widely so, and represents a more primitive type, and one approximating the bunodont forms of *Proboscidia* and *Artiodactyla*, and lower types. The same type of detention is displayed by *Palæsyops*, Leidy, of the American Eocene; *Chalicotherium*,* Kaup, of the Miocene of Europe and Asia; and *Titanotherium*, Leidy, of the American Miocene. It is with the latter genus that comparisons must now be made.

Titanotherium proutii, Leidy, is a large species, originally described by Dr. Hiram Prout in the American Journal of Science and Arts † as a *Palæotherium*. It was based on specimens brought by Dr. Prout from the Missouri. Subsequently, Messrs. Owen, Norwood, and Evans named it *Palæotherium? Proutii*;‡ they had procured other material, but based their name on Prout's descriptions. In the same year, Dr. Leidy proposed for it the generic name *Titanotherium*,§ without generic description or diagnosis. In his work on The Ancient Fauna of Nebraska,‖ Dr. Leidy gave a full specific description of the material which had been obtained up to that time, and it is on this and the figures accompanying that our knowledge of *Titanotherium* as a genus reposes. In the Journal of the Philadelphia Academy,¶ 1869, Dr. Leidy had described additional remains, chiefly cranial, some of which belong to different species, and perhaps some of it to those of the present allied genus.

Doctor Leidy gives the dental formula of *Titanotherium*, as I., 2; C., 1; P. m., 4; M., 3, for the maxillary series, and adds:** "Fragments of lower jaws exhibit the same number of molar and canine teeth, and probably there existed also the same number of incisors as in the upper jaw." In the museum of the Academy of Natural Sciences, one of Dr. Prout's original specimens, as indicated by the label and the one first figured by Dr. Leidy, is preserved, but it furnishes no evidence as to the number of premolars. Associated with it in the collection is a mandibular symphysis,†† marked as being one of Dr. Owen's original specimens. These two are peculiar in their iron-rust color, so different from that always characterizing the fossils of the White River epoch

* Professor Gill has created a family, *Chalicotheriidæ*, for this genus.
† II, 288, fig. 1, 1846; III, 248, figures, 1847.
‡ Proceed. Acad. Nat. Sciences, 1850, 66.
§ Proceed. Acad. Nat. Sciences, 1850, 122.
‖ Smithsonian Contrib. to Knowledge, vol. VI.
¶ Extinct Fauna Dakota and Nebraska, 1869, p. 206.
** Page 207.
†† Described by Leidy in his Fauna Dakota and Nebraska, p. 214.

both in Dakota and Colorado, and it is a point worth investigating whether they were really derived from beds of that horizon. The superior size and the color and mineral character of these specimens refer them as probably parts of the same species at least. The symphysis contains the alveoli for, and basal portions of roots of, one premolar, (with two roots,) one canine, and two incisors, on each side. The incisors were evidently well developed, and indicate in the clearest manner that *Titanotherium* and *Symborodon* are distinct genera. With a considerable number of mandibles at my disposal, I have failed to find any trace of inferior incisors in the latter genus; and if they were present at any time, it must have been only during early youth, and as a part of the deciduous dentition.

Prof. O. C. Marsh has recently* described, under the name of *Brontotherium*, a species allied to *Titanotherium proutii*, in which the mandibular dentition is stated to be I., 2; C., 1; P. m., 3; M., 3. If the mandibular fragment described by Professor Leidy as presenting four premolars belongs truly to the *T. proutii*, then the form described by Professor Marsh will occupy a position between it and *Symborodon*. Finally, Dr. Leidy described the horned snout of a species of this group under the name of *Megacerops coloradensis*.† The specimen differs in various respects from any species observed by me in Northern Colorado. It was derived from a locality remote from that which contains the *Symboroda*, from a bed of coarse sandstone entirely different in mineral characters from the argillo-calcareous beds from which the fossils described in this report were obtained. In the absence of knowledge as to the dental characters of this animal, and the consequent uncertainty as to which of the three genera above named it belongs to, I leave it for the present.

Six well-defined species of the genus are known to the writer, which vary in dimensions from that of the Indian rhinoceros to nearly the size of the elephant. They may be readily recognized by the following characters; the most important of which is the basal cingulum of the premolars:

A. Horn above the preorbital region:
- I. Premolars without inner basal cingulum:
  - *a.* Nasal surface continuous with front:
    - Horn-cores large, compressed; zygomata enormously expanded; cranium depressed.—*S. bucco.*
    - Horn-cores large; zygomata not expanded; cranium rather elevated; nasals very short.—*S. altirostris.*
    - Horn-cores mere tubercles; nasals not shortened.—*S. heloceras.*
- II. Premolars unknown; nasal plane sloping downward from a roof-shaped angle with the frontals:
  - Horn-cores very elongate, subcylindric, curved, partly composed of maxillary bones at base.—*F. acer.*
- III. Premolars with a strong internal basal cingulum:
  - Horn-cores short, very stout, and subtriangular in section; nasal bones more elongate.—*S. trigonoceras.*
  - Horn-cores small, compressed, followed by a tuberosity on the frontal bone.—*S. hypoceras.*

AA. Horn-cores above the orbit:
- Premolars with internal cingulum; horn-cores stout, compressed; nasals longer.—*S. ophryas.*

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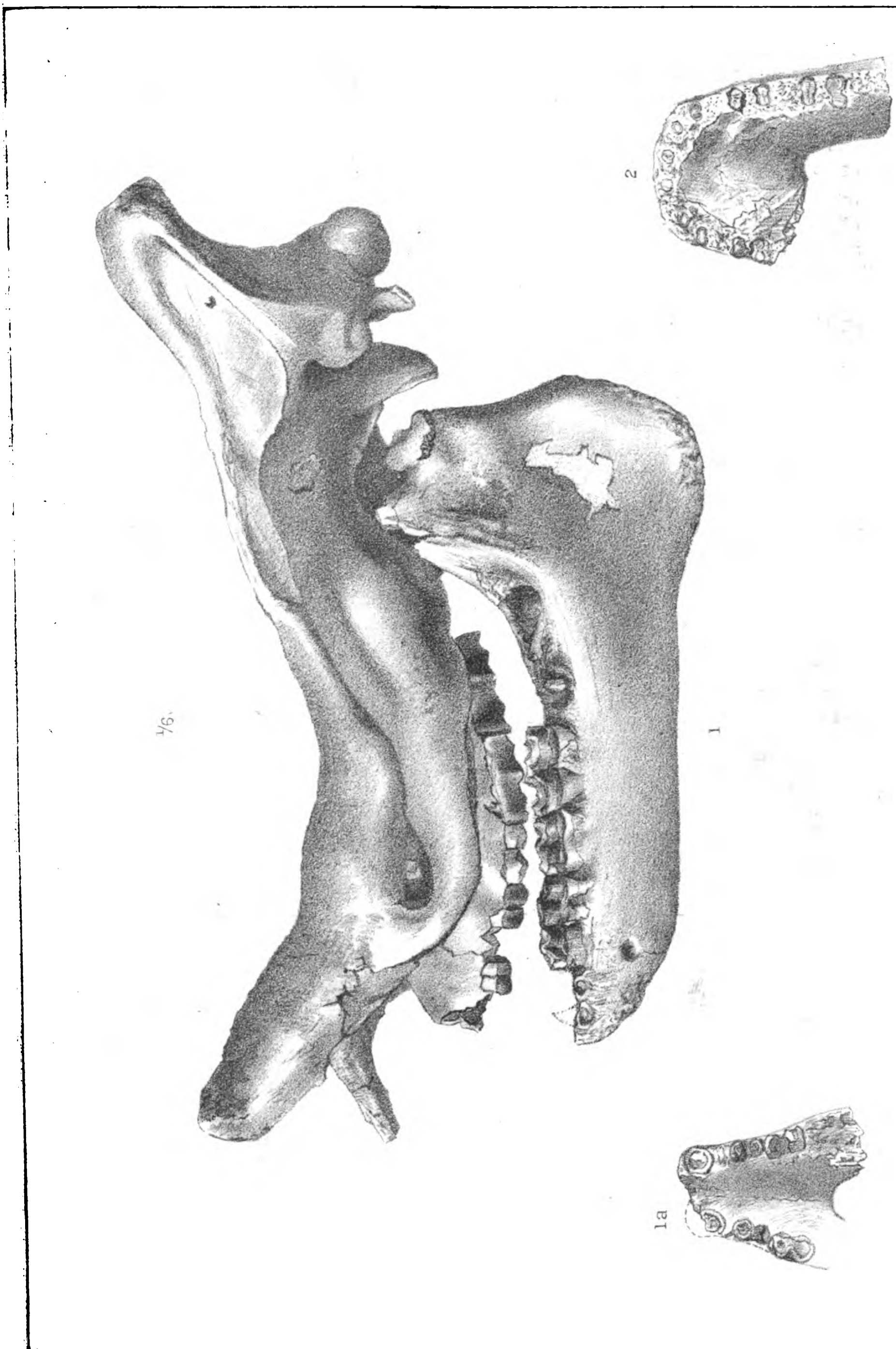
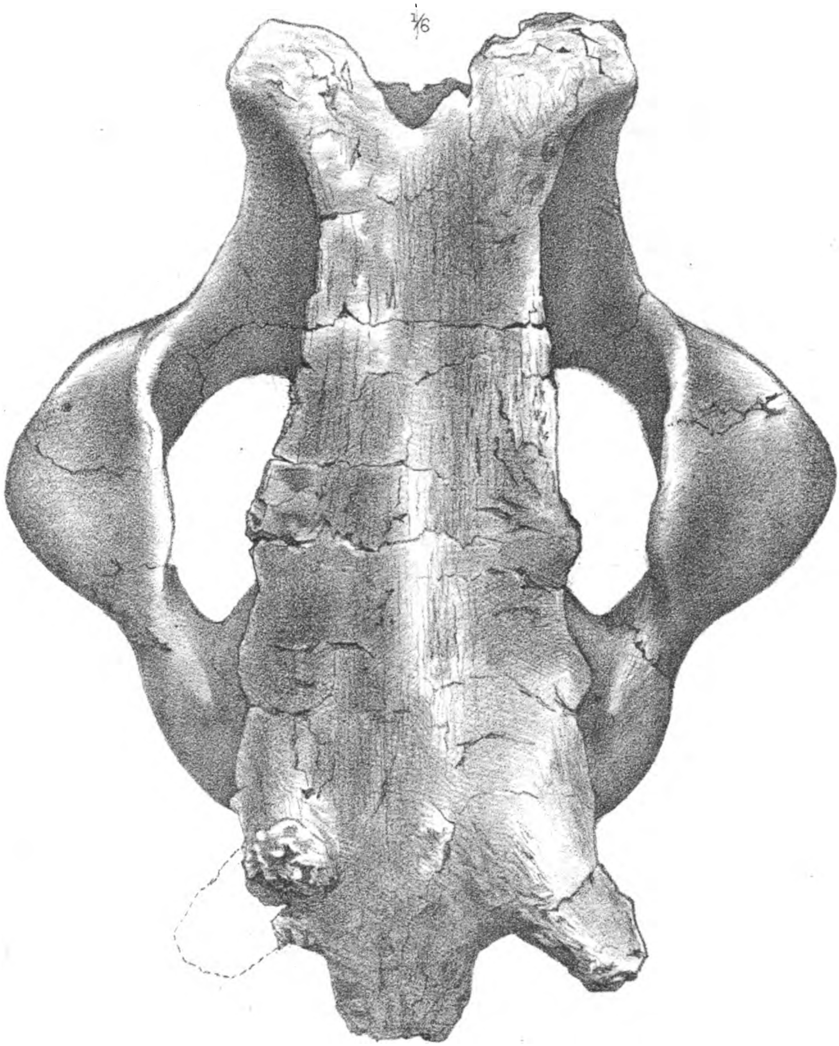
* Amer. Journ. Sci. Arts, 1873, p. 486.

† Report (4to) on Geol. Survey Territories, p. 239, pl. I, figs. 2, 3, and II, fig. 2.

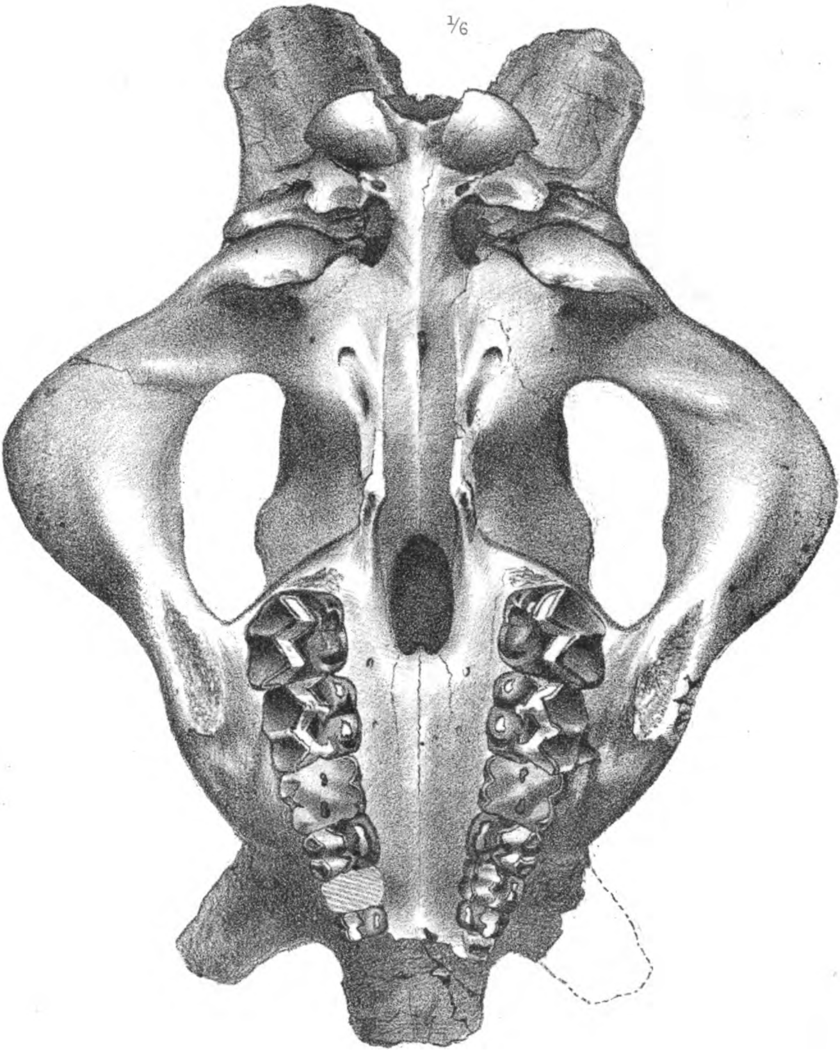


1. SYMBORODON BUCCO COPE. 2. TITANOTHERIUM PROUTII LEIDY.



T Sinclair & Son. lith. Phila.

SYMBORODON BUCCO COPE.



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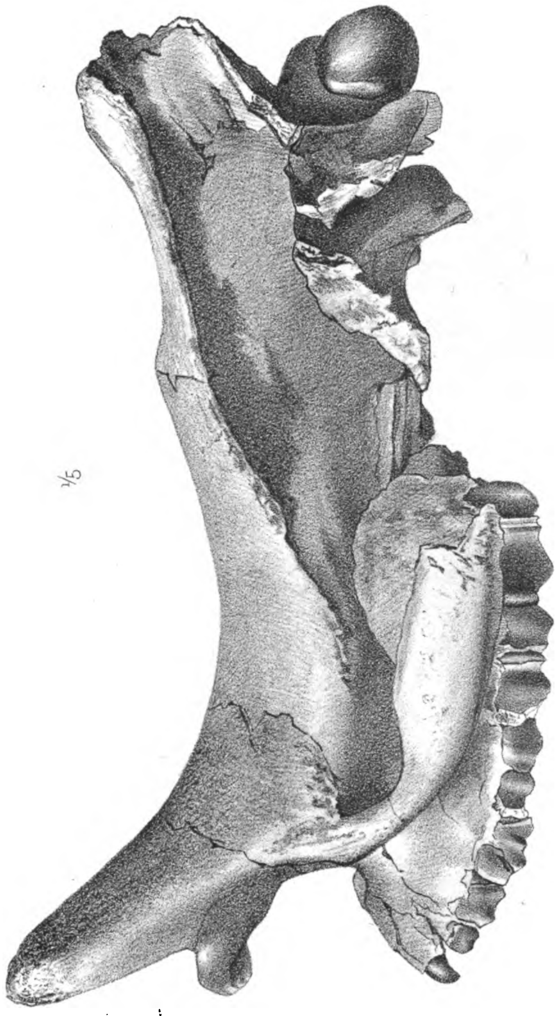

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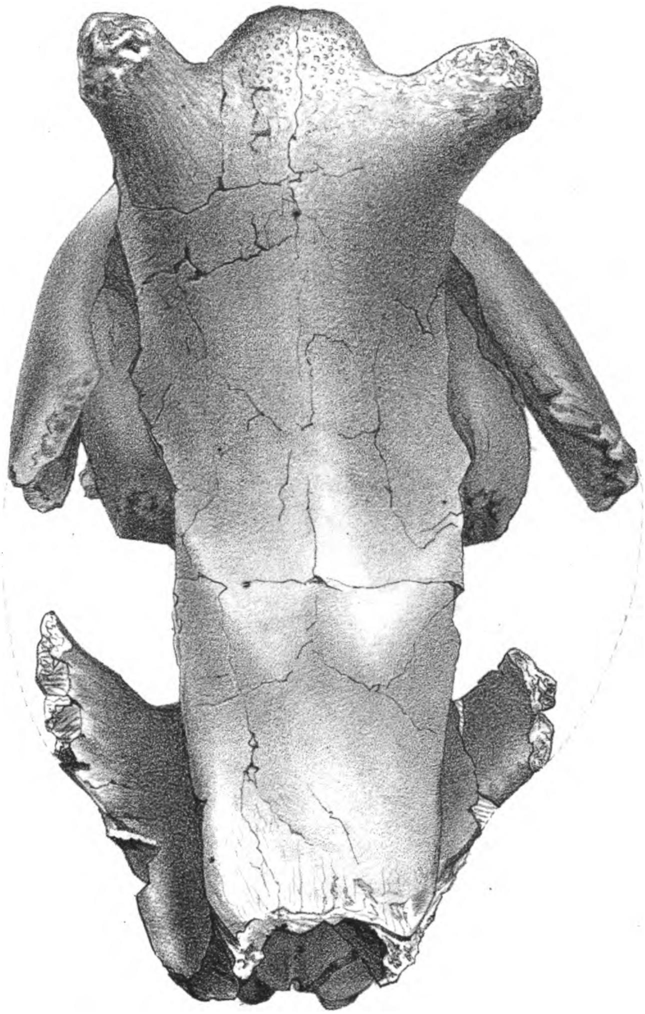
SYMBORODON ALTIROSTRIS COPE.



