DEPARTMENT OF THE INTERIOR.

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OF

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OF

THE TERRITORIES.

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PREFATORY NOTE.

Now that two numbers of the Bulletin have been issued by the Survey, a word of explanation as to the object of its publication seems to be necessary. The vast amount of new material in all departments of natural history collected in the West under the auspices of the Survey, and in some instance demanding prompt publication, suggested the present form, in order that this new matter might not be too much scattered, either in the proceedings of societies, or in independent papers not easily accessible to the scientific student. The annual report will not appear until late in the summer, (July or August,) and, in consequence, the Bulletin will be issued from time to time as the necessity arises for the prompt publication of valuable matter.

The article by Professor Cope in the present number of the Bulletin is one of no ordinary value. While I dissent from some of his views, I regard his researches as having a direct bearing on the solution of the problem to which I have repeatedly called the attention of geologists in my annual reports as the most important one in the geology of the western portion of our continent, viz: The relations of the Cretaceous and Tertiary periods to each other. I have always expressed my belief in the continuity of all the great formations from the Silurian to the present time, and that the highest privilege of the geologist is to discover the evidence that bridges over all chasms and obliterates all the lines of demarkation. When our knowledge of the geological history of the world is more complete, we may expect to find well-marked beds of passage or transition between all the great groups of the geological scale. Hitherto, the chasm between the Cretaceous and the Tertiary periods has been very marked; but the evidence now so rapidly accumulating points to the conclusion that this, too, will be bridged over. The solution of this problem has also a most intimate connection with the physical growth and history of the western portion of our continent. One of the principal objects of the survey for years has been, to collect all the evidence bearing on this subject that could be secured, and, with this thought in view, I have requested Professors Leidy and Cope to approach the problem through the extinct vertebrate fauna, Mr. Lesquereux through the fossil flora, and Mr. F. B. Meek through the study of the invertebrata. The differences of opinion as to the age of the formations under discussion have been very great.

Up to within a comparatively recent date I have regarded the entire Lignitic group of the West as of Tertiary age. My own explorations began at an early period (1853) in the Northwest, along the Missouri River and its tributaries. There, the Lignite group is largely developed, and is even at this time supposed by some of our best geologists and paleontologists to be of Middle Tertiary age. This group in the Northwest indicates a brackish-water deposit at the base, but is mostly of purely fresh-water origin. I traced this group, without interruption, from latitude 49° north, along the east base of the Rocky Mountains southward, to a point near Laramie Peak, latitude 43°, where it is overlapped by the White River deposits for a distance of about two hundred miles. The lignitic beds rise again to the surface about fifteen miles south of the Union Pacific Railroad. A very narrow range of mountains separates this group from the Laramie Plains, and prior to the elevation of the mountains, no doubt, the surface-continuity was unbroken. During the summer of 1868 I made a careful examination of the coal-beds at Bear River Station and Coalville, Utah, and there I found the first proof that I had

detected that the lignitic group extended down into undoubted Cretaceous beds. My statement at that time has been overlooked, and I here beg permission to call attention to it. In a paper published in the Proceedings of the American Philosophical Society of Philadelphia, dated February 19, 1869, page 48, will be found the following paragraph:

"Near Coalville, a little town in the valley of Weber River, five miles above the mouth of Echo Creek, coal outcrops several times. At Sprigg's opening, the dip is 20° or 30° east; and the coal-bed is about fifteen feet thick, capped with gray sandstone, much of it charged with pebbles. I was informed that in other places this pebbly sandstone rests directly on the coal-bed. A few hundred feet from Sprigg's opening, a shaft to strike the same bed has been sunk seventy-nine feet deep, through twelve feet of gravel and sand, into black clay, that grows harder downward, and contains numerous specimens of a species of *Inoceramus*, *Ostrea*, and *Ammonites*, showing that the black clays are certainly of Cretaceous age. If these beds do actually lie above the coal, as the dip would indicate, then this formation, of doubtful age, extending from Quaking Asp Summit to Salt Lake, must be Cretaceous, and some of the finest coal-beds in the West are in rocks of that age."

At Bear River City I found, in considerable numbers, *Inoceramus*, *Ostrea*, and other marine forms of mollusks above the principal coal-bed, which is nearly vertical in position; but neither at Bear River City nor at Coalville have I ever known of any plants being detected below the lowest coal-bed. At Evanston, about twelve miles west of Bear River City, the thickest bed of coal in the West is found, and above and below it I found, in 1871, a great number of species of plants, many of which have an extended vertical as well as horizontal range in the lignitic group. It is plain, therefore, that the coal at Evanston is of more modern age than that of the Bear River group, as shown at Bear River City and Coalville, Utah. As we go southward into Southern Utah, New Mexico, and Arizona, the greater portion of the coal-beds are in rocks of undoubted Cretaceous age. It seems conclusive, therefore, that the lignitic group began in the Cretaceous period in the marine seas and continued on upward, through the brackish-water times, into the purely fresh-water deposits.

The illustrated volumes on the paleontology of these formations, which will probably appear within a year, will doubtless define with greater precision the various divisions of the Cretaceous and Tertiary groups, and settle the vexed questions of age. The very elaborate and important volume, by Mr. F. B. Meek, on the invertebrate fossils, will be ready for the press the coming summer. The plates are now engraved. The memoir of Lesquereux on the flora of the Dakota group with twenty-eight plates is now ready, and he is now at work on the Tertiary flora. All the other volumes are in an advanced state of preparation.

I would call attention to the very important article in this number of the Bulletin by Professor Lesquereux on the extinct flora of the Dakota group; also the article on the new species of orthoptera, by Professor Thomas, and the interesting notes on the mountain-ranges of Colorado, by Mr. Gardner. The elevations of the mountain-peaks, which occur in the various districts surveyed by the party during the past summer, will prove of great practical value.

In Bulletin No. 1 I inadvertently omitted to include the names of Robert Adams, jr., assistant quartermaster, and Mr. C. Adams, among the members of the corps for 1873.

F. V. HAYDEN,
United States Geologist.

PHILADELPHIA, *February* 1, 1874.

SIR: Please find accompanying a catalogue of the species of *vertebrata* whose remains are known to occur in the various formations of the cretaceous period west of the Mississippi River. I preface it with a few notes on the stratigraphy of the upper beds, mostly taken while attached to the United States Geological Survey during the summer of 1872. I desire to express my indebtedness for the loan of much valuable material used in the present investigation to Professor B. F. Mudge, of Manhattan, Kansas; also to Dr. John H. Janeway, post-surgeon at Fort Hays; to Professor Merrill, of Topeka, and to Messrs. Weltman and Henry Swigart, of Evanston, Wyoming.

I am, with best wishes,

EDWARD D. COPE,
Paleontologist.

Dr. F. V. HAYDEN,
Director of the United States Geological Survey of the Territories.

REVIEW

OF

THE VERTEBRATA OF THE CRETACEOUS PERIOD FOUND WEST OF THE MISSISSIPPI RIVER.

BY EDWARD D. COPE, A. M.

SECTION 1.—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. The present list includes 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 *Pythonomorphor* from that State, discovered and sent to me by Dr. A. R. Roessler. I have also described a species of that order as common to Eastern New Mexico and Western Kansas; and Hayden and Seconti 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 enumerated in the following catalogue. 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 proven 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 cotemporary 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. Hay-

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

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

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

den has placed with reservations below the Fort Union series, leaving their final location for future discoveries.

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 Prof. Marsh‡ on the south side of the Uinta 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. vi.

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, l. c., p. 255; Lignite referred to the Miocene.