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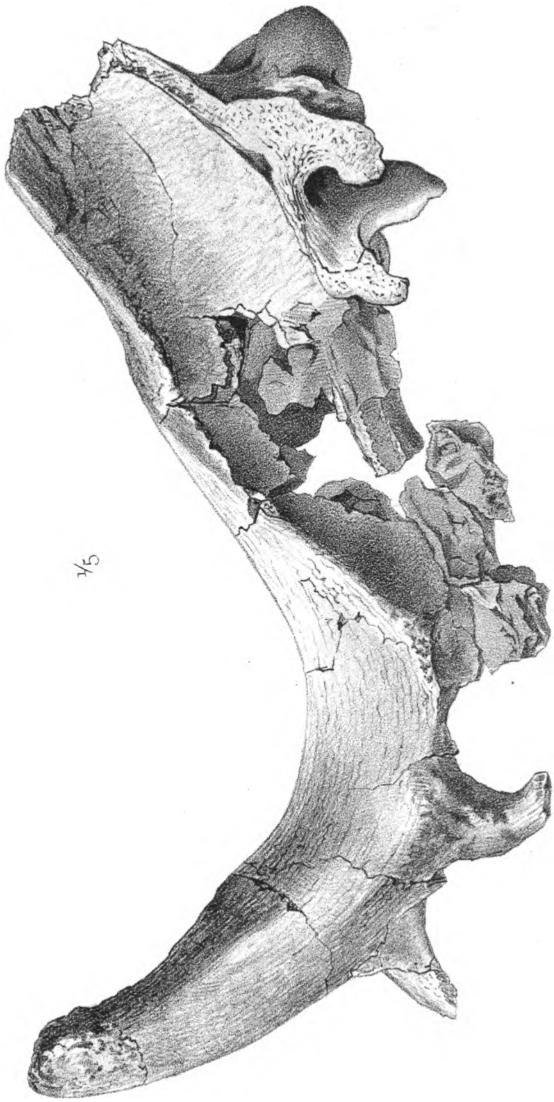

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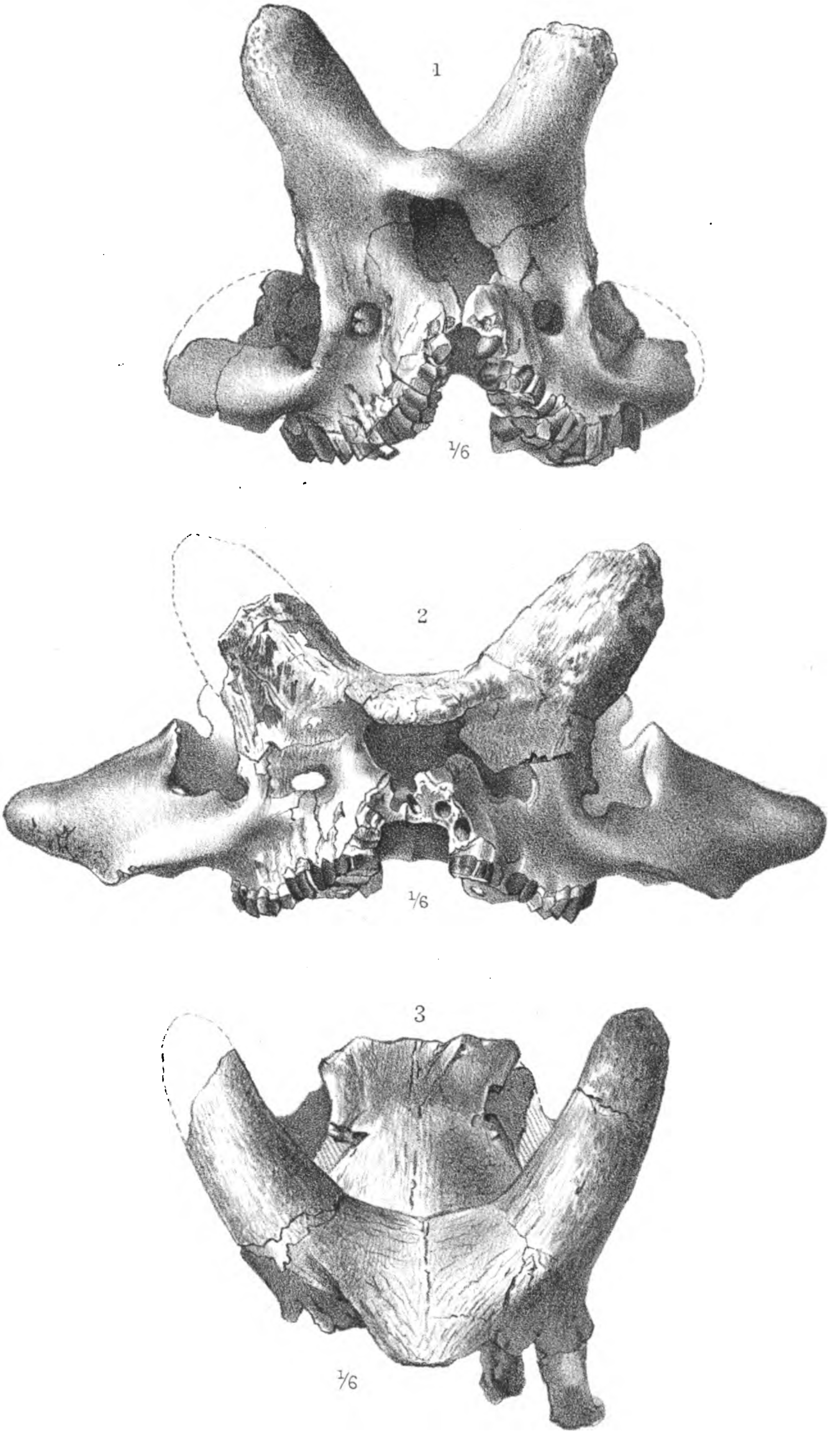
SYMBORODON ACER COPE.

T. Sinclair & Son, lith, Phila.



T Sinclair & Son, lith, Phila.

1. SYMBORODON ALTIROSTRIS. 2. SYMBORODON BUCCO.
3. SYMBORODON ACER.

It is probable that both sexes of these species are horned. This is the case with all of the crania which I obtained in which the nasal region is not wanting, and doubtless many of these are females. The only one which I obtained with reduced horns is one of the largest size, (*S. heloceras*,) and does not probably represent the only female of the collection.

The general appearance of these species when living must have combined features of the rhinoceros and elephant in almost equal proportions. The length of the femur indicates that the first joint of the leg was free from the abdominal integument, and that some of the species stood higher on the legs than the rhinoceros. There is indication of a trunk, probably a short one, since the neck is not so remarkably shortened as to render this organ absolutely necessary. The indications are: the massive borders of the nasal meatus separated laterally from the face by a vertical, obtuse angle; the great stoutness and shortness of the free end of the nasals, which much resemble the same region in the elephant; and the reduction of the premaxillary region and its teeth. It is altogether probable that it had no great length, resembling, perhaps, that of the tapir. These views are in accordance with those already expressed by Professor Marsh in his description of *Brontotherium ingens*.* Professor Leidy had previously inferred a short proboscis for the *Megaceratops coloradoenesis*. As compared with the *Eobasileidæ* of the Eocene, their appearance must have been less exceptional. The proboscidian foot, with short neck, reproduced the elephant; while the narrow head, with the posteriorly placed horns, and the very elongate muzzle, gave these a more suilline expression than the symborodons. The powerful horns, admirably situated for effective use, did not avail to secure their survival beyond the Miocene period more surely than did the laniary tusks of the *Eobasileidæ* in conquering for them a place in the ages that succeeded the Eocene. As the most powerful of the *Ungulata* of the Miocene, they were the legitimate successors of the *Eobasileidæ*, of the Eocene, as these were of the great land-saurians of the Cretaceous. A few mastodons and elephants contested with them the supremacy of the Miocene, and held it without rivals in the Pliocene; but why the less formidable rhinoceros should have continued with them, while the *Symborodons* disappeared, is a problem whose solution cannot yet be conceived.

The material on which the above determinations and deductions are based is abundant. The expedition obtained portions of fifty individuals, probably referable to this genus, and twenty-five complete or fragmentary crania. Those certainly determined belong to the species in the following proportion: *S. bucco*, 3; *S. torvus*, 2; *S. altirostris*, 2; *S. acer*, 3; *S. heloceras*, 1; *S. trigonoceras*, 6; *S. ophryas*, 1. Crania of *S. bucco* and *S. acer* were obtained with mandibles associated; the other species were not; nevertheless, it is probable that some of the various mandibles found separately pertain to the most abundant, *S. trigonoceras*.

SYMBORODON BUCCO, Cope, Synop. New Vert. Col., 1873, 10.

The largest species of the genus approaching nearly the living elephant in size. Represented by an imperfect cranium; by a cranium almost perfect, including, very probably, both mandibular rami, with entire dentition; a fragmentary skeleton, including parts of cranium, teeth, and vertebræ. The crania are very depressed in form, and exhibit a peculiarity in the horizontal expansion of the malar bones, and the still greater enlargement of the zygomatic processes of the squamosal.

*Amer. Journ. Sci. Arts, 1874, p. .

These form two horizontal bony masses of remarkable size, with the exterior border convex in both the vertical and horizontal planes. The nasal bones are flat and truncate wedge-shaped. The horns are situated above the face in front of the orbit, and are expanded in one plane, so as to be much flattened. Their length is moderate, and their direction outward and forward. There are slight angulations of the frontal and zygomatic margins, which form slight contractions of the zygomatic orbital fossa, one behind the orbit, the other marking the anterior four-tenths of the zygomatic fossa. The orbits are small and horizontally oval, and the temporal fossæ contracted. The latter are greatly extended posteriorly, and are bounded by an ear-shaped prolongation of the exterior occipital angular ridge to beyond the line of the foramen magnum. The plane of the vertex and front is wide and uninterrupted by tuberosities, but forms a gently concave continuum. The dentition is $\frac{2}{0}$, $\frac{1}{1}$, $\frac{4}{3}$, $\frac{3}{3}$. The anterior teeth are all small, the posterior large. There is no internal cingulum on the molars, which are smooth and with low internal cones.

Measurements.

	M.
Length of cranium, (33 inches)	0.840
Width of cranium, (25 inches)	.636
Length of nasal bones to bases of horns	.107
Length of orbit	.115
Width of nasals	.152
Width above orbits	.255
Width, least, between temporal fossæ	.170
Width of mass of zygomatic squamosal	.140
Width between temporal fossæ behind	.331

This large quadruped was considerably larger than the *S. acer*, Cope; but the horns are shorter, and of an entirely different form. Its orbits are remarkably small, and during life the eyes were directed more or less obliquely upward. The broad, flat, wedge-shaped head is not unlike that of snapping-tortoise (*Chelydra*) in its physiognomy.

I append here a description of the mandible, on which the species *Symborodon torvus* was established. I am not able at present to refer it to its proper cranium, but hope soon to have that opportunity. It nearly resembles that of *Symborodon bucco*. Dentition; I., (?) 0; C., 1; P. m., 3; M., 3; the canines slightly separated from each other, but not from the first premolar; crowns of the premolars with L-shaped crescents, as in *Rhinocerus;* of the molars with completed crescents; the last molar with third posterior crescent; symphysis mandibuli co-ossified; crowns of canines not projecting, conic. Symphysis oblique; ramus rather shallow. Last molar with three columnar ribs on the outer side, four on the inner, produced by the continuance inward of the ridges from the anterior and posterior outer cusps. Enamel nearly smooth; a cingulum round inner basis of crown of canine.

Measurements.

	M.
Length of mandibular ramus	0.520
Length of symphysis	.144
Length of series of molars	.320
Length of series of true molars	.215
Length of last molar	.083
Length of penultimate molar	.072

SYMBORODON ALTIROSTRIS, Cope, Synop. New Vert. Col., 1873, 12.

A large species represented especially by a nearly perfect cranium, and probably by several others, some of which are nearly perfect. The muzzle is shorter than in any other, and the orbit more anterior. The premaxillary and nasal bones are shortened; the latter broad, obtuse, and massive, and standing on a plane above that of the front. The vertex and front do not form a continuous concavity, as in other species, but are divided equally by a tuberosity on each side; posterior to these the vertex is flat and rather wide, while the front anterior to them is roof-shaped. The temporal fossæ do not project so far behind the occipital union as in some species, and the squamosal bone is not remarkably expanded laterally. There is a small postorbital angle. The front rises much to the basis of the horns. Each of these stands above the orbit and face at the base, and one-third of each over orbit; face and nasal bones above the latter. They are straight, with approximated bases, and but moderately divergent. They are subcylindrical at base, and compressed inward and forward at the narrow apex. The maxillary rises on the base, forming a squamosal suture on the anterior and lateral aspect, opposite the nasal meatus, and below the nasal bones.

The first premolar and two incisors are very insignificant; canines with short, stout crown. The premolars have no inner cingulum, but two smooth cones. The molars have only two inner cones, which converge toward the crescents. The latter do not give origin to any transverse crests.

Measurements.

	M.
Length of cranium, (25½ inches)	0.649
Length of crowns of teeth from canine	.444
Length of true molars	.240
Length of last molar	.083
Width of last molar	.084
Width of first premolar	.035
Length of first premolar	.026
Length of orbit	.090
Least width of parietal plane	.235
Length of nasals from horns	.045
Width of nasals at horns	.152
Length of horn-core above orbit, (9 inches)	.229
Length of horn-core above nasal bones	.140

This is one of the most formidably-armed species, and must have presented a most *outré* appearance in life, owing to the extreme shortness and elevation of the muzzle and anterior position of the orbit. The general form of the cranium reminds one of a pack-saddle without the hind cross-trees.

I owe the discovery of the beautiful cranium, which represents the species, to the acuteness of my assistant, William G. Shedd.

SYMBORODON HELOCERAS, Cope, Proceed. Amer. Assoc. Adv. Sci., 1873, 109; Synop. New Vert. Col., 1873, p. 14. *Megaceratops heloceras*, Cope, Pal. Bull. No. 15, p. 4.

Free portion of nasal bones as broad as long. Horn-cores mere tuberosities, with one flat outer, and one very convex, face presenting in the other directions; summit contracted, truncate, oval in outline. A distinct superciliary ridge. The upper surface of the cranium rather narrow, gently concave longitudinally. Molar teeth with smooth enamel; the crescents not displaying the T-shaped branches seen in *S. ophryas.* Zygomas deep, flat, not expanded.

Measurements.

	M.
Length from posterior rim of temporal fossa to middle of osseous eyebrow	0.472
Least width of parietal plane	.104
Superciliary width	.260
Elevation of horn-core	.050
Length of free nasal bones	.010
Width of free nasal bones at base	.010

SYMBORODON ACER, Cope, Proceed. Amer. Assoc. Adv. Sci., 1873, 109; Synop. New Vert. Col., 13. *Megaceratops acer*, Cope, Pal. Bul., 1873, No. 15, 4.