1856. Meek and Hayden, l. c., 113; referred to Lower Tertiary.

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

*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. Leidy, l. c., 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 proven 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 formation like that of the *Wealden* in Europe."* Meek and Hayden† remarked, "We are inclined to think with Prof. 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 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,

*Proceedings Academy Philadelphia, 1856, p. 73.
†L. c. 1856, p. 114.
*Hayden's Annual Report, 1872, p. 450.

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 Evansston 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 embedded 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 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

‡Hayden's Annual Report, 1872, pages 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.

a bed of melaniaus 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 land mark 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 vertabratæ 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 meganlax.*
Emys pachylomus.
Emys enthovetus.
Trionyx scutumantiquum.
Alligator heteorodon.

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 terminate 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 (*Emy enthnetus* 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 sand-stones, 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 descending 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 the formation must be accounted as Cretaceous, on account of the presence of the Dinosaurian *Agathaumas sylvestris;* and those above it, as I

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

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

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, (page 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. Lesquereux, 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 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 Prof. 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 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

†Exploration of the 40th parallel, p. 458.
*Annual Report, 1872, 534.

the bases of the Uinta* and Ham's Fork Mountains respectively, on beds of Jurassic age, which are probably Cretaceous No. 1, (Dakota.) The beds observed by Prof. Marsh on the south side of the Uinta Mountains, on Brush Creek, belong neither to the Dakota nor Bitter Creek epochs, but perhaps to No. 3, if, as Prof. Marsh asserts, the oyster found in a superjacent stratum is *Ostrea congesta*, Con.; it is in any case of no later date than the Cañon 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 becomes slaty in character, and descends 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, 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 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

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

very gentle 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 N. by E. and S. by W. trend, through which the Fontanelle cuts its way in a deep cañon. This range is monoclinal, the strata dipping 45° E. 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*, etc. 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 echelon* 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 bed 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 is passed by the Union Pacific Railroad at and west of Aspen Station, as is described by Dr. Hayden, (Annual Report, 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.**

* Cope, Paleontological Bulletin, No. 17, 1873.

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 (?) euthtunes. *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 identify 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

* Proceedings Acad. of Nat. Sciences, 1872, p. 279.
† Proceedings American Philosophical Society, 1872, p. 473.
* Hayden's Annual Report, 1872, p. 541.

led to suspect considerable lateral displacement 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 Prof. 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 molluscs 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 cotemporaneous 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.

* 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 (Lesquereaux,) 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, Gral. Surv., Colorado, 1869, p. 197, Dr. Hayden observes, "There is no proof, so far as I have observec in all the Western country, of true non-conformitp 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."

SEC. II.—LIST OF SPECIES OF VERTEBRATA FROM THE CRETACEOUS FORMATIONS OF THE WEST.

AVES.

NATATORES.

HESPERORNIS, Marsh.

HESPERORNIS REGALIS, Marsh, Amer. Jour. Sci. Arts, 1872, 56; loc. cit., 1872, 360.

Niobrara group, or No. 3 of the Smoky Hill.

GRACULAVUS, Marsh.

GRACULAVUS ANCEPS, Marsh, Amer. Jour. Sci. Arts, 1872 (iii), 364.

Niobrara Cretaceous of the Smoky Hill.

SAURURÆ.

ICHTHYORNIS, Marsh.

ICHTHYORNIS DISPAR, Marsh, Amer. Journ. Sci. Arts, 1872, 344 (iv), and 1873, 74 (v), Feb., 1873.

Niobrara Cretaceous of the Smoky Hill.

ICHTHYORNIS CELER, Marsh, loc. cit., 1872, 406 (iv); *Apatornis celer* (name only,) loc. cit., Feb., 1873.

Niobrara Cretaceous of the Smoky Hill.

REPTILIA.

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 the bones of the character of which have 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, 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 base 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 vertebra 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 were 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 further 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 limbs. 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 (36¾ 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 zygapophyses	.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)	.105
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 MIRABILIS, Leidy, Proceedings of the Academy, Philadelphia, 1868, 199; Cope, Extinct Batrachia, etc., 1868, 198; *Trachodon mirabilis*, Leidy, Proceedings Academy, Philadelphia, 1856, 72; Transactions American Philosophical Society, 1860, 140.

From the bad lands of Judith River, Montana. Known only from teeth.

HADROSAURUS OCCIDENTALIS, Cope, Extinct Batrachia, etc., p. 98; *Thespesius occidentalis*, Leidy, Proceedings of the Academy, Philadelphia, 1856, 311; Transactions of the Amerian 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 opisthocoelian 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 humerus or femur; it was found near the fragment of 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
Transverse diameter at middle	.072
Transverse diameter posteriorly	.121
Vertical diameter posteriorly	.092
Diameter of head of tibia antero-posteriorly	.250

HADROSAURUS AGILIS, Marsh, Amer. Journ. Sci. Arts, 1872, 301.

From the Niobrara or Cretaceous, No. 3, of Western Kansas. Smaller than the preceding species.

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 a 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 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 vertebral 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 the 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. genericus.—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 op-

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

posite 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 opisthocoelian, 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

	M.
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 elevation to neural canal	.094
Anterior width	.094
Median dorsal, length of centrum	.057
Median elevation to neural canal	.117
Median 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 much larger animal than the *Cionodon arctatus*, and one not very different in size from the *Lælaps aquilunguis*.

PALÆOSCINCUS, Leidy.

Proceedings Academy, Philadelphia, 1856, 72.

PALÆOSCINCUS COSTATUS, Leidy, loc. cit.

Bad lands of Judith River, Montana.
Founded on dental characters only.

TROÖDON, Leidy.

Loc. cit., 1856, 72; Transac. Amer. Philos. Society, 1860, 147.

TROÖDON FORMOSUS, Leidy, loc. cit.

Bad lands of Judith River, Montana.
Founded on teeth only.

AUBLYSODON, Leidy.

Proceed. Acad. Natural Science, Philadelphia, 1868, 198; *Dinodon*, Leidy, loc. cit,, 1864 72, not of Duméril.

AUBLYSODON HORRIDUS, Cope, Extinct Batrachia, etc., N. America, 120; *Dinodon horridus*, Leidy, Proceed. Academy, Philadelphia, 1856, 72; Transac. Amer. Philosophical Soc., 1860, 140; *Aublysodon mirandus*, Leidy, Proc. Academy, 1868, 198.

From the bad lands of Judith River, Montana.
Represented by teeth.

PTEROSAURIA.

PTERODACTYLUS, Cuv.

PTERODACTYLUS UMBROSUS, Cope, Proceed. Amer. Philos. Society, 1872, 471 (*Ornithochirus*), (published March 9, 1872).

Niobrara Chalk of Kansas.

PTERODACTYLUS INGENS, Marsh, American Jour. Sci. Arts, 1872, April (published March 7, 1872).

Niobrara Chalk of Kansas.

PTERODACTYLUS OCCIDENTALIS, Marsh, loc. cit., April, 1872 (published March 7); *Ornithochirus harpyia*, Cope, Proceed. Amer. Philos. Soc., 1872, 471 (published March 9); *Pterodactylus owenii*, Marsh, loc. cit., 1871, p. 472, not of Bowerbank.

Niobrara Cretaceous of Kansas.

PTERODACTYLUS VELOX, Marsh, loc. cit., April, 1872.

Niobrara Cretaceous of Kansas.

CROCODILIA.

HYPOSAURUS, Owen.

Journ. Geological Soc., London, v, 383.

HYPOSAURUS VEBBII, Cope, Proceed. Amer. Philos. Soc. 1872, 310.

Benton or No. 2 Cretaceous of Kansas.

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.

BOTTOSAURUS (?) HUMILIS, Leidy; *Crocodilus humilis*, Leidy, Proceed. Acad. Nat. Sciences, Phila., 1856, 75 (teeth only).
Bad lands of Montana (Judith River).