Another huge mammal, second only to the preceding in size, but more formidably armed, was its contemporary. It is represented in my collection chiefly by the entire upper portion of a cranium; the greater part of a skeleton, with upper part of cranium and lower jaw with teeth; and by portions of skeleton, with horns, of a third. Top of head concave longitudinally, somewhat convex between the orbits, and flat, forming a narrow plane between the temporal fossæ; latter produced backward. Orbit not inclosed behind; an overhanging superciliary ridge. Nasals exceedingly short and massive, abruptly decurved, each supporting a large acute horn-core, which is connected with its fellow by a ridge at the base, and diverges widely from it, with an outward and forward curve to the acutely-compressed apex. Each horn-core composed externally of the ascending portion of the maxillary bone as high as some distance above the base of the nasals. Nasals abruptly contracting to a stout subangular apex. Zygomatic arch deep.

Mandibular ramus massive, and in every respect stouter than in *S. bucco*, and similarly without incisor-teeth.

Measurements.

No. 1.

	M.
Length of cranium, (35 inches)	0.895
Length from posterior rim of temporal fossa to middle of superciliary ridge	.345
Width of front between eyebrows	.210
Length of horn-core on inner side, (10 inches)	.254

No. 2.

Length of first and second molars	.135
Width of second inferior molar	.040
Depth of ramus at second inferior molar	.123

This was a truly formidable beast, exhibiting a position of the horns strangely the reverse of that seen during the present period. Its size exceeded that of the Indian rhinoceros.

SYMBORODON TRIGONOCERAS, Cope, Synop. New Vert. Col., 1873, 13. *Brontotherium trigonoceras*, Marsh, Amer. Nat., 1874, p. .

A species similar in size to the last, but presenting peculiarities not shared by any other species of the genus. The first of these is the strong basal cingulum on the inner side of the premolars, which is continued in a less prominent form between the bases of the cones of the molars. The bases of the cones of the premolars are strongly plicate. The horns rise from a basis which is anterior to the orbit, and are short and very stout. They are triquetrous, with the faces interior, posterior, and lateroanterior, and are directed outward and upward. Their extremities are coarsely rugose and subtriangular, sending an apex toward the middle line, and decurved convex outwardly. The vertex and front are a continuous gentle concave plane, which is narrowed behind and widened in front to support the bases of the horns. A postorbital process. Orbit well developed, not remarkably anterior; nasals elongate, transversely plane, decurved, slightly emarginate at end. Premaxillary prominent, with distinct spine, and extending as far as the line of the end of the nasals. Squamosals not expanded. First premolar small; canine narrow.

Measurements.

	M.
Total length of cranium, (27 inches)	0.686
Total width, including zygomas	.433
Width between temporal fossæ at inion	.102
Width in front	.247
Width of orbit	.102
Length of horn above orbit	.122
Length of horn above nasals	.045

The horns of this species, though stout, are less formidable as weapons than those of some of the others.

At one locality teeth and a few other fragments of a very large individual were discovered, and a few feet distant a series of cervical and dorsal vertebræ of appropriate size. A little further off, in an opposite direction, a portion of the skeleton of a *S. bucco* was found, with the characteristically expanded zygomatic masses. It is not unlikely, however, that the vertebræ really belong to the *S. trigonoceras*. They indicate an animal of huge proportions, and present a marked feature in the enormous length of the neural spines of the dorsals. These are compressed at the end and enlarged at the summit, indicating that the animal supported a hump, somewhat as in the bison.

Measurements.

	M.
Length of crown of fourth upper premolar	0.050
Width of crown of fourth upper premolar	.065
Length of cervical vertebræ, (to base of ball)	.060
Depth of articular face behind	.114
Width of articular face behind	.110
Diameter of cervical canal	.024
Diameter of vertebral canal	.065
Length of centrum of dorsal to ball	.065
Depth of articular face behind	.108
Width of articular face behind	.111
Depth of base of diapophysis	.070

A peculiarity of the dorsal vertebræ consists in the presence of two tuberosities at the base of the articular convexity, resembling the articular facets for chevron-bones, but at the opposite end of the centrum.

Beside the above, six more or less complete crania were found, and two others without horns and otherwise mutilated, so as to render it uncertain whether they do not belong to the *S. ophryas*. These exhibit some range in size; one of them presents the following—

Measurements.

	M.
Total length of skull, (30 inches)	0.762
Length to orbit	.172
Length to posterior base of horn	.280
Width at zygomas, (17 inches)	.432
Height of horn above orbit	.127
Length of free part of nasal bones	.127
Width of base of nasal bones	.133
Width of horn on antero-exterior face	.120
Width between temporal fossæ posteriorly	.260
Width between apices of horns, (17 inches)	.432

Professor Marsh described* a species allied to or identical with this one, under the name of *Brontotherium ingens.* It was based on a cranium which has so great a resemblance to those of *S. trigonoceras* that I have regarded it as pertaining to it,† and written Professor Marsh's name as a synonym, as it was published several months later than mine. Subsequently,‡ Professor Marsh pointed out a number of characters which he finds in my description as justifying him in retaining the species as distinct. He states that it is "nearly or quite twice as large in bulk. The horn-cores also are very differently placed; the nasals are more elongated, and not emarginate at their extremities; the premaxillaries are not prominent. The squamosals are greatly expanded, and there is no postorbital process." Commencing at the last of these definitions, I would remark that (1) the postorbital process is a rudiment in one of the crania, and is entirely wanting in a larger one; (2) the squamosal processes of the zygomata are not more expanded than might be looked for in the adult male of *S. trigonoceras*, and would not be regarded as remarkable in this respect by one who has seen the larger expansions of the *S. bucco;* (3) there is no difference in the premaxillaries, which are more prominent than such species as *S. altirostris;* (4) "The nasals are more elongate and not emarginate at their extremities;" Professor Marsh's figure represents the nasals quite elongate as compared with other species, and exactly as in some of my specimens; the emargination is slight and is not always present in *S. trigonoceras;* (5) there is no difference in the form and position of the horn-cores; (6) the superior size: I have no crania so large as that described by Professor Marsh, which he states to be $0^{m}.915$ long and $0^{m}.558$ wide through the zygomas, with horn-cores 20 inches apart at the apices. My largest measures $0^{m}.762$, $0^{m}.432$, and 17 inches, respectively. The specimen from which vertebræ and a premolar tooth were described above approaches nearer in dimensions; thus, the fourth premolar measures—

	S. trigonoceras.	*S. ingens.*
Length of crown	0.050	0.053
Width of crown	.065	.069

While still under the impression that the species are the same, I defer final conclusion until all of my material is in suitable condition for study

SYMBORODON OPHRYAS, Cope; *Miobasileus ophryas*, Cope, Pal. Bull., No. 15, 3; Proc., Amer. Assoc. Adv. Sci., 1873, 108.

Established on a cranium with nearly complete dentition, but without mandibular ramus. Head elongate, concave in profile from the interorbital region to the supraoccipital crest. This is transverse and concave, the posterior borders of the temporal fossæ extending behind it. These fossæ leave a narrow, flat vertex between them. Zygomatic arch stout and rather deep; a strong postglenoid process. Nasal bones very massive; their free portion elongate, hornless. A massive horn-core rising from above each orbit; no superciliary angle or ridge. Orbit not inclosed behind. Of molar teeth only P. m. 3–4, M. 1–2–3, preserved; the M. with two, the P. m. with one inner cone and two outer continuous crescents. The latter send inwards to one side of the cones a transverse ridge. Incisors and canines unknown. The malar bone is flat and proportionally deep below the orbit. Front concave transversely just behind between the horns. Latter massive and a little compressed. Nasal bones convex longitudinally and transversely, slightly rugose. Trans-

*Amer. Journ. Sci. Arts, 1874, Jan., p. 85.
† Bulletin of U. S. Geological Survey of Terrs., No. 2, p. 28.
‡ American Naturalist, Feb., 1874, p. 84.

verse ridges of teeth with transverse expansions at their inner extremity, being thus T-shaped.

Measurements.

	M.
Length from apex of nasals to occipital condyles, (axial, 26.5 inches)	0.664
Length from occipital condyle to fundus of palate	.376
Length from occipital condyles to end of palatine lamina pterygoidea	.270
Length of four last molars	.242
Length of three last molars	.195
Length of last molar	.068
Width of palate at narial notch	.116

The dental characters of this species ally it to the *S. trigonoceras*, but the form as well as the position of the horns is quite different. Instead of being triangular, a section of the base of these is elliptic. Extremity conical.

SYMBORODON HYPOCERAS, Cope; *Miobasileus hypoceras*, Cope, MS.

This species reposes on a fragmentary cranium only, which embraces nasal, maxillary, frontal, malar bones, &c., both zygomata, premolar and parts of molar teeth, &c. These fragments were taken out of the matrix by the writer, and were found in juxtaposition. They represent parts of the same skull, and, as no other was found in the same bank, are probably without admixture.

The first characteristic of this species is the elongate form of the face anterior to the orbit as compared with other species. The column which separates the orbit from the infraorbital foramen is flat and has a wide external face, instead of being a cylindric column as in *S. acer*, *altirostris*, *bucco*, and *ophryas*. In *S. trigonoceras* it is wider, but, instead of being flat, presents a strong vertical ridge of the lachrymal bone. The infraorbital canal is hence longer than in those species, the more as it does not communicate with the orbit at as anterior a position. Between this point and the preorbital border, the orbit is strongly concave. From the infraorbital canal to the narial orifice, the face is flat, and the border of the meatus is thin, somewhat as in *Rhinocerus*, but includes a narrow prolongation of the large sinus common to this genus. The premaxillary bone does not appear to enter into it. It is evident from the weakness of this support that there could have been no horn of great size or strength above it, and the character of the horn-core preserved is consistent with this view. This consists of the extremital part, thus not exhibiting the basal sinuses. Its section is a compressed oval, narrowed in front; its profile with parallel outlines and a little recurved and not very rugose. Its size as compared with the rest of the skull is the smallest in the genus, and not more than half the proportions of the *S. altirostris*.

A bone of the upper cranial walls was found in place above the second and third premolars, but presents some puzzling peculiarities of form. It is either the posterior part of the nasals or anterior portion of the frontals, and a short decurved border is either that of the nasal meatus or of the orbit. The left maxillary and lachrymal bones are the ones preserved, and the present bone probably belongs to the same side, which agrees with a mark I placed upon it when I exposed it, indicating the anterior and posterior extremities. There can therefore be little doubt that the element is the frontal. The reason for this investigation is the fact that it supports on its anterior extremity a large osseous tuberosity, which consists of a mass of bone co-ossified with the upper surface, as in the horn of the giraffe. It is broken off at the antero-external sutural line of the bone, so that it probably extended over the adjacent margin of the maxillary. It resembles in form the short-horn cores of *Symborodon heloceras*, but is not as in that species an autogenous part of the bone, and its base is therefore not excavated by the anterior part of the frontal sinuses. Thus it is probable that this species possessed two pairs of osseous processes or cores on each side, the one on the nasal, the other on the frontal bone. The absence of interior sinus shows that the latter is not homologous with the horn-core of the typical species of *Symborodon*, while the structure of the post-narial walls (composed of both nasal and maxillary) is clear as to the presence of those sinuses. The horn-core first described is probably from the left side as indicated by its shape. Their existence is also to be inferred from a fragment which resembles the base of the usual horn-core of the other species, especially *S. trigonoceras*. From the preceding it may be derived that this species possesses either two pairs of horn-cores, of which the posterior are on the frontal bone, or that it possesses a single pair on the frontal bone only. As the former is much the most probable supposition, I hesitate to separate this species as a genus distinct from the *Miobasileus ophryas*, which it resembles in many respects.

A portion of the margin of the frontal bone supports an angular projection, doubtless postorbital. The malar bone has an extensive surface of attachment with the maxillary. Its anterior portion bounding the orbit below is a narrow prominent rib, as in *S. trigonoceras*, and different from that of *S. ophryas*. The zygomata are strong, but not expanded; they resemble those of *S. trigonoceras*; but, while shorter than in a specimen of the latter, the squamosal process is deeper. A portion of the nasal bone shows that they were short and light.

There are teeth or alveoli representing four premolars and three true molars as well as a canine. In a right premolar, No. 2, there is a strong basal cingulum, from which coarse plicæ extend inward. The inner cones are confluent into a curved ridge, which is connected by a lower ridge with the outer crescents. The latter are entirely confluent. The canine has a short recurved obtusely conic crown, with a strong cingulum round its posterior base, as in other species of the genus.

Measurements.

	M.
Length from front of orbit to glenoid fossa, (axial)	0.365
Depth of malar below orbit	.020
Depth of squamosal process	.082
Length of molars and last three premolars	.293
Length of last three premolars	.110
Length from nasal meatus to orbit	.103
Length of crown of second premolar	.029
Width of crown of second premolar	.038
Height of crown of canine	
Diameter of crown at base	
Depth of frontal tuberosity	.038
Diameter of frontal tuberosity	.075
Diameter of horn-core, transverse	.038
Diameter of horn-core, longitudinal	.049

Although the specimen from which this species is described is as large as the smaller of the *S. trigonoceras*, it does not belong to an old animal, as the cranial sutures are distinct. It makes one more addition to our knowledge of these curious forms, whose abundance during the Miocene period reminds one of the antelopes of the present period in Africa. It is so distinct from the typical species of *Symborodon* as to render it not unlikely that it will be proper to call it *Miobasileus hypoceras*.

HYRACODON, Leidy.

HYRACODON NEBRASCENSIS, Leidy; Ext. Fauna Dak. and Neb., p. 232.

Abundant in Colorado as in Dakota. During maturity, the first inferior premolar is shed, while that of the upper jaw is retained, leaving the formula $\frac{3}{4}$, $\frac{4}{4}$.

HYRACODON ARCIDENS, Cope, Paleont. Bull., No. 15, 2.

Established primarily on a specimen which includes the left maxillary and premaxillary bones with the teeth as far posteriorly as the fifth molar. Some of these were not fully protruded, and the third premolar of the deciduous dentition was attached, the removal of which displayed the crown of the permanent tooth. The species is about the size of the *H. nebrascensis*, and differs in the form of the inner lobes of the molars and of the first premolar. All the molars have the outer longitudinal and inner transverse crests, the posterior short, the anterior much curved backward round it, and thus forming the inner boundary of the tooth-wall. The first premolar is shorter than the others, and has a short anterior lobe. The milk-molars show more nearly transverse crests as in *Rhinocerus*, but the first premolar had the anterior lobe. Canine and first incisor short, conic; second incisor with an outer lobe; median incisor transverse; enamel smooth.

Measurements.

	M.
Length of four superior molars	0.072
Length of diastema	.006
Length of canine and incisors	.020
Length of first premolar	.014
Width of first premolar	.012
Length of third premolar	.021
Width of third premolar	.022
Height of third premolar	.025

ACERATHERIUM, Kaup.

At least three species of this genus have left remains in the White River beds of Colorado, for the third, which I formerly referred to the preceding genus, may find a more appropriate place here. They are distinguished as follows:

I. Crowns of premolars 2–3–4 broader than long:
  Smaller: symphysis mandibuli much shortened and contracted.—*A. mite.*
  Larger: symphysis elongate, with large incisors.—*A. occidentale.*
II. Crowns of premolars 2–3 as long as or longer than wide:
  Size of *A. occidentale;* P. m., 2, subcuneiform.—*A. quadriplicatum.*

ACERATHERIUM MITE, Cope.

This species is intermediate between the *A. occidentale* and *Hyracodon nebrascensis*, not only in size, but in its short concave diastema, and short, contracted symphyseal region. There are two large external incisors, which are not only absolutely but relatively much smaller than in the *A. occidentale.* If any median incisors exist, they must be small, as the narrow fracture-surface below the original alveolar border exhibits no trace of alveoli. The mandibular teeth are rather elongate, the first having two roots. The ramus has not the incurvature to the diastema seen in *H. nebrascensis*, and is relatively not so deep, and more robust below the last molar than in that species.

Associated with this mandibular ramus, I found the large part of the skeleton of the same animal and the superior molar dentition of two individuals of the same size. The teeth resemble those of the *A. occidentale*, but, besides the smaller size, exhibit differences in the structure of the premolars. The first is about as broad as long; has a strong anterior basal cingulum, and both of the transverse crests strongly curved backward at their inner extremities. The second is transverse, and the transverse crests are simple and distinct distally. The third premolar has its inner anterior angle produced at the base of the crown. The transverse crests form a continuous circuit inwardly, and it is the posterior which curves forward and joins the anterior a short distance external to the inner termination of the latter. In the fourth premolar, the transverse crests are entirely distinct, and the anterior is the longer, causing, as in the third, the protuberance of the inner anterior angle of the shoulder of the crown. Both are bounded at the base by a cingulum, which extends round the posterior base to the outer crest. The posterior transverse crest sends forward a process toward (in one specimen joining) the anterior at one-third the length from its end. The transverse crests of the true molars are simple, and the anterior cross-crest the thickest; no cingula on the inner bases.

Measurements.

	M.
Length of inferior molar series	0.172
Length of premolars only	.080
Length of first premolar	.015
Length from first premolar to end of symphysis	.040
Length of symphysis	.048
Width of symphysis at diastema	.040
Depth of ramus at last molar	.050
Thickness of ramus at last molar	.030
Diameter of inferior incisor	.010
Length of series of superior molars	.153
Length of series of superior premolars	.073
Length of first premolar	.013
Length of fourth premolar	.022
Width of fourth premolar	.032
Length of penultimate molar	.037
Width of penultimate molar	.038

The other series of molars presents similar dimensions, and a few slight variations in structure.

The remainder of the skeleton pertains to one or the other of these individuals. The axis strongly keeled below; the anterior articular surfaces are widely expanded, and the posterior is concave and oblique. Its neural carina is elongate and elevated behind. The dorsal and lumbar vertebræ are slightly opisthocœlian. The glenoid cavity of the scapula is a broad oval, and the coracoid is quite prominent, but obtuse. The internal condylar tuberosity is strong, the external almost wanting; the internal distal crest is very strong. The supracondylar fossæ are very deep. The radius is a stout bone, and attached to the slender ulna by coarse sutural surface, which is very narrow along the middle of the shaft. The femur is stout, and its large trochanter is recurved anteriorly as well as posteriorly so that both faces are concave. There is an elongate crest in place of the little trochanter. The trochlear groove is angular, and bounds a pit just above its proximal end; the condyles are subequal.

The crest of the tibia is deeply grooved, and the spine divided by a wide gutter. The external face is concave proximally, and turns to the front distally. The inner proximal face unites on the last third of the length, to become the internal face. The distal posterior face narrows upward, and runs out below the inner facet of the head. The astragalus has the hour-glass face quite open. The inner tuberosity of the head extends within the line of the trochlea a half-inch. The cuboid facet is oblique and parallel to the outer margin of the head, and constitutes one-fourth the width of the latter.

Measurements.

	M.
Length of radius	0.198
Diameter of its carpal face	.041
Width of humerus, distally	.058
Depth of outer condyle of humerus, distally	.048
Long diameter of glenoid face of scapula	.042
Short diameter of glenoid face of scapula	.038
Length of femur, (over all)	.295
Proximal width of femur, (over all)	.100
Diameter of head, (antero-posterior)	.042
Least transverse diameter of shaft	.035
Transverse diameter of condyles	.060
Antero-posterior diameter at condyles	.084
Length of tibia	.230
Diameter of head, antero-posterior	.580
Diameter of head distally, antero-posterior	.036
Diameter of head distally, transverse	060
Diameter of head of astragalus, transverse	048

This rhinoceros was about the size of a mule.

ACERATHERIUM OCCIDENTALE, Leidy, Ext. Fauna Dak. and Neb., p. 228, Plate xxii.

Several specimens from different localities.

ACERATHERIUM QUADRIPLICATUM, Cope, *Hyracodon quadriplicatus.* Cope, Pal. Bull., No. 15, p. 1.

This species is similar to the last in bulk, with greater proportional elongation of the teeth of the premolar series, at least. It is represented by two individuals, one possessing the permanent, the other the temporary dentition, at least in part.

The former presents only the second and third premolar teeth with an alveolus of the first. The third premolar has four roots and strong basal cingula fore and aft only. The transverse crests are simple and separate. A strong but short crest originates from the outer marginal crest between them, and being in near proximity to the anterior and transverse, it nearly isolates a triangular valley with it. There is a low tubercle between the bases of the inner extremities of the transverse crests. The second premolar is three-rooted only, and is narrowed anteriorly. Its two inner cross-crests are widely separated, and the intervening branch is rudimental. The anterior prolongation of the external crest is longer than the posterior.

The second specimen consists of molars in both maxillary bones, viz: the four premolars, probably deciduous. They differ in appearance from those above described, but not in essential details.

The transverse crests are little curved, and the outer elevated crest uninterrupted. A short elevated fold proceeds from the latter, dividing the head of the transverse valley. A compressed conic tubercle stands between the inner extremities of the crests. The first premolar has two transverse crests and an anterior tubercle. The posterior crest is strongly curved backward at its inner end. A strong cingulum surrounds the base of the crown except on the outer side.

Measurements.

	M.
Length of three anterior molars	0.090
Length of third molar	.030
Width of third molar	.033
Length of first molar	.026
Width of first molar	.019

ANCHITHERIUM, Kaup.

Three species of this genus left their remains in considerable abundance in the Miocene of Colorado. One of these is the *A. bairdii*, Leidy; a second is similar to, and a third smaller than, that well-known animal. They are chiefly known from molar teeth, but greater or less portions of the entire skeleton are frequently found. The following are some of the characters by which the teeth may be recognized:

I. Anterior median tubercle not separated from inner, obsolete on the second premolar:
   - A median ridge on each outer lobe, and basal tubercle between the inner.—*A. bairdii.*

II. Anterior median tubercle well separated from inner:
   - Second premolar with anterior median tubercle distinct at both ends; no inner basal lobe.—*A. cuneatum.*
   - No inner basal lobes; crescents with concave outer faces.—*A. exoletum.*

These are the only species of horses known to occur in the Colorado Miocene.

ANCHITHERIUM BAIRDII, Leidy, Ext. Fauna Dak. and Neb., p. 303, Pl. xx.

Not uncommon.

ANCHITHERIUM EXOLETUM, Cope, *spec. nov.*

Established on a portion of the right maxillary bone, which contains the last premolar and first premolar in perfect preservation and part of the third premolar. These teeth differ from the corresponding teeth in *A. bairdii* in many respects, resembling in the constitution of their outer lobes some of the symborodonts. The outer faces of these are uniformly concave to near the shoulder, leaving a very narrow basal ridge and no longitudinal median ridges. The intercrescentic ridge is incurved and not straight. The anterior middle tubercle is separated from the inner by a deep fissure and grooves to the base; the median is, on the other hand, continuous with the posterior inner. The posterior median is very small. The anterior and posterior basal ridges are small, and there is no trace of basal tubercle between the two medians. Enamel smooth.

The size of this animal was probably that of the *A. bairdii*, but the molar teeth have the antero-posterior diameter greater in proportion to the transverse than in that species. The *foramen infraorbitale exterius* is over the front of the fourth premolar; it is above the front of the third in *A. bairdii.*

Measurements.

	M.
Length of fourth and fifth molars	0.0275
Length of fourth molar	.0140
Width of fourth molar	.0125
Elevation of fourth molar	.0080
Length from front of malar to *foramen infraorbitale anterius*	.0140

This species differs from the *A. agreste*, Leidy, in size about as the *A. bairdii.* The former is only known from mandibular teeth.

ANCHITHERIUM CUNEATUM, Cope, Paleont. Bull., No. 16, p. 7, (August 20, 1873,) specimen No. 1.

The smallest species of the genus represented by both maxillary bones of one individual; several loose molars and a maxillary bone with teeth of others. In the first-named specimen, the second premolar has the elongate form of the corresponding deciduous molar of *A. bairdii*, but I am not sure whether it is the deciduous or permanent one in the present case, as the series only includes the fifth molar. The middle anterior tubercle is directed forward, inclosing an angular fossa with the inner. The latter is separated from the posterior by a basal tubercle, but there is none on the third premolar. The posterior median tubercle is well developed. The outer faces of the outer lobes are concave; sometimes with a faint median ridge.

The fore and aft cingula are well developed, and the basal parts of the posterior transverse ridges are connected with the posterior median tubercles.

Measurements.

	M.
Length of M. 2 and 3 of No. 1	0.0260
Length of M. 1 of No. 1	.0130
Width of M. 1 of No. 1	.0110

The specimen measured as No. 2 in the original description does not belong to the species.

Another specimen contains what are without doubt the permanent third, fourth, and fifth molars. These resemble the corresponding ones of the specimen just described, differing only in being a little smaller. Besides the small size, they differ from those of *A. bairdii* in the entire absence of the inner basal tubercles, and in the rapid reduction in size of the molars from the fifth forwards. The anterior median lobe is very distinct, and the posterior median small.

Measurements.

	M.
Length of third, fourth, and fifth molars	0.0350
Length of third molar	.011
Width of third molar	.011
Width of fifth molar	.014
Length of fifth molar	.013

Since the description of this species was published, Professor Marsh has described an *Anchitherium* of about the same size, from the Miocene of Nebraska, under the name of *A. celer.** It will be desirable to institute comparisons between these to settle the question of their distinctness or identity.

* Amer. Journ. Sci. Arts, 1874, p. 251.

ANCHITHERIUM AGRESTE, Leidy, Report U. S. Geol. Surv. Terrs., (4to,) I, p. 251, Pl. vii.

A portion of the left mandibular ramus, with the last two true molars remaining, indicates a larger species than any of the preceding, and not materially different from that described by Leidy as above.

ARTIODACTYLA.

OREODON, Leidy.

Remains of species of this genus are exceedingly abundant in the Miocene of Colorado, but represent but two species, which are identical with those already known from Dakota and Nebraska.

OREODON CULBERTSONII, Leidy, Ext. Fauna Dak., &c., p. 86.

OREODON GRACILIS, Leidy, Ext. Fauna Dak., &c., p. 94.

About one specimen in ten of the genus belongs to this species.

POËBROTHERIUM, Leidy.

Extinct Fauna Dakota, &c., p. 141.

This genus differs from *Amphitragulus*, Pom., in the association of the first inferior premolar with the canine and incisors rather than with the remaining premolars. Dental formula I., $\frac{?}{3}$; C., $\frac{1}{1}$; P. m., $\frac{4}{4}$; M., $\frac{3}{3}$; the diastema between the first and second premolars only; canine more or less approximated to the first incisor. The arrangement in the anterior part of the upper jaw has not yet been described. There is a diastema behind the first premolar, and one in front of it. The canine is a weak, simple-crowned tooth, and is immediately preceded by a large, canine-like, exterior incisor. The existence of other superior incisors cannot be demonstrated in my specimens.

As already known from the descriptions of Leidy, the otic bullæ are enormously expanded. Their walls are either occupied with an extensive diploë, or lined with a cancellous layer, which gives a reticulate net-work or section. The osteology of this genus presents a number of interesting features. The cranium only has been described by Professor Leidy. The following observations are based on portions of several skeletons, which include the maxillary, mandibular, and other cranial bones, which I extricated from the matrix myself. The dentition agrees with that figured and described by Leidy.

The *atlas* is rather broader than long, with thin diaparapophyses, pierced by the usual foramen at the middle of the base, and produced well backward at the outer margin. The articular facets of the axis are continuous below the *foramen dentale*. The neural arch is regularly convex and without keel on its posterior .4; but the anterior .6 consists of a flat facet descending obliquely to the neural canal, with a median keel and prominent lateral angle descending to the base of the diapophysis in front. The third and fourth cervical vertebræ are enlarged and quite elongate, and present the usual peculiarity of the *Camelidæ* in the position of the canal for the vertebral artery. It perforates a part of the base of the neurapophysis, and not that of the diapophysis. The latter is a decurved lamina, extending the entire length of the centrum, and sending a strong angular ridge from the posterior outer angle to the anterior zygapophysis. The zygapophyses are connected by a strong longitudinal angular ridge. The neural spine is a prominent keel of no great elevation. The hypapophysis is an acute keel, low in front, but produced downward and backward to a rugose, obtuse extremity. The centra are slightly opisthocœlian; the articular surfaces so moderately interlocked as to constitute a form intermediate between that of the camel's and of the *Macrauchenia*. An anterior dorsal vertebra is more strongly opisthocœlian, resembling that of the llama. The diapophysis has a reniform tubercular surface, which looks downward; from its posterior-inferior angle, a strong, fold-like ridge originates, and is continued as the posterior margin of the neural arch. Below the capitular facet, a short ridge originates, which incloses a median fossa, with its fellow on the anterior half of the centrum. A lumbar exhibits a strongly-depressed centrum, and the absence of an epiphysis from it and from the dorsal described indicate the immaturity of the individual.

The *humerus* is a little expanded distally, and is truncate from the trochlear margin on the inner side. The posterior portion of this face is produced into a strong tuberosity, of which a trace may be observed in the llama, which prevents the extension of the fore-arm beyond an angle of 180°. The inner trochlear face has the greater sweep and less width, and is uninterrupted; the outer is wider, and is divided into two nearly coincident planes. There is a supracondylar, but no arterial foramen, as in *Oreodon*.

The fore-arm is long and slender, and the *ulna* co-ossified its entire length, except a foramen near its distal end. The medullary cavities of the two bones are separated for the proximal half of their length. A shallow groove distinguishes the ulna proximally, and at the middle of the shaft the latter forms an acute edge. Distally, the combined bones present three planes, two lateral and a median. The lunar facet is most impressed; the scaphoid and cuneiform are equally prominent.

The *carpus* consists of eight bones, the entire mammalian number, all entirely distinct. The second series presents the most important peculiarities. The *trapezium* is small and posterior; the *trapezoïdes* has an almost entirely lateral presentation, and is also small, and fits an angle of the magnum; the metacarpal facets of these bones are continuous and uninterrupted. The *magnum* is flat and transverse; the *unciform* is nearly as broad, and less depressed; it presents two inferior articular faces, the lesser interior for the third metacarpal; that for the fifth metacarpal is wanting.

There are two principal and two rudimental *metacarpals*. The third articulates with half of the trapezoïdes, the magnum, and a fourth of the unciform; the fourth with the remainder of the unciform. The second and fifth are very short and wedge-shaped, and closely adherent in shallow fossæ of the third and fifth respectively. The latter are distinct, and present no traces of present or prospective attachment; their opposed faces are only flattened on the proximal three-fourths, and rounded on the remaining fourth. Their articular extremities present no basal ridge, and the median keel is posterior, terminating at the distal center. The basal *phalanges* are short, and with a distal trochlear groove; those of the second series are half as long.

Another specimen displays, in addition to cranium with teeth, vertebræ, &c., the hind limbs. The *astragalus* is that of a true ruminant, but the astragalus and cuboid bones are entirely distinct. The ectocuneiform is a subcubical bone, and is distinct from the inner cuneiform behind it, and which is relatively larger than in the typical *Ruminantia*. The metatarsals are two in number, and are distinct throughout their length, the distal portions being not even flattened for mutual contact. They are very much elongate and resemble those of the fore limb. There is, on the external, a proximal excavation for the rudiment of the fifth metatarsus, like that which contains the fifth metacarpus. Probably there is a similar second, but the indications are lost. The distal end of the fibula is not co-ossified with the tibia.

The above analysis determined some interesting relations of this genus. The cervical vertebræ indicate affinity to the *Camelidæ*, and there is nothing in the remainder of the structure to contradict such relation. The separation of the *os trapezoïdes* is found in the camels, and very few others only among *Ruminantia;* but, in the presence of the *trapezium Poëbrotherium* shows relationships to more ancient types, as *Anoplotheriidæ*, &c. The reduction of the digits to two and the separation of the metacarpals point in the same direction; indeed, the number of carpals and metacarpals is prcisely as in *Xiphodon*. But the mutual relations of these bones are quite different from what exists in that genus, and is rather that of the *Camelidæ* and other ruminants, or what Kowalevsky has called the "adaptive type." This author has seen, in the genus *Gelocus*, Aym., from the Lowest Miocene, or Upper Eocene of France, the oldest ruminant and the probable ancestor of a number of the types of the order; but among these he does not include the *Camelidæ*. The present genus is a more generalized type than *Gelocus;* in its separate trapezoid and distinct metacarpals, it represents an early stage in the developmental history of that genus. It also presents affinity to an earlier type than the *Tragulidæ*, which sometimes have the divided metacarpals, but the trapezoïdes and magnum co-ossified. In fact, *Poëbrotherium*, as direct ancestor of the camels, indicates that the existing *Ruminantia* were derived from three lines represented by the genera *Gelocus* for the typical forms; *Poëbrotherium* for the camles; and *Hyæmoschus* for the *Tragulidæ*. The first of these genera cannot have been derived from the second, on account of the cameloid cervical vertebræ of the latter, and all three must be traced to the source whence were derived, also, the *Anoploheriidæ*, and perhaps the little-known *Dichodontidæ*.

The two distinct metacarpals, separate trapezium and trapezoïdes, cameloid cervical vertebræ, and dentition characterize this type as a peculiar family, which may be called *Poëbrotheriidæ*. The genus from which it takes its name was originally referred by Leidy to the *Camelidæ*. I have been unable to detect any characters by which *Protomeryx hallii*, Leidy, can be placed in a distinct genus from the present one. It rests on a portion of a lower jaw of an individual somewhat larger than the usual size of *P. vilsonii*.

POËBROTHERIUM VILSONII, Leidy, *loc. cit.*, p. 141; Cope, Bull. U. S. Geol. Surv., No. 1, 24.

Several individuals procured. The size was about that of a sheep, but the limbs and neck were much longer. The latter resemble, in their slender proportions, those of the *Xiphodon gracile* of the Paris Eocene, and exceed those of any of their contemporaries in this respect.

Measurements.