SAUROPTERYGIA.

POLYCOTYLUS, Cope.

POLYCOTYLUS LATIPINNIS, Cope, Extinct. Batr. Reptilia N. Am. 1869, 36, plate i, figs. 1–13; Hayden's Geol. Survey Wyoming, 1870, 388.
From the Niobrara Chalk of Kansas.

PLESIOSAURUS, Comyb.

PLESIOSAURUS GULO, Cope, Proceedings Academy Philadelphia, 1872, p. 128.
Niobrara Cretaceous of Kansas.

PLESIOSAURUS OCCIDUUS, Leidy; *Nothosaurus occiduus*, Leidy, Proceed. Academy Philadelphia, 1870, 74; Report Geol. Survey Territories (4to), 1873, I, 345; tab. xv, figs. 11–13.
Lignite Cretaceous of Moreau River, Dakota.

PIRATOSAURUS, Leidy.

PIRATOSAURUS PLICATUS, Leidy, Cretaceous Reptiles of North America, 29, tab. xix, fig. 8.
Cretaceous of the Red River, Minnesota.

ELASMOSAURUS, Cope.

ELASMOSAURUS PLATYURUS, Cope, Notes on Geology of Southern Div. Pacific R. R., by J. Leconte, 1868, 68; Extinct Batrachia Reptilia N. America, etc., 1869, 44; Hayden, Geol. Survey Terrs., 1870, Wyoming, 393; *Discosaurus carinatus*, Cope, Leconte's notes, loc. cit.
Niobrara Cretaceous of Kansas.

ISCHYROSAURUS, Cope.

Extinct Batr. Rept. N. America, 1869, 38; Ischyrotherium, Leidy, Proceed. Academy Philadelphia, 1856, 89; Transac. American Philos. Soc., 1860, 150.

ISCHYROSAURUS ANTIQUUS, Cope, loc. cit.; *Ischyrotherium antiquum*, Leidy, loc. cit.; Trans. Amer. Philos. Soc., tab. x, figs. 8–17.
Lignite period between Moreau and Grand Rivers, Nebraska.

TESTUDINATA.

PROTOSTEGA, Cope.

Proceedings Am. Philos. Society, 1872, 422.

PROTOSTEGA GIGAS, Cope, loc. cit.
From the Niobrara Cretaceous of Kansas.

TOXOCHELYS, Cope.

Proceed. Academy Nat. Sciences, Philadelphia, 1873, 10.

TOXOCHELYS LATIREMIS, Cope, loc. cit.; *? Cynocercus incisus*, Cope, loc. cit., 1872, 129; Leidy, Report U. S. Geol. Survey Territories, I, 279, tab. xxxvi, figs. 17–21.
Niobrara Cretaceous of Kansas.

CYNOCERCUS, Cope.

Proceedings Amer. Philos. Soc., 1872, 308.

CYNOCERCUS INCISUS, Cope, loc. cit.
Niobrara Cretaceous of Kansas.

TRIONYX, Geoffr.

TRIONYX FOVEATUS, Leidy, Proceed. Academy, Philadelphia, 1856, 73; Transac. Amer. Philosoph. Society, 1860, 148, tab.

Bad lands of Judith River, Montana.

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 unfrequently 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 0m.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 pits. 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.

COMPSEMYS OBSCURUS, Leidy; Cope, Extinct Batrachia, etc., 124; *Emys obscurus*, Leidy, Proceedings Academy, 1856, 812.

Lignite of Long Lake, Nebraska.

PYTHONOMORPHA.

The reptiles of this order are the most abundant in the marine Cretaceous of Kansas, or the Niobrara group of Dr. Hayden. Material acquired since my first account confirms the idea there maintained that

they were of an elongate snake-like form, which the two pairs of short paddles did not materially modify. These limbs were situated in the anterior half of the length, the resulting form being like that of some of the snake-like terrestrial lizards at present inhabiting various countries, especially of the southern hemisphere. Although I do not possess any specimen with complete vertebral column, an approximate idea of its length may be gained by comparison of parts which are more or less complete in different species. Thus, in *Clidastes propython* the cervicals and dorsals number about 33; in a *Liodon latispinus* the lumbars number 7, and a series of caudals with diapophyses 32, with but little diminution in size; the last with stout but reduced diapophysis. Caudals without diapophysis in a species of *Platecarpus* number 27, and there were at least as many, probably a larger number, beyond these.

The well-distinguished genera of the order known from North American strata are the following:

I. Cervical hypopophyses separate, articulating:
  A zygosphenal articulation:
    Chevron-bones co-ossified with centra..... *Clidastes.*
    Chevron-bones free ..... *Sironectes.*
  No zygosphenal articulation:
    Teeth subcylindric facetted; chevron-bones free. *Platecarpus.*
    Teeth mostly compressed, cutting; humerus with narrrow extremities; chevron-bones free..... *Liodon.*
    Teeth subcylindric facetted; chevron-bones co-ossified ..... *Mosasaurus.*
II. Cervical hypopophyses continuous and entire:
  No zygosphen ..... *Baptosaurus.*

CLIDASTES, Cope.

Proceedings Academy Philadelphia, 1868, 233; Transactions American Philosophical Society, 1870, 211; *Edestosaurus*, Marsh, American Journal of Science and Arts, 1871, June; Cope, Proceedings American Philosophical Society, 1871, December.

There are specific differences in the form of the palatine bones in this genus from the more transverse or expanded type of the *C. propython* to that of the *C. planifrons*, where they are narrowed posteriorly in some degree to the *C. tortor*, where they are vertically placed in the posterior half. *Clidastes* is nearly allied to *Platecarpus*, with which *Sironectes* associates it as an intermediate genus. The number of species already known is considerable, and the genus is divided into sections for convenience of reference.

A. Centra of dorsal vertebræ depressed:

a. Frontal bones without median keel:

CLIDASTES PLANIFRONS, sp. nov.

A large species represented by large portions of the cranium including quadrate bone, by cervical and dorsal vertebræ and fragments of other elements, all belonging to one individual. They are well preserved, and have suffered but little from distortion.

The frontal bone is especially massive, and is plane on the superior surface. The superciliary borders are strongly concave, a feature either little or not at all marked in other species known to me. It is thickened, but the fossa of the postfrontal bone extends far toward the front and middle on the inferior surface. Anterior to the prefrontal

angle the frontal contracts, narrowing regularly to the line of the nares. The prefontal has the remarkable form characteristic of *Clidastes stenops*; that is, with the exposed face subvertical or steeply roof-shaped instead of horizontal. A groove descends on each side to each nareal orifice, and the intervening longitudinal ridge is deeply fissured by a parallel groove. The parietal fontanelle is entirely in the parietal bone. The postfrontal is massive.

The *quadrate* bone presents a very prominent internal angle as in other *Clidastes*, and has the posterior hook much prolonged downward and inward, with a button and surrounding groove on its inner side. The stapedial pit is narrow oval as in *Liodon proriger*. The mediar-posterior ridge is prominent and united with the distal internal longn tudinal, extending to the narrow posterior angle of the distal articulai face. There is no internal ridge, but a strong obtuse ridge extends along the outer side, turning backward into a rough process opposite the origin of the base of the ala. Between this and the distal articular face is a subtriangular rugose area.* The palatine bone has its anterior and posterior extremities broken away, the fragment supporting six teeth. The bone is flat, much as in the species of *Platecarpus*, the tooth-line passing from the inner margin behind to the outer before; the roots being more exposed on the external side; the external process is stout. The crowns of the palatine teeth are curved with lenticular section, one face being much more convex than the other; the enamel is shallowly striate-grooved.