	M.
Length of continuous six molars	0.058
Depth of mandible at M. 2	.022
Length of atlas, (on centrum)	.035
Length of third cervical vertebra	.056
Width of centrum behind	.020
Depth of centrum behind	.015

	M.
Depth of centrum behind, with hyapophysis	.020
Expanse of diapophysis of fourth cervical	.034
Expense of zygapophyses of fourth cervical	.038
Length of centrum of first dorsal	.025
Width of centrum of first dorsal	.020
Depth of centrum of first dorsal	.014
Width of humerus cistally	.024
Length of radius	.183
Width, proximally	.018
Width distally, (greatest with ulna)	.023
Length of lunar, (anterior face)	.009
Length of magnum, (anterior face)	.004
Width of carpus distally	.020
Width of III. and IV. metacarpal proximally	.019
Width of III. metacarpal proximally	.011
Width of III. metacarpal distally	.009
Length of III. metacarpal	.131
Length of proximal phalange	.017
Length of phalange of second row	.010
Total length of hind foot, (No. 2)	.243
Length of tarsus	.040
Length of astragulus	.025
Length of metatarsus	.147
Length of unguis	.015

HYPISODUS, Cope.

Synopsis New Vertebrata Colorado, 1873, pp. 5, 7.—Bulletin U. S. Geological Survey, No. 1, p. 26.

With this genus we enter a group of true ruminants which are allied in many respects to genera now living in the warm regions of Africa and Asia, namely, the *Tragulidæ*. The premolar teeth are similarly sectorial in their character, excepting the last in *Hypisodus* and *Leptomeryx*, and the metapodial bones are co-ossified into a common bone late in growth; a deep intervening groove always remaining. The cuboid and navicular tarsal bones are more or less completely co-ossified. The relations of the lateral metapodial bones are not yet determinable.

Dental formula of *Hypisodus*: I., $\frac{?}{3}$; C., $\frac{?}{1}$; P. m., $\frac{?}{4}$; M., $\frac{3}{3}$. In the maxillary bone, two posterior premolars are preserved; the last has a single internal crescent, which extends from the posterior external crescent as an oblique branch inward and forward. In the mandibular series, the six incisors, two canines, and two first premolars form an uninterrupted series of ten subequal teeth, and are followed by a long diastema. There is no diastema behind the first premolar. The number and relations of the teeth (the P. m. superior nos. 1–2 unknown) are much as *Poëbrotherium*, but the molars are more prismatic in form.

HYPISODUS MINIMUS, Cope, Bull. U. S. Geol. Surv., 1874, No. 1, p. 26. *Leptauchenia minima*, Cope, Pal. Bull., No. 16, p. 8; *Hypisodus cingens*, Cope, Synop. New Vert. Col., p. 7.

Represented by numerous remains of a species not larger than a gray squirrel.

The antero-exterior vertical ridge of the molars is more prominent and overlaps the preceding tooth more extensively than in the other species. The posterior-superior molar is narrowed behind, and has a small heel-column. In the mandible, the third premolar is three-lobed, and the first premolar is not separated from the second by a hiatus. The superior molars exhibit no basal shoulder, but have distinct roots. The inferior molars are still more prismatic, and the roots of the last are short; enamel smooth. The valleys of the anterior lower molars disappear with use more readily than in some of the allies. The second inferior premolar is one-rooted.

The symphysis is spatulate, and emarginate distally, very convex below, shallowly concave above. The diastemata are occupied by sharp borders, which are slightly approximated at the posterior part. The teeth are directed anteriorly, and are subequal. The mental foramen is just in front of the bounding angle of the symphysis.

Measurements.

	M.
Length of symphysis	0.0090
Width, (least)	.0035
Width at I. 5	.0042
Width at I. 3	.0046
Length of three molars above, (No. 1)	.0120
Length of last molar	.0050
Width of last molar	.0030
Length of three inferior posterior molars, (No. 2)	.0130
Length of inferior last molar	.0058
Width of inferior last molar	.0025

Probably the least-known species of *Artiodactyle*. This exceedingly small ruminant was very abundant during the period of the oreodons, &c.

HYPERTRAGULUS, Cope.

Bulletin U. S. Geol. Survey, No. 1, 1874, p. 26.

This genus is allied to *Dremotherium*, Geoff., and *Leptomeryx*, Leidy. The diagnosis may be thus compared; that of the first I derive from Pomel:

Hypertragulus, Cope: Molars, 6–6; first superior premolar without internal lobe; inferior premolars differing in form, the first one lobed, situated at a distance from the second, which is not three-lobed.

Dremotherium, Geoff.: Molars, 6–6; first superior premolar without interior lobe; inferior premolars similar, three-lobed, and contiguous.

Leptomeryx, Leidy: Molars, 6–6; first and second superior premolars three-lobed, and with an internal lobe; third with an inner and an outer crescent; inferior premolars similar, three-lobed, and contiguous.

In *Hypertragulus*, the third upper premolar exhibits an internal as well as an external crescent. The canine of the inferior series stands in the middle of a considerable diastema, which is preceded by three incisors.

HYPERTRAGULUS CALCARATUS, Cope, Bull. U. S. Geol. Surv., p. 26; *Leptauchenia calcarata*, Cope, Pal. Bull., No. 16, p. 7.

The second superior premolar is quite short, and its inner lobe small. The last premolar has a strong cingulum on the anterior, and especially on the posterior faces of the last premolar. The superior molars have no rib or column opposite the interval between the crescents; the last molar exhibits four ribs on the outer side. The second (third) inferior premolar is compressed and elevated and much shorter than the third, which is three-lobed. The posterior crescents of the last inferior molar are opposite, and not separated posteriorly by a fissure.

This very abundant species of musk is a little smaller than the *Leptomeryx evansii*.

Measurements.

	M.
Length of five molars	0.0260
Length of three true molars	.0175
Length of last true molar	.0080
Width of last true molar	.0070

This species is smaller than the smallest of the genus yet described.

HYPERTRAGULUS TRICOSTATUS, Cope, Bull. U. S. Geol. Surv., No. 1, 1874, p. 27.

A second species, about the size of the last, is represented by the superior molars of one individual, and perhaps by numerous mandibles which I cannot certainly associate with them. The last premolar has, as in the preceding species, a strong posterior cingulum; but there are only three ribs on the outer side of the third molar, the characteristic heel being absent. The latter also lacks the cingulum, which passes round the inner side of the bases of the crowns in *C. calcaratus*, its representative being the basal tubercle between the inner lobes of that and the other molars.

LEPTOMERYX, Leidy.

LEPTOMERYX EVANSII, Leidy, Ext. Fauna Dak. and Neb., p. 165; *Trimerodus cedrensis*, Cope, Pal. Bull., No. 16, p. 8.

The form of premolars characteristic of *Trimerodus*, as cited, pertains also to this genus. The specific name represents the smaller forms, but I find a considerable range in size in the numerous specimens obtained, and do not at present regard them as belonging to more than one species.

STIBARUS, Cope.

Paleontological Bulletin, No. 16, p. 3.

This genus is known from a portion of a mandibular ramus which supports two premolar teeth, one in an imperfect condition. These teeth are of unusually large size as compared with the depth of the ramus, especially in their antero-posterior diameter. The mental foramen issues opposite the anterior root of the first, which is also preceded by a diastema of uncertain length. The second premolar is sectorial in its form, and entirely symmetrical bilaterally, *i. e.*, its cutting edge is median, and there is no incurvature or ribbing of the inner or outer side, but the sides slope symmetrically to the apices of the three cusps of the crown.

The character of this tooth is quite that of some carnivorous animals, *e. g.*, of some *Canidæ*, but the elongate preceding premolar, diastema, and absence of canine alveolus lead me to the opinion that it is an artiodactyle, with the sectorial premolar teeth of the group just considered. The elongate form of these teeth resembles most that of *Poëbrotherium*, but it differs from this genus, as from the others, in the most decided manner. But one species is known.

STIBARUS OBTUSILOBUS, Cope, *loc. cit.*, p. 3.

This species is rare in Colorado, as but one specimen has come under my observation. It is represented by a portion of a mandibular ramus, which supported the two anterior premolars. The teeth are elongated and compressed, with low crowns and flattened roots; the crown of the third is four-lobed. Third premolar with large anterior lobe and posterior heel. Median lobes obtuse; three last lobes connected by a low edge. Enamel slightly rugose.

Measurements.

	M.
Length of bases of three premolars	0.076
Length of basis of third premolar	.008
Elevation of crown of third premolar	.004
Depth of ramus at third premolar	.007

PELONAX, Cope.

This genus embraces species which are nearly allied to *Elotherium.* It is more hippopotamoid than that genus, in the possession of four digits on all the feet and a rudimentary fifth on the pes. According to Kowalevsky, *Elotherium* possesses but two digits of the fore-foot. The *E. mortonii* and *E. ingens* of Leidy represented the genus during the Miocene period in North America, species which Kowalevsky is disposed to unite with the *E. magnum*, Aym., of Europe.

PELONAX CRASSUS, Marsh. (?) *Elotherium crassum*, Marsh, Amer. Journ. Sci. and Arts, 1873, p. 487.

According to Marsh, the digits in this species are 4–5. Three crania, one nearly complete, represent this species in our collections, so far as I can determine from Marsh's very brief description. The form of the skull is very different from that of the *Elotherium mortonii.* The posterior portion from the orbits is abbreviated and the sagittal crest descends from the protuberant frontal region. The orbits present upward and forward, and the temporal fossa is higher than long; the face and muzzle are long and narrow. The malar portion of the zygoma is considerably deeper than the squamosal portion. The descending process of the zygoma is directed downward and forward, as described by Marsh. There is a small, supernumerary, single-rooted premolar close behind the second in all three crania. The length of one of the skulls is eighteen inches. The measurements of the teeth agree with those given by Marsh.

PELONAX RAMOSUS, Cope; *Elotherium ramosum*, Cope, Bull. U. S. Geol. Surv. Terrs., 1874, No. 1, p. 27.

Established on the greater part of a mandible with teeth, from a cranium, which, when complete, must have measured nearly two feet and a half in length, indicating an animal no smaller than the largest living rhinoceroses. The species is remarkable for the great size of the tuberosities on the under side of the mandibular rami, especially of the anterior pair. The symphysis is narrow and deep in front, and the tuberosities form two branches, whose bases occupy the entire lower part of its infero-anterior face. They are some inches long, and are directed outward and downward. The posterior edge is acute, and the extremity very rugose, as though for the attachment of a horny or cartilaginous cap or apex. The outer face is flat; the inner, convex. The second tuberosity is below the first true molar, and is flat and with apex obtuse in profile, and turned outward. The molar teeth number seven; the first and second of the four premolars have but a single root, and are separated by a short diastema. The tubercles of the molars are low; the crowns of some of the premolars have a cingulum in front and behind. The canines are lost, but their alveoli indicate huge size; the root possesses an open groove on the front of the inner side. The outer incisors are large and close to the canine; the last molar is two-lobed and rather small.

Measurements.

	M.
Length of series of inferior molars	0.370
Long diameter of canine alveolus, (28.5 lines)	.060
Length of true molar series	.140
Length of crown of fourth premolar	.053
Height of crown of fourth premolar, (worn)	.022
Width of symphysis between canines	.090
Length of chin-process, (3.5 inches)	.090
Width of chin-process antero-posteriorly	.080
Length of interval to second tuberosity	.150
Length of basis of second tuberosity	.075
Length of symphysis	.175
Depth of ramus at P. m. 2	.100

The only species with which it is necessary to compare the *Pelonax ramosus* is the *Elotherium imperator*, Leidy, (=*E. superbum*, an older though less appropriate name,) known from a canine and incisor-teeth from California and Oregon. The long diameter of the canine is to that of *E. ramosum* as $5\frac{1}{2}$ to $7\frac{1}{8}$.

CARNIVORA.

HYÆNODON, Laiz. et Par.

HYÆNODON HORRIDUS, Leidy, Ext. Fauna Dak., &c., p. 39: Cope, Bull. U. S. Geol. Surv., No. 1, p. 9.

HYÆNODON CRUCIANS, Leidy, *loc. cit.*, p. 48; Cope, *loc. cit.*, p. 9.

This and the preceding species were found rather rarely, and in about equal proportions.

AMPHICYON, Larl.

AMPHICYON VETUS, Leidy, Ext. Fauna Dak., &c., p. 32.

CANIS, Linn.

CANIS HARTSHORNIANUS, Cope, Synop. New Vert. Col., 1873, p. 9.

Indicated by a portion of the mandibular ramus with the first tubercular molar and alveolus of the second. The species was 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 parallelogramic outline of the crown. The outer anterior tubercle is much the larger, while the inner ones are both obsolete. In *C. gregarius*, Cope, the tubercles are equal, and there is no cingulum. Root of tubercular molar subround in section as in *C. 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

Named for my friend, Dr. Henry Hartshorne, professor of natural sciences in Haverford College.

As compared with the corresponding parts of the *Amphicyon vetus*, the specimen of this species displays the characters of the genus *Canis*. The first tubercular molar is considerably smaller—not much more than half as large, and the second very small, and supported by but one cylindric root. The alveolar portion of the ramus is at the same time as stout as that of the *A. vetus*.

CANIS LIPPINCOTTIANUS, Cope, Synop. Vert. Col., 1873, p. 9.

Among the numerous remains of dogs associated with those of rodents and insectivora, I have observed several portions of mandibular rami with teeth which indicate a species intermediate in size between the *Canis hartshornianus* and the *C. gregarius*. It was therefore not very different from the coyote in size. 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

CANIS GREGARIUS, Cope, Pal. Bull., No. 16, p. 3.

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

This species is more abundant than all the other carnivora of the Colorado beds 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.

This species is about the size of the *Amphicyon gracilis*, Leidy, from the White River beds of Dakota, and I suspected at one time that I had found that species in Colorado. Dr. Leidy describes that dog as having a two-rooted second tubercular molar, a character befitting its reference to *Amphicyon*, but very distinct from anything found in *Canis gregarius*. Leidy's figure (7–8, Pl. v) exhibits also an equality in the size of the incisor-alveoli and production of the premaxillary bone not found in the present species.

CANIS OSORUM, Cope, Synop. Vert. Col., 1873, p. 10.

Represented by two mandibular rami of a species of about the size of a weasel. One of these exhibits four premolars, the other a fourth premolar with fangs of a sectorial, and one or two tuberculars. The first premolar is one-rooted and close behind the large canine; the third exhibits no posterior lobe, and the crown is low. The ramus is shallow and stout.

In the second specimen, which is only provisionally referred here, the proportion of the base of the crown of the fourth premolar is identical with that of the first-described specimen. It exhibits a posterior median lobe. The succeeding tooth was a little larger, and the first root following placed transversely in the jaw.

Measurements.

	M.
Length of bases of four premolars, (No. 1)	0.0113
Length of basis of P. m. III	.0030
Elevation of crown of P. m. III	.0020
Length of basis of crown of P. m. IV.	.0040
Depth of ramus of mandible at P. m. IV	.0060
Length of bases of P. m, IV, M. I	.0080
Depth of ramus at first molar	.0060

BUNÆLURUS, Cope.

Synopsis Vertebrata Colorado, 1873, p. 8.

Char. gen.—Molars two, the first sectorial and without inner tubercle; the second small, tubercular. Premolars simple, acute; mandible not widening forward. This is one of the forms which associates the *Felidæ* and *Mustelidæ*. With the tubercular tooth of the latter, the sectorial resembles that of the cats, in the absence of all trace of the inner tubercle, but is again weasel-like in the well-developed heel of the sectorial. The genus is probably without the peculiarities of the *Drepanodons*, &c., *i. e.*, the downward expansion of the mandible, &c. The genus *Ælurogale*, of Delfortrie, is said to present a dental structure not unlike that of *Bunælurus*, but I have not had the opportunity of reading his diagnosis.

BUNÆLURUS LAGOPHAGUS, Cope, *loc. cit.*, 1873, p. 8.

Represented by a portion of a mandibular ramus, which carries the sectorial and tubercular teeth, and another, more perfect, from the right side, which contains the two last premolars as well as the sectorial and tubercular teeth. Thus the number of premolars is uncertain. Those preserved are narrowly acuminate; the basal lobes of No. 3 quite small. The middle lobe of the sectorial is considerably higher than the anterior, and the heel, though short, is well developed. Tubercular small; crown longitudinally extended.

This feline was about the size of a half-grown cat.

Measurements.

	M.
Length of crowns of four molars, (No. 1, immature)	0.0140
Length of two true molars	.0065
Length of sectorial tooth	.0050
Width of sectorial tooth	.0021
Elevation of sectorial tooth	.0045
Depth of ramus at sectorial tooth	.0050
Depth of ramus at sectorial, (No. 2, adult)	.0070

DAPTOPHILUS, Cope.

Paleontological Bulletin, No. 16, p. 2.

General character of dentition as in *Machærodus*, but the mandibular teeth are: C., 1; P. m., 3; M., 1, a premolar tooth being added. Second premolar three-lobed; carnassial tooth with short cutting-heel; tubercular none. Superior canine much compressed, denticulate, not grooved.

DAPTOPHILUS SQUALIDENS, Cope, *loc. cit.*

Established on a specimen in which the permanent sectorial of the lower jaw is protruded, but the temporary sectorial not yet displaced by the permanent last premolar. Second premolar with strong, subequal anterior and posterior basal lobes and two-rooted. Enamel smooth.

Sectorial with two posterior lobes, the lower prominent. Ramus decurved at symphysis. Superior canine in shape, like a tooth of a shark of the genus *Oxyrhina*; flat within, slightly convex without; the front cutting-edge turned inward at the basis; both edges denticulate. The fang of the inferior canine penetrates beyond a point below the first premolar.

Measurements.

	M.
Length of bases of three posterior molar teeth	0.040
Length of basis of second molar tooth	.010
Elevation of basis of crown of second molar tooth	.009
Length of basis of crown of fourth molar tooth	.017
Elevation of basis of crown of fourth molar tooth	.013
Depth of ramus at fourth molar tooth	.015
Depth of ramus at second molar tooth	.018
Length of fragment of upper canine	.025
Width of fragment of upper canine at base	.011

Size of the panther.

Should it be ascertained that this cat developes a tubercular molar, (of which I can now find no trace,) it will be necessary to estimate it as a second species of *Dinictis*. Besides the large basal lobes of the second premolar, the inferior canine has an apparently larger size and more posterior extent of the fang; certainly much greater than in the *Hoplophoneus oreodontis*, which resembles the *Dinictis felina* in this region exteriorly. In accordance with the continuation of the canine alveolus, the inferior border of the jaw is rounded, and though flared on the outer margin for the large superior canine, it is not truncate as in the saber-toothed tigers generally. Coincidentally the superior canine is reduced in size, being relatively shorter than in *D. felina*.

HOPLOPHONEUS, Cope.

Bulletin U. S. Geological Survey Terrs., No. 1, p. 23, 1874.

Char. gen.—Dental formula of mandible, I., 3; C., 1; P. m., 2; M. 2. Superior canine greatly developed; end of mandible expanded and thickened to protect it.

This is simply *Machærodus* with a tubercular molar, as in *Dinictis*. The dental formula is the same as that of *Bunælurus*, but the latter probably has the character of *Felis* in its anterior dentition.

HOPLOPHONEUS OREODONTIS, Cope; *Machærodus oreodontis*, Cope, Synop. New Vert. Col., 1873, p. 9.

Char. specif.—The species was established on a young individual with part of the temporary dentition remaining. A jaw of an adult furnishes additional characters. The first premolar (the third) has two roots and is as large as the second, instead of being smaller, as in *Drepanodon primævus*. The second (fourth) has a prominent anterior basal tubercle, as in the last-named species, but which is, according to Leidy, wanting or very small in *Dinictis felina*. The anterior angle of the mandible is not produced downward so much as in the *Drepandon*, but is more as in *Din'ctis felina*, with which the present species agrees nearly in size. The diastema is very short and rises to the base of the large inferior canine. There is a mental foramen below the anterior root of the first premolar, and two vascular foramina on the front face of the ramus, one above the other. In the form of the second premolar, this species resembles *Drepanodon occidentalis*, Leidy; but that species is supposed not to possess the tubercular molars, and is nearly twice the size of the present animal.

Measurements.

	M.
Length of ramus to end of molar series	0.065
Length of molar series	.048
Length of base of first premolar	.014
Length of base of sectorial	.017
Depth of ramus at sectorial	.017
Depth of ramus at diastema	.024
Depth of ramus at symphysis	.024

The second specimen is immature, and presents the following characters. It is represented by an incomplete manibular ramus of the right side, containing two incisors, and the deciduous sectorial, with portions of other teeth. The incisors are very stout, and exhibit slightly-curved conic crowns, with a serrulate cutting-edge on the inner face. The sectorial tooth has the elevated acute anterior lobe, which forms with the median lobe the usual sectorial shear. Posteriorly to the median, there are two acute lobes, the third as high as the anterior, while the fourth nearly reaches the line of the base of the anterior notch. There is no anterior basal lobe. The sectorial was of large size, judging by the alveolus. The first premolar was also large and two-rooted. The alveolus for the inferior canine is flat on the inner side. The increasing anterior depth of the ramus indicates an expansion for the protection of the large superior canine.

From the same locality as the last. About the size of the Canada lynx.

Measurements.

	M.
Length of bases of crowns of premolars I and II	0.0210
Length of bases of crowns of premolar II	.0110
Elevation of crown of premolar II	.0110
Elevation of crown of incisor II	.0055
Diameter of crown of incisor II	.0035
Length of diastema behind canine	.0110

QUADRUMANA.

MENOTHERIUM, Cope.

Bulletin U. S. Geological Survey of Terrs., No. 1, 1874, p. 22.

This new genus is probably quadrumanous, and allied to the lemurs; 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 monkeys 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 genus is apparently allied to the *Leptochœrus* of Leidy.

MENOTHERIUM LEMURINUM, Cope, *loc. cit.*, January, 1874.

Char. specif.—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

This animal was about as large as the domestic cat.

TESTUDINATA.

TESTUDO, Linn.

Remains of species of this genus are very abundant in the Miocene of Colorado, and present much greater variety of structure than do the tortoises of the White River beds of Dakota. This is most strikingly seen in the forms of the lobes of the plastron, which may be flat and truncate, deeply bifurcate or produced into a wedge-shaped process. I have distinguished four species, as follows:

TESTUDO CULTRATUS, Cope, Pal. Bull., No. 15, p. 6.

This species introduces several from the same formation as the *Peltosaurus*, which agree with the existing genus *Testudo* in their short, stout metapodial and phalangeal bones, and single anal scutum of the carapace.

In the present species, the prominent peculiarity is seen in the form of the lip of the anterior lobe of the plastron, each half of which is an elongate pyramid, its depth and width being equal. The marginal bones were short, stout, and recurved. Length of carapace nearly 18 inches.

TESTUDO LATICUNEUS, Cope, Pal. Bull., No. 15, p. 6.

In this species, the anterior lip of the lobe of the plastron is very prominent and wedge-shaped, and with dentate margin, and is flat and thin. The posterior lobe is subtruncate. The mesosternal bone is hexagonal and broader than long, and is pointed behind. The pygal bone is triangular, and the anal marginal is convex in both sections and abbreviated below. Each marginal bone behind the bridge presents a mucro, where a dermal suture reaches the margin. Anal scutum very wide. All the sutures double lines. Length from 18 inches to 2 feet; width two-thirds the length. Carapace rather flattened.

This is the most abundant species of the formations; several good specimens obtained.

TESTUDO AMPHITHORAX, Cope, Pal. Bull., No. 15, p. 6.

Anterior lobe of plastron broadly truncate, scarcely lipped; posterior lobe openly emarginate. Mesosternum longer than broad, acute in front, very obtuse behind. All the sutures simple. Anal marginal shortened but convex. Form depressed. Length and width as in the last.

TESTUDO LIGONIUS, Cope, Pal. Bull., No. 15, p. 6.

Posterior lobe of plastron produced into two flattened, sharp-edged, wedge-shaped processes, separated by a deep notch, as in *Hadrianus corsonii*. Marginal bones behind very wide, or, considered separately, long and narrow, with a step-like angle and notch where the scutal suture reaches the margin.

The form of the anterior lobe of the plastron is yet uncertain, though fragments found with the type resemble that of *T. laticuneus*. At least three incomplete specimens obtained.

STYLEMYS, Leidy.

STYLEMYS NEBRASCENSIS, Leidy; *Testudo nebrascensis*, Leidy, Report Geol. Surv. Terrs., (4to,) vol. i, p. 339.

LACERTILIA.

PELTOSAURUS, Cope.

Palentol. Bulletin, No. 15, p. 5.

Premaxillary undivided, with spine; a zygomatic postorbital; and parieto-quadrate arches. Teeth pleurodont, with obtuse, compressed crowns, of similar form on all the jaw-bones. Body covered with osseous scuta, which are in places united by suture. Vertebræ depressed, with simple articulations. Median, hexagonal, dermal scuta on the parietal bone. Parietals united.

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. The primary group to which it is to be referred is not difficult to determine.*

The frontal and parietal bones are each undivided, and there is no fontanelle in either or their common suture.† 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.

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 *Amphisbœnia*, 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

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

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

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.

PELTOSAURUS GRANULOSUS, Cope, Pal. Bull., No. 15, p. 5.

Indicated by considerable portions of a skeleton, which I excavated from the matrix. Parietal bone broad and flat, frontal little narrowed, gently convex, both with finely granular upper surface. Scuta not keeled, finely granular. Number of teeth on premaxillary bone, 7; teeth on dentary, 10 in $0^m.010$. Surfaces of dentary smooth.

Measurements.

	M.
Median width of parietals	0.0140
Median width of frontals	.0080
Length of mandibular ramus to cotylus	.0400
Diameter of vertebral centrum, (transverse)	.0030
Length of vertebral centrum	.0055

Size about that of the American *Heloderma*.

EXOSTINUS, Cope.

Synopsis New Vert. Colorado, p. 16.

Char. gen.—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.

These details, so far as they go, resemble those of *Peltosaurus*, and *Exostinus* is doubtless to be referred to the same natural tribe of lizards, the *Diploglossa*. The rugosities of the cranium indicate its greater resemblance to *Heloderma* than to *Gerrhonotus*, but the teeth are much more like those of the former genus than the latter. This genus and *Peltosaurus* constitute our first definite knowledge of the extinct forms of *Diploglossa*.

EXOSTINUS SERRATUS, Cope, *loc. cit.*

Char. specif.—A series of tubercles along each supra-orbital border, longitudinal at the front, 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 0m.0050.

Measurements.

	M.
Length of frontal, (nearly complete)	0.0070
Width of frontal posteriorly	.0034
Width of frontal at post-orbital 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 common eastern scinc, (*Eumeces fasciatus.*)

ACIPRION, Cope.

Synopsis Vert. Colorado, p. 17.

Char. gen.—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, *loc. cit.*

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

DIACIUM, Cope.

Synopsis Vert. Colorado, p. 17.

Established on the sacral vertebra of a large lizard, which presents such peculiarities as to indicate that its affinities are remote from those above described.

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 QUINQUEPEDALE, Cope.

Char. specif.—Two hypapophysial tubercles below the ball. Centra slightly depressed, the cup excavated above and below. An angulation extends backward 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
Diameter of articular cup, { 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 *Varanidæ*.

CREMASTOSAURUS, Cope.

Synopsis Vert. Colorado, 1873, p. 18.

Established on vertebræ which differ from those of *Peltosaurus* in the absence of the sharp ridges which connect the anterior zygapophyses with the posterior in the dorsal vertebræ. They are better developed in the cervical region. The species of this genus which are known are ntermediate in size between those of *Peltosaurus* on the one hand and *Exostinus* and *Aciprion* on the other.

Dorsal vertebræ without zygosphene.

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 round 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, *loc. cit.*, p. 18.

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

The dorsal vertebræ, which are appropriately associated with the cervicals, 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. Neural spine a keel extending from the front of the arch and rising into a short 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.

CREMASTOSAURUS UNIPEDALIS, Cope; *Diacium unipedale*, Cope, Synop. Vert. Col., p. 18.

Represented by a sacral vertebra of an individual smaller than any of those of the last-described species, and 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
Diameter of cup, vertical	.0018

PLATYRHACHIS, Cope.

Synopsis Vert. Colorado, p. 19.

Char. gen.—Dorsal vertebræ united by the zygosphene, as well as the usual articulation. Centrum much depressed, flat below. Neural arch depressed, an angle connecting the zygapophyses. Neural spine a keel, projecting beyond the posterior margin in a mucro.

PLATYRHACHIS COLORADOENSIS, Cope, *loc. cit.*, p. 19.

Char. specif.—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 zygapophysis	.0025

The size of this species is similar to that of the two species already described from teeth; but the vertebral articulation is not appropriate to *Exostinus* with existing lights.

OPHIDIA.

NEURODROMICUS, Cope.

Synopsis Vert. Colorado, p. 15.

Char. gen.—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.

NEURODROMICUS DORSALIS, Cope, *loc. cit.*

Char. specif.—Articular surfaces of centrum round; the ball with a slightly upward-looking obliquity. Hypapophysis continued to cup as a prominent carina. A ridge connecting zygapophyses. Neural spine extending its base forward, so as to stand on the entire length of the neural arch.

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.*)

CALAMAGRAS, Cope, *loc. cit.*

Char. gen.—An obtuse hypapophysial keel most prominent posteriorly. No ridge from the zygosphene; that from the parapophysis wanting or rudimental. Neural spine posterior, short, and obtuse. Neural arch not produced posteriorly; zygosphene wider than articular cup. Articular surfaces moderately oblique. A concavity separating the articular surfaces of the diapophysis and parapophysis.

This genus differs from *Boavus*, as described by Marsh, in the absence of ridges and concavity of parapophysis.

CALAMAGRAS MURIVORUS, Cope, *loc. cit.*, p. 15.

Char. specif.—Articular surfaces a broad transverse ellipse. Hypapophysis terminating in an appressed point. No inferior lateral ridge on centrum; a trace of one on the posterior part of neural arch.

Measurements.

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

Represented by six consecutive vertebræ. Size that of the water-snake, (*Tropidonotus sipedon.*)

CALAMAGRAS TRUXALIS, Cope, *loc. cit.*, p. 15.

Smaller. Articular surfaces more oblique. Neither centrum nor arch with ridges; hypopophysis low, without apical point. Parapophysial surface very short vertically.

Measurements.

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

Size of the garter-snake; four vertebræ preserved.

CALAMAGRAS ANGULATUS, Cope, *loc. cit.*, p. 16.

The largest species, distinguished by the presence of a low ridge on the centrum from the parapophysis to the middle of the centrum. Neural spine on the posterior half of the neural arch short, truncate. Hypapophysis short, ending in an obtuse point. Parapophysis larger than in other species, nearly equal to the diapophysis.

Measurements.

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

APHELOPHIS, Cope, *loc. cit.*, p. 16.

Char. gen.—Similar to the preceding in the absence of acuminate diapophysial process, the zygosphene exceeding the articular extremity in width, and the simplicity of the posterior border of the neural arch. There are no longitudinal ridges, the hypapophysis being entirely wanting. The articular faces of the parapophysis and diapophysis continuous without intervening concavity.

APHELOPHIS TALPIVORUS, Cope, *loc. cit.*, p. 16.

Char. specif.—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 a 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 cups,	transverse	.0018
	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 *C. truxalis*.

CHAPTER V.

THE LOUP FORK EPOCH.

In the Pliocene strata already described, mammalian remains are exceedingly abundant over limited areas; those of horses in an especial manner. Those obtained are as follows:

	Species.
Carnivora	4
Perissodactyla	8
Artiodactyla	7
Proboscidia	1
Testudinata	1
Total	21

The most important paleontological results are, (1) the discovery that the camels of this period possessed a full series of upper incisor-teeth; (2) that the horses of the genus *Protohippus* are, like those of *Hippotherium*, three-toed; (3) that a *Mastodon* of the *M. ohioticus* type existed during the same period.

List of species.

CARNIVORA.

CANIS, Linn.

CANIS, *sp. incerta*.

Represented by a portion of the left ramus of the mandible, which contains alveoli for, and portions of, I., 3; C., 1; and P. m., 4. The incisors are closely crowded by the huge canines, which have larger proportions than dogs generally, resembling more those of the bears, or large feline carnivora. The first premolar is one-rooted, and separated by a long diastema from the canine. The second premolar is two-rooted, and separated from the first by a short diastema. The third is also separated by a diastema from the second, which exceeds that in front of the latter. The fourth follows the third immediately. The mental foramina are two, one large, below the first premolar, the other smaller, but little below the alveolar margin, opposite the posterior margin of the second premolar.

Measurements.

	M.
Length of fragment	0.175
Length from incisors to P. m. 4	.095
Length of basis of P. m. 3	.017
Length of basis of P. m. 2	.013
Vertical diameter of canine at basis	.029
Length of symphysis	.075
Depth of ramus at P. m. 2	.047

This large species is about as large as the *Canis haydenii* of Leidy, and may be identical with it. It is characterized, among dogs, by the weakness of its premolars as much as by the strength of its canines.

CANIS SÆVUS, Leidy, Anc. Fauna Neb., p. 28.

TOMARCTUS, Cope.

Paleontological Bulletin, No. 14, p. 1.

Established on a mandibular ramus, supporting a perfect carnassial tooth and fangs of the following dentition: C., 1; M., 4; the last incomplete; hence the number of posterior teeth unknown. The ramus is much narrowed in front. The carnassial has an inner tubercle within and behind the median lobe, and a large posterior heel supporting both inner and outer tubercles. The succeeding tooth was wide.

This genus is apparently one of the *Canidæ*. The carnassial tooth is identical with that of the genus *Canis*, but the existence of only two premolars in advance of it is a feline rather than canine character. The jaw diminishes rapidly in size anteriorly, and the fragment contains part of the fang of a large canine tooth, whose crown, like that of the two succeeding teeth, is broken off. The form was evidently a short-faced type of dog, concerning which additional information will be looked for with interest.

TOMARCTUS BREVIROSTRIS, Cope, Pal. Bull., No. 16, p. 2.

Second premolar two-rooted. Anterior half of the carnassial with the usual sectorial structure; the anterior lobe the smaller. The inner tubercle bout the same height. The heel constitutes one-third the length of the tooth, and its lateral tubercles are angular; the posterior low. Enamel slightly rugose.