The articular faces of the cervical *vertebræ* are all transversely oval, not much depressed; those of the dorsals are also transverse, but less so than the cervicals. Five cervicals and nine dorsals are preserved. The hypopophyses, both fixed and free, are very large and stout. The odontoid is large and prominent, and deeper than long. The diapophyses are short, and send a narrowed extension forward to the rim of the cup on all the cervicals and three dorsals. The vertical portion of their surfaces diminishes anteriorly as the horizontal extends, till, on the axis, it is horizontally subtriangular in outline. The zygosphen is smaller on the anterior than the posterior vertebræ; on the latter, the zygantrum possesses special facets for it. The cups, especially of the dorsals, are emarginate for the neural canal. A smooth band borders the circumference of the ball in front. The surface in general is smooth, with rugose lines and grooves extending to the articular face of the fixed hypopophysis, and apex of the free, and on the upper roof-like surface of the posterior zygapophyses. The inferior surfaces of the centra display a more or less prominent longitudinal median ridge.

* The nomenclature of these ridges is that proposed in the Extinct Batrachia, etc., p. 183, with "internal" changed to *external*, and *vice versa*, in accordance with the observations of Professor Marsh.

	M.
Depth of mandible at cotylus	.040
Depth of sphenoid condyle	.032
Width of proximal articular surface of quadrate, (transverse)	.023
Width of distal articular surface	.043
Length of third cervical centrum	.062
Depth at bottom of third cervical centrum	.030
Width at bottom of third cervical centrum	.037
Length of articular end of fixed hypapophysis	.025
Length of free hypopophysis	.029
Length of a median dorsal centrum	.072
Width at bottom of a median dorsal centrum	.048
Depth at bottom of a median dorsal centrum	.040

This species needs only to be compared with the *Clidastes stenops*, Cope, which exhibits the same peculiarity of roof-shaped pre-frontal bones. That species has the cervical articular faces entirely round; the frontal bone is keeled in the middle, and the palatine much more vertically compressed. The quadrate bone differs in various respects; among others, in the round form of the stapedial pit. As compared with the species described by Professor Marsh as *Edestosaurus dispar* and *E. velox*, it differs in the form of the quadrate, which in these species is much as in *C. tortor* and *C. stenops; i. e.*, with short proximal hook, oblique inferior articular surface, round pit, &c. In this species the quadrate is truncate distally, &c.

This fine species was discovered by the veteran geologist Prof. B. F. Mudge, during his annual expedition of 1873.

aa. Frontal bones with median keel:

CLIDASTES TORTOR, Cope; *Edestosaurus tortor*, Cope, Proceed. Amer. Philos. Society, Dec., 1871.

Niobrara Cretaceous of the Smoky Hill River.

CLIDASTES STENOPS, Cope; *Edestosaurus stenops*, *loc. cit.* Hayden's Annual Report U. S. Geol. Survey, 1871, p. 330.

Niobrara Cretaceous of the Smoky Hill River.

CLIDASTES REX, Marsh, Amer. Journ. Sci. Arts, 1872, June.

Niobrara Cretaceous of the Smoky Hill River.

CLIDASTES AFFINIS, Leidy, Report U. S. Geol. Survey Terrs., I, p. 281, tab. xxxiv, f. 6–9 and 11.

Niobrara Cretaceous of the Smoky Hill River.

aaa. Frontal bones unknown:

CLIDASTES DISPAR, Marsh; *Edestosaurus dispar*, Marsh, Amer. Journ. Sci. Arts, 1871, June.

Niobrara Cretaceous of the Smoky Hill River.

CLIDASTES VELOX, Marsh, *loc. cit.* (*Edestosaurus*).

Niobrara Cretaceous of the Smoky Hill River.

CLIDASTES VYMANII, Marsh, *loc. cit.*

Niobrara Cretaceous of the Smoky Hill River, Western Kansas.

CLIDASTES PUMILUS, Marsh, *loc. cit.*

Niobrara Cretaceous of the Smoky Hill River.

A A. Centra of dorsal vertebræ compressed:

CLIDASTES CINERIARUM, Cope, Proceed. Amer. Philosophical Soc., 1870, 583.

Niobrara Cretaceous of the Smoky Hill.

SIRONECTES, Cope.

The characters of this genus are such as to unite closely that which precedes it with that which follows in the present enumeration. It is more nearly allied to *Platecarpus* in the only species known, where the zygosphen is weak, but articulates with special facets on the lateral walls of the zygantrum. The form of the bones of the limbs is unknown.

SIRONECTES, ANGULIFERUS. *Sp nov.*

Established on a portion of the left mandible, with a series of thirty one vertebræ of a single individual discovered by Prof. B. F. Mudge in the gray calcareous shale of Trego County, Kansas.

Some of the vertebræ have suffered from pressure, but the centrum of an anterior cervical is little or not at all distorted, as are also many of the caudals. All the dorsals and cervicals have transversely oval articular faces openly notched above for the neural canal. The fixed hypapophyses are large, the last one small and subconic, abruptly following a large truncate one. The three succeeding dorsals are keeled below; the keel of the last low and obtuse. The zygosphen is weak and deeply notched in the middle; on the anterior cervicals it is rudimental, but on the dorsals supports a well-developed articular facet, which meets a corresponding one of the zygantrum. The fixed hypapophyses and roofs of the posterior zygapophyses are rugose, with grooves and ridges. The articular faces of the caudals are broad, vertical ovals as far as the specimens extend; the series including only a part of those with diapophyses. On the anterior caudals, the chevron facets are compressed. The neural spines are thinned out in front, obtuse at the base behind, but expanding to a thin edge above it; the sides longitudinally grooved. Diapophyses on the middles of the sides of the centra. Some ribs have the heads not expanded but truncate. The angle of the mandible is produced backward and below the plane of the lower margin of the ramus in a marked manner. The lower margin and the surface next the smooth edge are rugose.

Measurements.

	M.
Depth of mandible at posterior margin of cotylus	0.058
Length of centrum of anterior cervical	.070
Diameter of the ball, vertical	.028
Diameter of the ball, transverse	.040
Expanse of diapophyses of ball	.095
Expanse of anterior zygapophyses	.064
Expanse of diapophyses of anterior dorsal	.115
Length of centrum of anterior dorsal	.071

	M.
Length of centrum of anterior caudal	.053
Depth of cup of anterior caudal	.044
Width of cup of anterior caudal	.041
Width of neural spine	.033
Elevation of neural spine, (apex lost)	.070
Diameter of centrum of twenty-fourth caudal, vertical	.039
Diameter of centrum of twenty-fourth caudal, transverse	.040
Length of centrum of twenty-fourth caudal	.042

This species appears to have had proportions not unlike those of *Platecarpus coryphæus* the specimen described being larger than that on which the latter is based. It is also rather larger than the *Clidastes planifrons*, the largest of its genus, but which, since its caudal vertebræ are unknown, may be found to be a *Sironectes*. It differs specifically from the *S. anguliferus* in the less development of the zygosphen, especially on the anterior vertebræ, and its deep emarginations in front where well developed. From its general characters I anticipate that the quadrate bone of this species will prove to be more like that of the *Platecarpi;* that of *C. planifrons* is that of the genus to which I have referred it.

PLATECARPUS, Cope.

Extinct Batrachia and Reptilia N. Am., 1869, pp. 185, 199. Proceedings Academy Philadelphia 1872, p. 141; *Holcodus*, Copei *nec* Gibbsii, Proceed. Amer. Philos. Soc. 1871, December; *Lestosaurus*, Marsh, Amer. Journ. Sci. Arts, 1872, June (Separata, p. 9).

Besides the characters assigned to this genus in the analytic table already given, *Platecarpus* is characterized by the form of its teeth, which are neither compressed, as in *Liodon*, nor broadly angularly faceted, as in *Mosasaurus* (and *Holcodus*, *fide* Marsh), but are curved and with subcylindric section. The exposure of the roots of the palatine teeth is largely less or scarcely greater on the outer than on the inner side. The caudal vertebræ of the type-species, *P. tympaniticus*, are unknown; but the quadrate bone and form of palatine teeth are quite similar to those of the other species already referred to it.

The species *P. mudgei* and *P. tectulus* resemble each other in the form of their quadrate bone, and are referred to this genus provisionally only. The *P. simus*, Marsh, resembles the *P. crassartus*, Cope, but appears to differ in the more depressed articular faces of the dorsal vertebræ.

a. The stapedial pit inclosed between ridges:

PLATECARPUS ICTERICUS, Cope; *Holcodus ictericus*, Cope, Proceed. Amer. Philosophical Society 1870, 577, and 1871, December; *Lestosaurus ictericus*, Marsh, Amer. Journ. Sci. Arts, 1872, June.
Niobrara chalk of the Smoky Hill River.

PLATECARPUS CORYPHÆUS, Cope; *Holcodus coryphæus*, Cope, Proceed. Amer. Philos. Society, 1871, December; *Lestosaurus coryphæus*, Marsh, *loc. cit.*

Niobrara chalk of the Smoky Hill River.

PLATECARPUS FELIX, Marsh; *Lestosaurus felix*, Marsh, Amer. Journ. Sci. Arts, 1872, June, tab. xiii, fig. 4.

Niobrara chalk of the Smoky Hill River, Kansas.

PLATECARPUS CURTIROSTRIS, Cope; *Liodon curtirostris*, Cope Proceed. Amer. Philos. Soc., 1871, December; *Lestosaurus curtirostris*, Marsh, *loc. cit.*

Niobrara chalk of the Smoky Hill River, Kansas.

aa. Relations of stapedial pit unknown:

PLATECARPUS CRASSARTUS, Cope; *Liodon crassartus*, Cope, Proceed. Amer. Philos. Soc., 1871, 168; and December.

Niobrara chalk of Eagle Tail, Colorado.

PLATECARPUS SIMUS, Marsh; *Lestosaurus simus*, Marsh, *loc. cit.* 1872, June.

Niobrara chalk of the Smoky Hill River.

PLATECARPUS LATIFRONS, Marsh; *Lestosaurus latifrons*, Marsh, *loc. cit.* 1872, June.

Niobrara chalk of the Smoky Hill River, Kansas.

PLATECARPUS GRACILIS, Marsh; *Lestosaurus gracilis*, Marsh, *loc. cit.*, 1872, June.

Niobrara chalk of the Smoky Hill River, Kansas.

PLATECARPUS (?) GLANDIFERUS, Cope; *Liodon glandiferus*, Cope, Proceed. Amer. Philos. Society, 1871, December.

Niobrara beds of the Smoky Hill, Kansas.

aaa. Stapedial pit excavated in a plane surface:

PLATECARPUS MUDGEI, Cope; *Liodon mudgei*, Cope, Proceed. Amer. Philosophical Soc., 1870, p. 581; *Holcodus mudgei*, Cope, *loc cit.* 1871, December; *Rhinosaurus mudgei*, Marsh, American Journ. Sci. Arts, 1872, June.

Niobrara chalk of the Smoky Hill River.

PLATECARPUS TECTULUS, Cope; *Holcodus tectulus*, Proceed. Amer. Philos. Soc., 1871, December.

Niobrara chalk of the Smoky Hill River.

LIODON, Owen.

Proceedings British Assoc. Advancement of Science, 1841, p. 144; Cope, Transac. Amer. Philosophical Society, Extinct Batrachia, etc., 1870, p. 200; Proceedings Amer. Philos. Society, 1871, December.

The typical species of this genus, *Liodon anceps*, Owen, is very little known, but few remains having so far been obtained from the English chalk, its locality and horizon. Numerous North American species resemble it in the forms of the crowns of the teeth, and it is probable, though not certain, that they agree in other respects also. Several names have been proposed for our species; the earliest of which is *Macrosaurus*, Owen. This name applies to species with compressed dorsal vertebræ as *L. lævis* and *L. mitchillii*, both from the New Jersey greensand. For the species with depressed dorsal vertebræ, as *L. validus*

from New Jersey, *L. perlatus* from Alabama, and *L. proriger* from Kansas, the name *Nectoportheus* was proposed, and briefly characterized (Extinct Batr. Reptilia N. America, 1870, p. 208.) Prof. Marsh subsequently gave the Kansas species the name of *Rhinosaurus*; which name being pre-occupied more than once, I changed it to *Rhamphosaurus*.* This name will remain for species of the type of *Liodon proriger*, if they be found to represent a genus distinct from *Nectoportheus* or *Liodon*, of which there is as yet no evidence.

LIODON MICROMUS, Marsh; *Rhinosaurus micromus*, Marsh Amer. Journ. Sci. Arts, 1872, June, tab. xiii, figs. 1–2.

Niobrara chalk of the Smoky Hill.

LIODON NEPÆOLICUS, *sp. nov.*

Rhamphosaurus nepæolicus, Cope, MSS.

Represented by the mandibular and parts of the maxillary and premaxillary bones, the quadrate, a dorsal vertebra, &c., of a single individual. These all indicate an animal related to the large *L. proriger*, but not more than one-third the size or less. It is about the same size as the *L. micromus*, Marsh, but is much more like the *L. proriger* in characters, so as to render it important to ascertain whether it be not a young individual of that species. An examination having convinced me that such is not the case, the points of distinction will be given further on.

The *premaxillary* is very prominent, forming a rostrum whose inferior face is narrowed below, and then suddenly descends to a prominent transverse ridge, which bounds the anterior alveoli in front. The four premaxillary teeth stand on an area a little broader than long. Extremity broken. The anterior suture of the *maxillary* is vertical and zigzag. It displays a lateral contraction just behind the first tooth, while the anterior margin of the nostril is above the third tooth. The teeth of both jaws have broadly oval bases, and apices with two cutting edges and lenticular section. The inner face is more convex than the outer, most so in the anterior part of the jaws, and neither is facetted. The enamel is finely striate-grooved, especially toward the base. The mandible is light and thin, and diminishes in depth posteriorly. The coronoid is small, and the angle is produced backward, and but little downward. The rami are not complete; the large portions preserved exhibit teeth at intervals of precisely an inch. Professor Mudge, who discovered the specimen, states that the jaw, when together, measured 26 inches in length, which would leave 13 inches for the dentary bone. This is, therefore, not far from the true number of teeth.

The *quadrate* resembles that of *L. dyspelor* in various respects. The internal longitudinal ridge is very prominent, and extends from the proximal angle to the distal articular face, in line with the plane of the short acuminate hook. The great ala is narrow and rather stout; the proximal articular face slopes steeply outward. The stapedial pit is a narrow straight groove (perhaps partly closed by pressure). The knob is represented by a longitudinal crest bordering the meatus below on the outer side, and not continuing to the distal articulation. The sur-

* This name was applied by Fitzinger to two species of lizards, which had already received several generic names, and hence became at once a synonym. Further, he did not characterize it; for these reasons the name was not preoccupied at the time I employed it as above; hence there is no necessity for Prof. Marsh's subsequent name *Tylosaurus*, given on the supposition of preoccupation.

face of the latter is crescentic, with an angle on the outer anterior border. This angle is the summit of a short low rugose ridge, which extends part way to the knob. Outer edge only of the great ala radiate grooved; posterior angle of distal condyle produced.