Measurements.

	M.
Length of first three molars	0.041
Length of third molar, (carnassial)	.033
Elevation of third molar, (carnassial)	.014
Width of third molar at middle	.009
Length of heel of third molar	.007
Depth of ramus at third molar	.021

In the abbreviation of the dental series in front, this species resem

MARTES, Cuv.

MARTES MUSTELINUS, Cope, Pal. Bull.,* No. 14. (*Ælurodon.*)

A small, single-rooted, second molar of the lower jaw. First molar sectorial, with a rather narrow posterior heel, one-third its length, and a small inner tubercle at the base of the second outer cusp. Last premolar with a short posterior heel, and distinct outer tubercle on the posterior side of the cusp. Margin of jaw strongly everted below masseteric fossa.

Measurements.

	M.
Length of three last molars	0.018
Length of sectorial molars	.010
Width of sectorial molars, (greatest)	.005
Height of posterior cusp, (greatest)	.005

This species was about as large as the domestic cat, and less than one-third that of *Ælurodon ferox*, Leidy.

PERISSODACTYLA.

ACERATHERIUM, Kaup.

ACERATHERIUM MEGALODUS, Cope, Pal. Bull., No. 14, p. 1.

This large species and the *A. crassus*, Leidy, were very abundant during the Pliocene period in Western North America. Their remains are everywhere mingled with those of horses and camels. The former, and probably the latter, are to be referred to a distinct section of *Aceratherium* on account of the existence of but three premolar teeth in the mandibular series, and probably in the maxillary also. One of our specimens exhibits the missing superior premolar on one side. The outer incisor below is a large tusk, while the inner is small and caducous, points in which this genus resembles the genera above named, and differs from the African and tichorhine species, or genus *Atelodus* of Pomel.

A posterior upper molar represents the *A. crassus* in the original collections described by Leidy. A well-developed tubercle, which rises

* These publications may be procured at the Naturalist's agency, Salem, Mass., or of the writer.

from the bottom of the valley between the inner extremities of the cross-crests in the last and penultimate molars of *A. megalodus*, is wanting in the *A. crassus;* partly on this account I refer my second large Pliocene rhinoceros to the latter, represented by a perfect cranium, with dentition of both jaws nearly complete, with large portions of skull and dentition, with other bones, of other specimens.

The nasal bones are not co-ossified, and but little convex. They are smooth and long and slender, indicating that this rhinoceros was without a horn. The inion is anterior to the line of the occipital condyles, and is considerably elevated and bilobed. The temporal fossæ approach each other, being separated by a narrow rib only. The ramus mandibuli is rather slender, and projects well in front of the line of the nasals. The dentition is I., $\frac{?}{2}$; C., $\frac{0}{0}$; P. m., $\frac{3(-4)}{3}$; M., $\frac{3}{3}$. The usual anterior premolars are wanting in the lower jaw, and in the upper jaw in one specimen and on the right side of the other; hence I suspect $\frac{3}{3}$ to be the normal dentition of the species. As they are $\frac{4}{4}$ in *Rhinocerus* and *Aceratherium*, the present animal may be placed in another genus under the name of *Aphelops*. The middle incisors were caducous. The outer are very large and cylindric at base; the attrition of their inner faces would indicate an opposing pair, but these I did not find, and the premaxillary sutures of the maxillary are exceedingly slender. The first lower premolars are not very narrow. The transverse crests of the superior molars widen inwardly, but do not come into contact with each other. On the posterior margin of the posterior is a deep notch, which almost divides it across. There are no other lobes. The last molar is narrowed. These teeth are notable for their very large size as compared with that of the skull generally. In one specimen, P. m. 2 (the anterior) is 0.8 the second molar in transverse diameter; but in an older specimen it is less than half the same.

Measurements.

	M.
Length of molar series	0.255
Length of second molar, crown	.050
Width of second molar, crown	.050
Width of second premolar, crown	.033
Length of second premolar	.032
Length of first (second) lower premolar	.028
Width of first (second) lower premolar	.016
Total length of cranium	.560
From inion to end-nasals	.456
From foramen magnum to inion	.138
Width at orbits	.173
Depth of mandible at first molar	.070

About the size of the Indian rhinoceros, but with much larger teeth.

ACERATHERIUM CRASSUM, Leidy; *Aphelops crassus*, Cope, Bull. U. S. Geol. Surv., No. 1, 1874, p. 12; *Rhinoceros crassus*, Leidy, Anc. Fauna Dak. and Neb., &c., p. 228.

Leidy states that the formula of dentition of this species is identical with that of the Indian rhinoceros, and elsewhere that it is probably a true rhinoceros, as distinguished from *Aceratherium*. He does not appear to have possessed material to verify these statements.

An imperfect mandibular ramus, containing the last molar and alveoli of the four teeth which precede it, differs from the corresponding one of *A. megalodus* in the greater thickness in proportion to the depth. It is absolutely both shallower and thicker than a corresponding ramus of the allied species, while the teeth are larger, the last three occupying exactly a space equal to that supporting the last four of *A. megalodus.* The last molar is larger than the penultimate in *A. crassum*, (larger in *A. megalodus*,) and encroaches on the base of the coronoid process; in all the jaws of *A. megalodus*, this tooth is considerably in advance of this process, which rises more abruptly than in it. This tooth is shown to be the last molar by the absence of any trace of alveolus or crown of a successional tooth behind it in the various jaws in question. In *A. crassum*, the coronoid process rises gradually from the front of the last molar.

Measurements.

	A. megalodu.	*A. crassus.*
Length of last four molars	0.160	0.215
Length of last molar	.044	.062
Length of first true molar	.036	.055
Width of first true molar	028	.033
Depth of ramus at M. 2	.087	.078
Width of ramus at M. 2	.047	.055

The last molar is not quite protruded in the type specimen of *A. crassum.*

Near to the specimen just described, I found the left maxillary bone, with nasal, frontal, and other elements, of a rhinoceros, which differ in some respects from corresponding parts of *A. megalodus.* The rather larger teeth would coincide with the type of *A. crassum;* but that the specimens belong to the same individual is not certain. It is characterized by the same increase in size posteriorly of the molars; the M. 2 exceeding that of the *A. megalodus*, while the P. m. 2 (the first) is considerably smaller. The latter measures less than half M. 2, while it is 0.8 the diameter of the same in the *A. megalodus.* There is no rudiment of P. m. 1. Hence, this specimen displays fully the characters of the genus *Aphelops.* The nasal bones are long, acuminate, straight, and not co-ossified. They are tectiform, and distally compressed, instead of flattened, as in two specimens of the *A. megalodus;* they are also quite rugose at the extremity. These characters may be only sexual.

HIPPOTHERIUM, Kaup.

HIPPOTHERIUM SPECIOSUM, Leidy, Anc. Fauna Dak. and Neb., 282.

HIPPOTHERIUM PANIENSE, *sp. nov.*

Indicated by molar teeth in the collection. Two of these have elongate-curved crowns; the longer is a left posterior, the more abraded a right median. The latter is characterized by the generally greater simplicity of the enamel-boundaries of the lakes, as compared with the same portions of *H. speciosum*, with which it agrees in size. The only plications to be observed are the usual opposite ones entering the lakes from the middle of their adjacent boundaries, and a slight one at the inner angle of the same border of the anterior lake. The inner crescents are united, the posterior retaining its width posteriorly, and giving off the posterior inner column from its anterior half. Both the internal columns are longitudinally oval and rather small, the anterior well separated. The adjacent enamel-border gives off the usual projecting fold. Outline of crown nearly quadrate.

A second molar, less worn, presents therefore a little greater complexity of enamel-folds. Thus the anterior inner part of each lake is folded into a loop, and there is a second pair of opposite folds outside of the usual pair on the adjacent borders of the lakes.

A third molar is much more worn than either of the preceding, so as to throw the inner and median posterior areas together. The anterior median is well isolated and subround. There are no folds of the enamel-plates whatever.

Measurements.

	M.
Length of No. 1 from roots	0.027
Width of antero-posterior	.019
Width of extero-interior	.020
Length of No. 2	.032
Width of antero-posterior	.021
Width of extero-internal	.018
Length of No. 3	.018
Width of antero-posterior	.021
Width of extero-interior	.022

From the neighborhood of the Pawnee Buttes, Colorado.

PROTOHIPPUS, Leidy.

PROTOHIPPUS LABROSUS, Cope.

Having obtained a number of fragmentary and entire crania referable to species of the present genus, it becomes possible to correlate the mandibular with the maxillary forms, dentition, &c., as it has not been possible to do heretofore. Of mandibles there are four types, which I refer to species as follows:

Symphysis flat, shallow; no diastema between their incisor and canine teeth.—*P. labrosus.*

Symphysis narrower, deep; inferior molars smaller.—*P. sejunctus.*

Symphysis narrow, deep, contracted, and smaller; lower molars larger.—*P. perditus.*

These comparisons are instituted on one mandible of the first; two entire and three incomplete ones of the second; and two of the third types, all but two accompanied by superior molars or crania. The specimen of *P. labrosus* embraces the right maxillary bone, containing five molars; a second specimen includes three superior molars of the left side; it is also represented by several isolated molars.

Protohippus labrosus resembles the two species described by Leidy as *Merychippus* in the short crowns and long roots of the molar teeth, with thickened external ridges, separated by thin bands of cementum. It therefore differs from *Protohippus perditus* and *P. placidus*, resembling the first named in size. It is exactly intermediate between the *P. insignis* and *P. mirabilis* in size, and to it is no doubt to be referred Dr. Leidy's No. 4 of the latter.* Either there are three species of the present character, or Dr. Leidy's and the present forms must be arranged under one appellation. I prefer retaining them as distinct for the present, since I have nearly identical measurements in six different individuals, and four of the *P. perditus* equally uniform in dimensions. The latter always slightly exceed those of the *P. labrosus*, and differ in the longer dental crowns, with subacute exterior ridges; typically, the internal columns are oval in section, but may occasionally be subcylindric; they are cylindric in *P. labrosus*. The first specimen above mentioned I regard as typical, and describe it as follows:

The first premolar is well developed; in the first molar, the anterior lake is isolated from the inner fold. The anterior inner column is cylindric in all the teeth; the posterior similar, but joined with its crescent by attrition in most of them. The boundaries of the crescents are all simple, except a tendency to the middle infolding of the adjacent borders

* Ancient Fauna of Dakota and Nebraska, p. 300, figured plate xvii, Figs. 8–9.

of the crescents. The teeth are but little curved, and the base of the crown, with termination of the broad longitudinal gutters, is visible, although the attrition of the teeth, especially of the inferior incisors, does not indicate advanced age.

The mandible is distinguished by the length of the diastema and the flatness and shallowness of the symphysis. The permanent molars are all present in the specimen, and are robust in form. Except in the first and last, they are characterized by the small development of the anterior crescent horn and posterior tubercle of the inner side of the crown. The horn of anterior crescent of the first molar is well produced inward, broad, and simple; the entire tooth is narrower than the other molars except the fifth and sixth. The latter is a little longer than the others, and possesses a posterior crescent smaller than the others. The canines issue from their alveoli very close to the third incisors; the two pairs of first and second incisors are in a nearly transverse line, in consequence of the flatness of the symphysis. The median lake is half worn-out in the second incisors.

Measurements.

	M.
Length of four premolars and one molar	0.087
Length of crown of first premolar	.008
Length of crown of second premolar	.022
Width of crown of second premolar	.019
Length of crown of first molar	.018
Width of crown of first molar	.022
Height of crown of first molar	.011
Length of six inferior molars	.113
Length of first inferior molar	.020
Width of first inferior molar, (medially)	.009
Length of second inferior molar	.019
Width of second inferior molar	.012
Width of symphyseal trough, (least)	.015
Depth in front of *foramen mentale*	.016
Expanse of two middle pairs of incisors	.041

About the size of the ass.

This species is readily distinguished from the more common *P. perditus* by the peculiar form of the symphysis, more simple molar teeth, with shorter crowns, and the constantly smaller size; four mandibular teeth of the latter occupying the same space as five mandibulars in the *P. labrosus*. The first premolars are also larger and two-rooted, those of *P. perditus* in three specimens before me and of *P. sejunctus* in one example being but one-rooted.

PROTOHIPPUS SEJUNCTUS, Cope, Bull. U. S. Geol. Surv., No. 1, 1874, 15.

Represented in my collections by a nearly complete skeleton, with cranium and entire dentition; both mandibular rami and symphysis of a second; mandibles and dentition of two others, with appropriate molar teeth.

The skeleton, which I excavated with my own hands from the side of a bluff, adds considerably to our knowledge of this genus of horses. The side of the cranium displays a considerable depression in front of the orbit, which, though not so deeply impressed as described by Dr. Leidy in the known species, will refer this animal to the group regarded by him as a genus under the name of *Merychippus*. That the latter is distinct as a genus may be questioned, and I shall follow Dr. Leidy's later conclusion in uniting them.*

The structure of the feet in this genus, as indicated by the specimens of the present species, and of the *Protohippus placidus*, proves to be identical with that of *Hippotherium*, *i. e.*, tridactyle; the lateral toes of

* See Report on Geological Survey of the Terrs., vol. i, p. 322.

reduced proportions. This is important as distinguishing the genus trenchantly from *Equus*; and while the union of the inner columns of the superior molars distinguishes it from *Hippotherium*, a form of *P. perditus* is described below, in which the columns are more distinct than in individuals heretofore known.

The *P. sejunctus* is identical in measurements with the *P. labrosus*, and agrees with it in the simplicity of the enamel boundaries. It is also a short-crowned type, but the character is not so marked as in the latter. It differs strikingly in the deep and convex symphysis, and, in the only specimen in which its alveolar border is preserved, in the hiatus separating the inferior canine from the incisors. It exhibits also the small and one-rooted first premolar of the *P. perditus*.

The adjacent horns of the lakes of the molars are more produced outwardly than the remote ones, and the enamel borders have no plications. The sections of the inner columns are oval posteriorly and subround anteriorly. The wearing of the last molars indicates the full maturity of the animal; the canines are separated by a considerable interval from the third incisors. The inferior molars are similar in general to those of *P. labrosus*; in three individuals, the last lobe of the last molar is a cylindroid instead of a trough-shaped column.

The cranium in general form partakes of the shorter and more elevated outline seen in all the three-toed horses. The free part of the nasal bones and the diastema behind the canines are short. The outline of the vertex, from the nose to the sagittal crest, is quite plain, while the posterior part of the nasal bones, &c., is much narrowed by the large facial depression at the sides. This occupies the space between the nasal bones and the malar ridge above and below, and is bounded behind by the anterior border of the orbit; in front it is open, but its depression follows below the nasal bones to the diastema. While its area is strongly impressed, especially superiorly and inferiorly, it is not nearly so much so as indicated by Leidy in *P. insignis* and *P. mirabilis*, but more marked than in his figure of *P. perditus*. My specimens of the latter are not well preserved in the region in question.

The infraorbital foramen issues above the anterior border of the first true molar and the malar ridge above its posterior portion. The orbit is closed behind, and the sagittal crest is but an angle, and originates above the glenoid cavity. The inion is narrowed above, and projects backward over the upper edge of the foramen magnum; posteriorly, the occipital presents a pair of vertical fossæ, separated by a low ridge. Its external crest is not continued to that of the squamosal part of the zygoma. The meatus auditorius is quite small, as is also the mastoid tuberosity. The paramastoid is large and stout.

Measurements of cranium.

	M.
From occipital condyle to incisor-teeth	0.330
From occipital condyle to last upper molar	.140
From occipital condyle to fundus of palatal notch	.165
Length of entire molar series	.124
Length of crown of first premolar	.011
Length of crown of second premolar	.025
Width of crown of second premolar	.018
Length of crown of first true molar	.017
Width of crown of first true molar	.020
Height of crown of first true molar	.013
Length of diastema	.027
Height of crown of canine	.015
Width of arc of incisors	.050
Length from first incisor to first premolar	.039
Length from first incisor to nasal notch, (oblique)	.080

	M.
Length from first incisor to orbit	0.198
Diameter of orbit	.045
Width of nasals at notch	.031
Width of front at middle orbit	.076
Width of zygomata posteriorly	.132
Width between meatus	.088
Width between middle molars	.038
Width of occipital foramen and condyles	.054
Length of mandibular ramus	.270
Length from end-incisors to last molar	.190
Length from end-incisors to first molar	.077
Length from end-incisors to canine, (axial)	.025
Depth of symphysis in front of *foramen mentale*	.028
Depth of ramus at first premolar	.043
Depth of ramus at sixth premolar	.063

The *skeleton* is noteworthy for the disproportionately large size of the cervical, as compared with the dorsal vertebræ. The large size of the head, compared with the rest of the animal, was supplemented by the length and slenderness of the limbs, which considerably exceeded the proportions they bear in the existing horse. The lumbar vertebræ are slightly opisthocœlian, the dorsals strongly so. The cervicals are large and moderately elongate; the size results from the great development of the processes, since the centra do not materially exceed those of the lumbars. The atlas is not much expanded, and has a well-marked *tuberculum atlantis* and very low neural keel.