The *dorsal vertebra* is somewhat flattened by pressure; but the ball was evidently transversely cordate in outline. The bases of the dial pophyses are very rugose; an acute angle from the articular cartilage is directed toward it from the rim of the cup. Inferior face with an obtuse median keel. The *odontoid* bone is deeper than long (fore and aft).

As compared with *L. micromus*, this species differs in the much less attenuated premaxillary and maxillary bones, the anterior nostril, and absence of facets on the crowns of the teeth; from *L. proriger* in the absence of narrow concave facets on the anterior teeth, and anterior position of the nostril; from *L. dyspelor* in the less compressed or less knife-shaped dental crowns, and totally different form of the condyle of the quadrate.

Measurements.

	M.
Length of bases of two premaxillary teeth	0.026
Width of bases of two premaxillary teeth	.034
Length of bases of two maxillary teeth	.042
Depth of anterior suture of maxillary teeth	.028
Depth of maxillary at end of nares	.038
Length of quadrate	.082
Length of distal condyle	.040
Width of distal condyle	.017
Width of great ala on inner side	.032
Width of inner face above meatus	.037
Length of hook from stapedial pit	.028
Length of a dorsal vertebra	.059
Diameter of ball, vertical	.029
Diameter of ball, transverse	.048

This species was discovered by Prof. B. F. Mudge, who dug the type specimen from the gray shale of the Niobrara Cretaceous, a half mile south of the Solomon River, Kansas.

LIODON LATISPINUS, Cope, Proceed. Am. Philosoph. Society, 1871, 169, and December.

North Fork of Smoky Hill and Trego County, Kansas.

LIODON PRORIGER, Cope, Transac. Amer. Philosophical Soc., Extinct Batrachia, &c., 1870, 202; *Macrosaurus proriger, loc. cit*, on tab. xii, figs. 22–24; *Rhinosaurus proriger*, Marsh, Amer. Journal Sci. Arts, 1872, June; *Rhamphosaurus*, Cope, Proceed. Acad. Nat. Sci., 1872, 141.

Niobrara chalk of the region of the Smoky Hill River, Kansas.

LIODON DYSPELOR, Cope, Proceed. Amer. Philosoph. Soc. 1870, 574; *loc. cit.*, 1871, December; *Rhinosaurus dyspelor*, Marsh Am. Jour. Sci-Arts, 1872, 1872, June; *Tylosaurus dyspelor*, Leidy, Report of Geolog. Survey of Terrs., I, 271, tab. xxxv, figs. 1–11.

Niobrara chalk of Fort McRae, N. Mex.; Niobrara chalk of Smoky Hill, Kansas.

PISCES.

?SYNENTOGNATHI.

PELECORAPIS, Cope, *gen. nov.*

This genus embraces fishes with strongly ctenoid scales and abdominal ventral fins; there is a spinous dorsal fin apparently short, and not continued over the ventrals. The ribs and apophyses are slender, and the dorsal vertebræ short and pitted. The pubic bones consist of two antero-posterior plates, in contact on the middle line. The anterior portion projects to a median angle, and there is an angular projection of the lateral border. From the angle formed by these borders, a long cylindric rod projects forward; those of opposite sides slightly converging.

The general relations of this form are to the families which combine the features of the orders of physoclystous and physostomous fishes, namely, *Scombresocidæ*, *Atherinidæ*, &c. The pelvis has considerable resemblance to that of those families, but especially to that of *Exocœtus*. From this it presents subordinate differences.

PELECORAPIS VARIUS, *sp. nov.*

Represented by portions of perhaps two individuals, the larger of which includes a considerable part of the body, the head and tail being absent. On this specimen it is evident that the scales diminish in size toward the posterior part of the body, where they are small; on the anterior region there are two scales exposed in an oblique series, in 6 millimeters; on the posterior region, 3½ and 4 in the same. The concealed portions of the scale are sculptured with minute contiguous concentric grooves, without any radii. The exposed portion is thickened with a cementum-like layer, which is marked with a few radiating lines of pores which sometimes unite into an irregular groove. Teeth of the comb numerous and strong. Depth of body at pelvis, $0^{m}.074$; length of pelvis, $0^{m}.040$; of lamina, $0^{m}.022$; of rod, $0^{m}.022$; greatest width of pelvis, $0^{m}.023$; width at basis of rods, $0^{m}.014$; length of 17 consecutive vertebræ, $1^{m}.05$; diameter of a dorsal vertebra, $0^{m}.007$.

Discovered by Professor Mudge in a lead-colored clay, probably of the Benton epoch, 20 feet below the *Inoceramus* bed, 2 miles west of Sibley, Kansas.

ISOSPONDYLI.

PORTHEUS, Cope.

Proceed. Amer. Philos. Soc., 1871, 173; *loc. cit.*, 1872, 331.

Additional material establishes as correct the reference of sharp-edged compound rays to the pectoral fins, and narrower, simple ones to the ventrals; while the presence of a frontoparietal fontanelle is doubtful. The number of teeth in the premaxillary bone is subject to some variation, there being occasionally, besides the principal ones, a small accessory on one or both sides.

PORTHEUS MOLOSSUS, Cope, Proceed. Amer. Philos. Soc., 1871, 173; 1872, 333.

Common in the Niobrara Cretacious of the Smoky Hill region, Kansas.

PORTHEUS THAUMAS, Cope; *Saurocephalus thaumas*, Cope, Proceed. Amer. Philos. Soc., 1870, November; *loc. cit.*, 1872, 335.

Same locality as the last.

PORTHEUS LESTRIO, Cope, Proceed. Academy Natural Sciences, Philadelphia, 1873, 337.

Niobrara Cretaceous of Kansas near the Solomon River; abundant.

PORTHEUS MUDGEI, *Sp. nov.*

Represented by portions of the jaws with vertebræ of a single individual discovered by Prof. B. F. Mudge, in Trego County, Kansas. The prominent character is seen in the possession of four subequal teeth in the premaxillary bone, which therefore presents a relatively long alveolar border for their accommodation. The bone is also more massive than in the other species, and is peculiarly thick on the free inner edge. There are five or six subequal large teeth behind an edentulous space on the maxillary bone, while those on the posterior part are small. The specimen is smaller than is usual in other species of the genus.

Measurements.

	M.
Width of premaxillary bone	0.054
Elevation of premaxillary bone above first tooth	.060
Thickness of premaxillary bone at middle	.021
Depth of maxillary at condyle	.057
Depth of maxillary at fifth large tooth	.040
Length of basis of five large teeth	.036
Length of an anterior vertebra	.019
Diameter, vertical	.031
Diameter, transverse	.031

Occasionally the *Portheus lestrio* exhibits one or even two minute additional premaxillary teeth, but the three large teeth always remain a distinction from the four large ones of the *P. mudgei.*

PORTHEUS GLADIUS, Cope, Proceed. Acad. Nat. Sci. Philadelphia, 1873, 338.

Represented by a huge pectoral spine, which may belong to one of the preceding species.

Niobrara Cretaceous of the Solomon River, Kansas.

ICHTHYODECTES, Cope.

Proceed. Amer. Philos. Society, 1870, November; *loc. cit.*, 1872, 338.

ICHTHYODECTES ANAIDES, Cope, *loc. cit.*, 1872, 339.

Niobrara Cretaceous of the Smoky Hill.

ICHTHYODECTES CTENODON, Cope, *loc. cit.*, 1870, November; *loc. cit.*, 1872, 340.

Niobrara Cretaceous of the Smoky Hill.

ICHTHYODECTES HAMATUS, Cope, *loc. cit.*, 1872, 340.

Niobrara Cretaceous of the Smoky Hill.

ICHTHYODECTES PROGNATHUS, Cope, *loc. cit.*, 1872, 341; *Saurocephalus prognathus*, Proceed. Amer. Philos. Soc., 1870, November.

Niobrara Cretaceous of the Smoky Hill.

ICHTHYODECTES MULTIDENTATUS, Cope, *loc. cit.*, 1872, 342.
Niobrara Cretaceous of the Smoky Hill.

ICHTHYODECTES PERNICIOSUS, *sp. nov.*

Compound pectoral spines of this genus, which have heretofore come under my observation in considerable abundance, exhibit an undulating cutting margin with low waves, and a nearly uniform thickness. These I have attributed to such species as *I. anaides*, *I. ctenodon*, and *I. hamatus*. A spine pertaining to a fish of equal or greater size than these has been several times obtained, which evidently belongs to another and more formidably-armed species.

The cutting edge is coarsely serrate, each projecting tooth marking the end of one of the oblique component rods. The apex of each tooth is the end of a transverse thickening or low ridge of the surface of the spine, so that the cutting edge is equally acute at the bottoms of the concavities as at the rather obtuse apices of the teeth. The cement or enamel layer extends on both sides of the spine 0.75 inch from the cutting edge; it is composed of small aggregated tubercles. Length of fragment supporting twenty teeth, $0^{m}.235$; thickness of fragment at middle, $0^{m}.008$. Discovered by Professor Mudge.

DAPTINUS, Cope.

Proceedings Academy Philadelphia, 1873, 339.

DAPTINUS PHLEBOTOMUS, Cope; *Saurocephalus phlebotomus*, Cope, Proceed. Amer. Philos. Soc., 1870, November; Hayden's Annual Rept. U. S. Geol. Surv., 1871, 416.

Niobrara epoch, Rooks and Phillips Counties, Kansas.

SAUROCEPHALUS, Harlan.

SAUROCEPHALUS LANCIFORMIS, Harlan, Journal Academy Natural Sciences, I vol. iii, 331; Leidy, Transac. Amer. Philosophical Soc., 1860.

Cretaceous on the Missouri River.

SAUROCEPHALUS ARAPAHOVIUS, Cope, Proceed. Amer. Philos. Soc., 1872, 343.
Niobrara epoch of the Smoky Hill, Kansas.

ERISICHTHE, Cope.

Proceedings Academy Philadelphia, 1872, 280.

In this genus the teeth are implanted in deep sockets as in other *Saurodontidæ*, and the subalveolar line of foramina seen in *Saurocephalus* is wanting. The crowns of the teeth are compressed and knife-like as in *Daptinus*, but those of the anterior parts of the dentary and maxillary bones are greatly enlarged. Maxillary bone short and rapidly tapering to a narrow edentulous extremity. Greater part of the dentary with a rugose band on the inner side of the teeth; its distal portion with a row of small compressed teeth separating the large teeth into two areas.

ERISICHTHE NITIDA, Cope, *loc. cit.*

Represented by numerous portions of a cranium with a fragment of a pectoral ray discovered by Prof. B. F. Mudge near the Solomon River, Kansas. The ray is of the compound character already described as belonging to other genera of this family; its edge is not preserved.

The *maxillary* bones are subtriangular in form, and support three or four large lancet-shaped teeth at the middle of their length; there are no teeth beyond them, but on the deeper side there are several small lancet-shaped teeth; the outer alveolar edge is rugose. The teeth are very flat, acute, and perfectly smooth. The teeth on the greater part of the dentary are intermediate in size between the large and small ones of the maxillaries; they stand on the outer edge of a broad horizontal alveolar plane. There are three large teeth in a series at the end of the dentary on the outer side; they have been lost, but their bases are broader ovals than those of the maxillary bone. On the middle line of this part of the dentary is a close series of small compressed teeth, with striate enamel, standing on a ridge of the bone. They leave the last large tooth to the outer side, while on the inner side stand two or three lancet-shaped tusks of a short row further back. Posterior dentaries $0^{mm}.10$ apart.

Measurements.

	M.
Length of maxilary bone above	0.0880
Depth proximally	.0300
Length of crown of a large tooth	.0150
Width of crown at base	.0065
Length of hyomandibular	.1000

Niobrara epoch of Phillips County, Kansas. Discovered by Prof. B. F. Mudge.

PACHYRHIZODUS, Agass.

Dixon's Geology of Sussex, 1850, 374; Cope, Proceed. Amer. Philos. Soc., 1871, 344.

PACHYRHIZODUS CANINUS, Cope, *loc. cit.*, 344.

Niobrara epoch of the Smoky Hill River.

PACHYRHIZODUS KINGII, Cope, *loc. cit.*, 346.

Niobrara epoch of the Smoky Hill River.

PACHYRHIZODUS LATIMENTUM, Cope, *loc. cit.*, 346.

Niobrara epoch of the Smoky Hill.

PACHYRHIZODUS LEPTOPSIS, *sp nov.*

Represented by portions of the right and left dentary bones, with other portions of the cranium. The symphyseal part of the ramus is not incurved, as in *P. caninus* and *P. kingii*, but is obliquely truncate, indicating that the chin had a compressed form, and was not rounded, as in them. The lower portion of the bone is thin and laminiform to a deep groove, which extends from the edge of the symphyseal face along the inner side at one-third the depth of the ramus from the inner bases of the roots of the teeth. The latter are thus supported on a

thickened basis. They are rather remote in a functional condition, each interspace being entirely occupied by the alveolar fossa of the shed tooth. These bases are very stout and composed of dense bone; their apices rise a little above the edge of the external alveolar border. The bases of the crowns are oval, and they display an anterior cutting edge, which descends from the apex, thus differing materially from those of the *P. caninus*. The teeth diminish in size from the middle of the dentary bone to the symphysis; beside the latter are two teeth of reduced size. The outer face of the dentary is smooth, except some small impressed fossæ. The mental foramina are small and do not issue in a groove. Below them, on the outer face, is a fossa, with level floor to the inferior margin.

Measurements.

	M.
Length of margin bearing four teeth	0.050
Depth of ramus at third tooth	.025
Elevation of tooth basis	.008
Long diameter base of crown of ditto	.006

Niobrara epoch of Phillips County, Kansas.

PACHYRHIZODUS SHEARERI Cope, Proceed. Amer. Philos. Society, 1872, p. 347.

Niobrara epoch of the Smoky Hill River.

PHASGANODUS, Leidy.

PHASGANODUS DIRUS, Leidy, Proceed. Acad. Nat. Sciences, Philada., 1857, 167; Report Geolog. Survey Terrs. 1873, I, 289; tab. xvii, figs. 23, 24.

From Cannon Ball River, Dakota.

PHASGANODUS (?) GLADIOLUS, Cope; *Cimolichthys gladiolus*, Cope, Proceed. Amer. Philos. Soc., 1872, 353.

Niobrara epoch of the Smoky Hill River.

TETHEODUS, Cope, *gen. nov.*

Premaxillary bone a petrous mass without teeth; the maxillary with teeth in a single row, the anterior much enlarged; dentary with a single series, one anterior tooth much enlarged. Apices of teeth with trenchant edges.

A genus chiefly differing from *Enchodus* in the absence of the large tooth at the extremity of the premaxillary bone.