The limbs are slender, and the hoofs small. The humerus is more curved than in the horse, and has a strong tubercular deltoid crest. The proximal tuberosities are very different from those of the horse. The external is largely developed, but is not produced into a hook nor extended into a longitudinal crest. The inner bicipital tuberosity is a little more prominent, and curves hook-like outward, inclosing with the outer a deep notch. It is continued at right angles along the inner aspect of the head into a straight crest; their angle of union is prolonged downward as the deltoid crest. The outer tuberosity in the horse is double, and, while not hooked as in *Rhinocerus*, is a little more prominent than in the present species; the inner is not hooked as in the *P. sejunctus*. There is an ala on the inner side of the distal end of the humerus, and a supracondylar foramen, both of which are wanting in the horse.

The *radius* differs from that of the horse in being considerably longer than the humerus instead of a little shorter. It is gently curved and flattened, with the transverse ends about equally wide. The ulna is co-ossified with it throughout the length, excepting a small portion beyond the humeral cotylus, as in the horse.

The *femur* is stout, with the lesser trochanteric ridge well developed. The trochlea is wide, with subequally elevated bounding ridges. The *tibia* is considerably longer than the femur, and presents a long and prominent cnemial crest. The shaft is transverse, with external edge and inner plane narrower than the anterior. The trochlea is very oblique, the astragaline grooves well defined by the internal and external tuberosities. Fibula not preserved.

The right posterior foot, among others, is perfectly preserved. It is, like the radius and forefoot and the tibia, distinguished for its elongation and slender proportions, as compared with the horse. The *astragalus* differs from that of the horse in having the cuboid facet on a more pronounced neck, and in the narrowness of the trochlea. The navicular facet is subpentagonal and without emargination. The *cuboid* is largely extended posteriorly, where it bears a large tuberosity. The *naviculare* is shallow and concave proximally. The *ectocuneiforme* is of similar length; behind it a well-developed *mesocuneiforme*, which supports the internal metatarsal. The external metatarsals are situated behind the median, except for an inch at their distal extremities. Their articular surfaces are compressed, and present an obtuse trochlear angle, but no keel; they reach to the base of the condyle of the median metatarsal behind. The latter is very convex above, slightly flattened below. The lateral digits only reach to the distal end of the first phalanx. The penultimate phalanx of each is much produced behind; the last or ungueal is much compressed, and is literally a half-hoof. The coronet is half as long as the pastern, and the unguis or coffin-bone is acuminate in outline and elevated on the middle line. It is deeply fissured at the extremity, and the margin abounds in foramina. The nutritious foramina of the base are each in the apex of a triangular fossa, which is open posteriorly. This bone has proportions not unlike those ascribed by Leidy to a specimen from the Niobrara, but is rather smaller; but the foot to which it pertains measures but 10.5 inches, while that of *P. sejunctus* (without tarsals) is 11 inches in length.

Measurements.

		M.
Length of atlas, (extreme)		0.061
Width of atlas medially below		.035
Width of atlas in front of diapophyses		.060
Length of odontoid process		.023
Length of three posterior dorsal vertebræ		.076
Diameter of articular face of centrum of vertebræ	transverse	.021
	vertical	.015
Length of humerus, (axial)		.192
Diameter of proximal end	antero-posterior	.065
	transverse	.055
Diameter of condyles		.044
Length of radius		.229
Transverse diameter of radius	proximally	.045
	at middle	.026
	distally	.038
Antero-posterior diameter of radius	proximally	.026
	medially	.018
	distally	.023
Diameter of femur	shaft	.040
	condyles	.058
Length of tibia		.250
Length of foot, including tarsus		.325
Length of foot without tarsus		.277
Outside length of calcaneum		.075
Depth of calcaneum behind		.027
Width in front		.033
Total length of astragalus		.045
Total width		.041
Width of trochlea of astragalus		.018
Width of navicular facet		.022
Depth of navicular facet		.022
Width of cuboid facet		.008
Width of cuboid bone fore and aft		.023
Length of cuboid bone		.015
Length of internal metatarsus		.170
Transverse width of trochlea of median metatarsus		.021
Length of pastern		.042
Width of pastern proximally		.025
Length of coronet		.027
Width proximally		.025
Length of coffin		.036
Width of articular face		.021
Width between angles		.030
Elevation behind		.023

Remarks.—Professor Leidy has already observed that the structure of the molars in this genus is in type the same as that of the deciduous molars of *Equus*, and that hence *Protohippus* represents the more primitive condition of horse. In further confirmation of this view, I may add that the proportionate size of the head and length of limbs to size of body is greater than in the recent species of *Equus*, resembling in these points the colts of that genus. Acceleration of the growth of the body and prolongation of the face, the same in the widening (fore and aft) of the internal columns of the molar teeth, with retardation of the growth of the lateral phalanges, would express the process of evolution of the modern types of horse.

PROTOHIPPUS PERDITUS, Leidy.

Represented in the collections by the entire molar dentition of one cranium; the greater part of that of another, with incisors and canines; the four median molars of another; two superior molars, with mandible and teeth of a fourth; mandibular dentition of two others, with parts of mandibles and symphyses; and isolated molars of a large number of additional specimens.

Without this material, I should have hesitated to separate the two species above described as new; as it is, I have no question that they are well defined, and are not the species described by Dr. Leidy under the name of *Merychippus*. The two lower jaws at my disposal agree in dimensions with each other and with the superior molars and with Dr. Leidy's types, with which I have compared them, four of them having the same extent as five of those of the two species above described. In two successional superior molars little worn, one of the inner columns (the anterior) is not yet united with its corresponding crescent, and the borders of the lakes are more plicate than in more worn examples.

PROTOHIPPUS PLACIDUS, Leidy.

A portion of the skeleton of this species was excavated by myself from the rock of the Pliocene formation, which was accompanied by two teeth, characteristically those of this species, and the only ones I obtained which are referable to it. They are readily known from their small size absolutely, and it would seem relatively also. The vertebræ are similar in size and proportions; but the metatarsus is materially shorter than that of *P. sejunctus*, and the phalanges of all the toes, and especially the coffin-bones, considerably stouter. Compare measurements with those given above.

Measurements.

	M.
Length of median metapodial bone	0.173
Expanse of condyles of lateral metapodials	.042
Length of first lateral phalanx	.024
Antero-posterior width of first lateral phalanx	.016
Length of coffin-bone medially	.041
Width between angles	.037
Width of articular face	.026
Height of coffin-bone behind	.022

Thus both coffin-bones are larger, wider, and flatter than those of *P. sejunctus*, a character provided for by the greater lateral distal expansion of the metapodial bones. The shortness of the metapodial bone may be due to the fact of its being a metacarpal; the femoral condyles are adherent to it in the matrix, and there is a proximal facet like that for the cuboid bone in *P. sejunctus*. Were the bone a metacarpal, this facet would relate to the trapezoides, a contact which does not exist in either of the genera of three-toed horses, *Hippotherium* and *Anchitherium*, according to Kowalevsky.*

ARTIODACTYLA.

MERYCHYUS, Leidy.

MERYCHYUS MAJOR, Leidy, Anc. Fauna Dak. and Neb., 121.

A single superior first molar, presenting some peculiarities perhaps individual.

MERYCHYUS ELEGANS, Leidy, *loc. cit.*, 118.

A mandibular ramus, with the molars and last premolar; a little larger than Leidy's specimens from Nebraska.

PROCAMELUS, Leidy.

PROCAMELUS, *sp.*

Numerous parts of skeletons of a large species without teeth; possibly the *P. niobrarensis*, Leidy.

PROCAMELUS ANGUSTIDENS, Cope, Bull. U. S. Geol. Surv. Terrs., No. 1, 20.

Represented by the nearly entire mandibles, with most of the teeth of two individuals, and two superior molars referred with probability to the same.

This camel is the size of the *P. robustus*, Leidy, but differs from it in the much narrower teeth, especially the last molar and last premolar, the much smaller first molar, and totally different form of the second premolar. Thus, while the last molar has the same length, it supports an anterior expansion whose angles are the summits of ridges on the inner and outer sides of the crown, which are wanting in *P. robustus*. Behind the outer rib in *P. angustidens*, there is a considerable groove. While the third molar is as large as that of *P. robustus*, the first molar is strikingly smaller, while the third premolar is about as long, is only half as wide when worn to the same degree. The second premolar, instead of presenting a contracted subconic crown, is longitudinally extended and compressed, resembling closely the third premolar. The molars are remarkably flat on the outer side; each lobe being devoid of a median ridge, and the first and second even wanting that between the lobes. The diastemata are long, and the first premolar is compressed and equidistant between the canine and the second premolar. The diastema in front of the canine is not wider than one tooth. The lower incisors are broad and oblique. The lower posterior boundary of the symphysis is almost immediately below the first premolar.

Measurements.

	M.
Total length of dental series to first incisor	0.240
Length from first to third incisor on crowns	.035
Length from first incisor to canine	.040
Leng h from first incisor to first premolar	.073
Length from first incisor to second premolar	.103
Length of molar series	.134
Length of premolars 2–3–4	.039
Length of second premolar	.016
Length of fourth primolar	.016

* Palæontographica, 1873, pl. vii.

	M.
Width of fourth premolar, (half worn)	0.005
Length of first molar, (half worn)	.019
Width of first molar, (half worn)	.014
Length of third molar	.047
Width of third anterior column	.013

In the second specimen the molars are a little narrower.

PROCAMELUS HETERODONTUS, Cope, Bull. U. S. Geol. Surv. Terrs., 1874, No. 1, 20.

Represented by the right distal portion of a mandibular ramus, with incisor, canine, and premolar teeth, and by the greater part of the dentition of the premaxillary and maxillary bones. These indicate an animal of the size of the species last described.

An interesting fact in the structure of the genus is indicated by these specimens, namely, that the premaxillary bones support a full series of incisor-teeth, a fact not heretofore known, as the pieces in question had not been previously identified by authors. The median incisors were inserted into rather small sockets, and were separated by diastemata from the third or caniniform incisor, from each other, and from the anterior extremity of the bone.

A second result of the investigation is that the genus *Homocamelus*, Leidy, is probably the same as *Procamelus;* and that *H. caninus* should be regarded as the *P. robustus*, unless new evidence exists to the contrary. The former was established on dentition of the upper series alone; the latter on that of the lower jaw. In the present species, we have the two kinds of teeth combined. The relations are, however, quite different from those found in the *P. robustus* and the *P. angustidens.* As to the reference of *H. caninus* to the former rather than the latter of these two, it depends on their coincidence in the transverse width of the premolar teeth, and is rendered probable by the fact that they are from the same horizon and approximate locality.

In the superior and inferior dentition of *P. heterodontus*, it is to be noticed that the first premolar is situated well anteriorly, the space separating it from the second premolar being twice as long as that between it and the canine; in *P. robustus*, these interspaces are equal (in the lower jaw) as in *P. angustidens.* In the present camel, the third incisor is separated from the canine in the lower jaw by a space nearly equal to that between the canine and first premolar; in *P. angustidens*, and, probably *P. robustus*, (= *H. caninus*,) this space is very much less, and just sufficient to admit the superior caniniform incisor. In the present species the lower border of the symphysis is below the canine, and hence the symphysis is much shorter than in *P. angustidens*, as it is steeper and concave on the antero-inferior face. It is not co-ossified in the specimen, while it is so in the *P. angustidens.* On each side of the suture below is a small, compressed, descending tuberosity. The mental foramen is below the first premolar. The second and third lower premolars are two-rooted and compressed; the third presents an angle inward at its anterior end.

The premaxillary bones attenuated and simple in front, with little indication of contact or connection across the middle line. The side of the muzzle is concave above the first premolar. Last incisor vertical in direction.

The maxillary teeth associated with the above-described premaxillary bones represent the entire series, except the second and third premolars. These present strong exterior ribs between the columns, and weak ones between on the third molar. These teeth present no extra lobes, tubercles, nor columns, and the cement-deposit in the lakes is very small. The third premolar and first molar are about as broad as long.

Measurements of the upper jaw.

	M.
Length of true molars	0.083
Length of last molar, (outside)	.036
Width of last molar, (anterior column)	.016
Length of first molar	.020
Width of first molar	.019
Length of last premolar	.014
Width of last premolar	.013
Length from first premolar to canine	.016
Length from first premolar to third incisor	.036
Length from third incisor to end of premaxillary	.038

Measurements of the lower jaw.

	M.
Length from apex of third incisor to end of third premolar	0.120
Length from apex of third incisor to second premolar	.698
Length from apex of third incisor to first premolar	.052
Length from apex of third incisor to canine	.025
Depth at third premolar	.040
Depth at canine	.041

From the heads of Pawnee Creek, Colorado.

PROCAMELUS OCCIDENTALIS, Leidy, Anc. Fauna Dak. and Neb., 151.

Specimens in fine preservation, but referred, with some doubt, as above. The dimensions of the teeth are intermediate between those of the species above named and the *P. gracilis*, Leidy.

MERYCODUS, Leidy.

MERYCODUS GEMMIFER, Cope, *loc. cit.*, 22.

A small ruminant, represented by jaws and teeth of three individuals found in association with the species above described by the writer. These embrace only the true molar-teeth in good preservation. They resemble those of *M. necatus*, Leidy, in form and size, but differ in having a rudimental column between the principal columns at their bases, a character which I have satisfied myself does not exist in the Niobrara specimens described by Dr. Leidy by autopsy. These only appear on the grinding faces after prolonged attrition. First molar equal to the last premolar in antero-posterior diameter.

Measurements.

	M.
Length of four posterior molars	0.037
Length of true molars	.030
Length of second molar	.090
Width of second molar	.040
Length of third molar	.013
Width of third molar	.006
Depth of jaw at second molar	.015

PROBOSCIDIA.

MASTODON, Cuv.

MASTODON PROAVUS, Cope, Synop. Vert. Col., 1873, 10.

Represented by an entire anterior molar, portions of posterior molars, and an astragalus, all found associated by the writer. They probably pertain to the same individual.

The general character of the transverse crests of both kinds of teeth is similar. Each crest is composed of two obtuse lobes, whose diameter is greatest exteriorly, but contracts toward their point of contact on the median line. Their section is therefore pyriform, with the apex inward. In an anterior tooth, the cutting-edges are obtuse and descend from the outer margin to the line of division between them. This line is a narrow fissure in the anterior tooth dividing the cones for more than half their height. This fissure is similar in the posterier molars, but the cones are more elevated and compressed, and are irregularly lobed with low tuberosities, especially on the posterior face. The outer face of the cone of the last pair is separated from the posterior by a low, vertical, ridge. There is a posterior heel, whose summit is continuous with one of the cones.

The valleys are open and spreading, as in *M. ohioticus*, and there appear to have been no intermediate nor accessory lobes or cones. There is a cingulum round the anterior molar, which is strongest behind. One of the cones sends a rib inward and downward to a position on the cingulum, which partially incloses a fossa on the outer side.

Enamel generally smooth.

The tibial face of the astragalus is convex antero-posteriorly, little concave, and oblique transversely. The inner side is elevated, and also shortened from the back forward, so as to leave a considerable neck for the navicular facet. This is convex and oblique, extending nearly to the edge of the tibial face on the outer side. The peroneal face is shallow, and exhibits a small facet and a fossa. The calcaneal facet of the inner side is much produced inward. The external one is a broad oval.

Measurements.

	M.
Length of crown of anterior molar	0.055
Width of crown of anterior molar	.050
Elevation of cones of the same	.025
Width of valley between apices of the cones	.027
Elevation of cone of posterior molar	.042
Transverse diameter of the same at base of fissure	.035
Long diameter of the astragalus	.093
Transverse diameter of the astragalus	.100
Exterior depth of the astragalus	.025
Interior depth of the astragalus	.058
Transverse width of navicular facet	.055

The anterior molar described has but two transverse crests, but is considerably larger than the two crested teeth in *Trilophodon ohioticus*. As the other portions indicate a smaller species, the position of this tooth becomes a matter of question. This point, together with the isolated or conic and furrowed character of the divisions of the crests, with the smaller size, separate it from the common species. It also belongs to an earlier geological period. From *M. mirificus*, the wide, open valleys, simplicity of the cones, and larger size distinguish it.

TESTUDINATA.

STYLEMYS, Leidy.

STYLEMYS (?) NIOBRARENSIS, Leidy.

Abundant.

APPENDIX.

The essays and papers in which the descriptions and determinations of most of the species of extinct *Vertebrata* included in the preceding report originally appeared are the following:

Cope, Paleontological Bulletin, No. 14; published July 25, 1873.
Cope, Paleontological Bulletin, No. 15; published August 20, 1873,
Cope, Paleontological Bulletin, No. 16; published August 20, 1873.
Cope, Paleontological Bulletin, No. 17; published October 25, 1873.
Cope, Synopsis of New Vertebrata from the Tertiary of Colorado; published October 16, 1873.
Hayden, Bulletin of the United States Geological Survey of the Territories, No. 1; published January 21, 1874.
Hayden, Bulletin of the United States Geological Survey of the Territories, No. 2; published April 19, 1874.