TETHEODUS PEPHREDO, *sp. nov.*

Both premaxillary and portions of the maxillary and dentary bones of one specimen represent this species. They show it to have been a powerful fish of the size of the *Enchodus petrosus* below mentioned. The premaxillaries are excavated by the usual three oblique fossæ above to the inner side. The alveolar face is a ridge extending obliquely across from a tuberosity on the inner side behind the apical tuberosity. There is no surface for the attachment of a tooth, and no scar or other trace of the former existence of one. The maxillary underlaps it by an oblique suture, and supports a large tooth similar to that at the end of the premaxillary in *Enchodus*, behind which are seen the crescentic scars of the previously-shed teeth. The outer face of the basal cementum of this tooth

is perfectly smooth. The distal portion of the *dentary* bone is toothless; its anterior tooth is a fang with base excavated in front; and an angle rising from the external side of it becomes a latero-exterior cutting edge of the crown to the apex. The inner posterior, or more convex face, of the tooth is regularly and closely striate-grooved. On one dentary there are three or four small denticles in front of it on the outer side. The smaller teeth have two cutting edges, and the posterior face at the base is grooved striate. This regular grooving, as well as the large size of the first maxillary, distinguishes this fish from the *Enchodus anceps*.

Measurements.

	M.
Length of premaxillary bone above	0.075
Depth of premaxillary	.033
Width of basis first maxillary tooth	.010
Length of dentary at first tooth	.020
Length of dentary to first tooth	.020
Length of first tooth	.032
Interval between maxillary teeth	.008

Niobrara epoch of Phillips County, Kansas; discovered by Prof. B. F. Mudge.

ENCHODUS, Agass.

ENCHODUS PETROSUS, *sp. nov.*

Established on the maxillary and premaxillary bones, of both sides of the same individual. In the latter bone the anterior margin is truncate obliquely upward and backward, its lower margin passing into the base of the single large tooth; alveolar surface elongate, posteriorly narrowed to an obtuse edge. The maxillary exhibits both borders obliquely truncate, with sutural face. The alveolar aspect supports two teeth, one larger than the other.

The premaxillaries are very massive, and exhibit on their upper faces three oblique fossæ, the posterior transversely subdivided. External face smooth.

Measurements.

	M.
Length of premaxillary, (distal end lost)	0.067
Greatest width of alveolar face	.018
Depth of outer face	.030
Diameter at basis of tooth	.009

Obtained by Professor Mudge from beds of the Niobrara epoch in Kansas.

ENCHODUS (?) ANCEPS, Cope; *Cimolichthys anceps*, Cope, Proceed. Amer. Philos. Society, 1872, 552.

Niobrara epoch of the Smoky Hill River.

ENCHODUS CALLIODON, Cope, *loc. cit*, 354.

Niobrara epoch of the Smoky Hill River.

ENCHODUS SHUMARDII, Leidy, Proceed. Acad. Nat. Sciences Philadelphia, 1856, 257; Report U. S. Geol. Survey Terrs., I, 1873, 287, tab. xvii, fig. 20 Sage Creek, Dakota.

EMPO, Cope.

Proceed. Amer. Philosophical Soc., 1872, 347; *Cimoliichthys*, Cope, *loc. cit.*, 348, (attributed to Leidy, but not his genus).

A large number of additional specimens have been examined since the description above cited was published; as several of these embrace crania with the bones in place, and greater or less portions of the bodies, many important additions to the definition can be made.

The anterior end of the maxillary is subconic and generally compressed, as originally described under *E. semianceps*, and free from well-marked sutural surface. The distal part of the bone has a greater vertical extent, and exhibits points of attachment for bones or ligaments. This relation, the reverse of what might be supposed without violating analogy, I have proved on two crania where they are in place. I have only seen the premaxillary in one species, the *E. semianceps*. It resembles that of *Enchodus* in its solid, massive character, and the presence of a prominent tooth at the anterior extremity. It bears two teeth near the middle of its length, a character which may be specific only. At the anterior extremity of the maxillary, there is a short series of large teeth, which continues gradually or abruptly into a series of much smaller teeth along the inner or posterior border of the alveolar face. This terminates in one or two abruptly larger teeth near the distal end of the bone. The outer alveolar border is occupied by a row of teeth of large size, similar to those at the proximal end, which commences opposite the most distal of the latter. Their size is reduced opposite to the two large distal ones, and is recovered again in the single row on the narrowed distal portion of the maxillary. The teeth are compressed at the tip, and generally bear one or more cutting edges.

The *dentaries* support several series of teeth, one of large ones on the inner side, and several smaller on the outer. The small ones are double-edged, and diminish in size to the external margin; the inner ones are like the large ones of the maxillary series, with a flattened cutting apex.

There are other tooth-bearing bones, which I cannot positively locate. Some of these are laminiform, and are covered on one edge and for some distance on the adjacent sides with a dense brush of small acute conic teeth. This bone is palatine or pterygoid. Another is a massive tongue-shaped bone with one narrowed extremity and the other expanded into a lamina in the same plane. It supports a median series of teeth mostly in two rows, whose crowns are curved and simply conic. This bone is sometimes nearly symmetrical, so as to resemble a vomer; but in others it is distinctly unsymmetrical, and hence probably a lateral element. In one specimen it lies pressed down on the dentary with the teeth on the inferior side. Another bone is rod-like, with triangular section, with a single row of small conic teeth set on the edge, whose section gives an angle. This, doubtless, belongs to the branchihyal system, to which, perhaps, the piece first described may be attached. The latter I call the *pharyngeal* bone until fully identified.

The *vertebræ* are not grooved as in *Saurodontidæ*, but sculptured with raised lines only on the greater part of the column. Posteriorly deep lateral grooves appear. The ribs are well developed, and the abdominal cavity not elongate. Ventral fins are not in the abdominal position in the best identified specimens of *E. sulcata*. No strong fin-rays can be certainly referred to the genus. The body was covered with very large scales on the side and on the middle line of the back; some of the latter having the character of shields. They have the surface, in some spe-

cies, marked with raised radiating ribs, or inosculating ridges, whose edges are sometimes serrate.

Several species of this genus appear to have existed. I originally referred some of them to Dr. Leidy's genus *Cimolichthys;* but I find that they do not possess the same type of teeth. The *Empo nepaeolica* probably belongs to it, and the generic characters formerly given express the peculiarities of dentition of the distal part of the maxillary bone. The genus therefore takes this name. From several allied genera here enumerated, it differs in the presence of the outer series of small teeth on the dentary bone, and the inner series of the maxillary, with the absence of long teeth on the front of the former.

EMPO NEPAEOLICA, Cope, Proceed. Amer. Philosophical Soc., 1872, 347.

Niobrara epoch of the Smoky Hill region.

EMPO SULCATA, Cope; *Cimolichthys sulcatus*, Cope, *loc. cit.*, 351.

Niobrara epoch of the Smoky Hill and of Rooks County, Kansas.

EMPO SEMIANCEPS, Cope; *Cimolichthys semianceps*, Cope, *loc. cit.*, 351.

Niobrara epoch of the Smoky Hill region, and of Trego and Rooks Counties, Kansas.

EMPO MERRILLII, *sp. nov.*

Indicated by numerous portions of cranial bones, including those supporting the teeth. On the proximal part of the maxillary, the large teeth grade into those of the small inner series insensibly; at the distal end the two large ones of the inner side are opposite to the reduced ones of the outer series. Both maxillary and mandibular teeth are striate-grooved on the outer side at the base. The pharyngeal bone is peculiar in not bring widely expanded at one end, and in having a narrow basis generally for the two rows of teeth it supports. The (?) palatine bone exhibits the teeth *en brosse*, seen in *E. semianceps*, but principally on one side, and the thickened edge supports on one of its marginal angles a series of much larger conical teeth.

Measurements.

	M.
Width of maxillary inferiorly at middle	0.012
Depth of maxillary distally	.018
Depth of maxillary proximally	.011
Depth of (?) palatine	.018
Width of pharyngeal bone at middle	.009

Niobrara epoch of Ellis County, Kansas. Dedicated to Professor Merrill, of Topeka, who has made a number of important additions to our knowledge of the extinct vertebrata of Kansas.

EMPO CONTRACTA, *sp. nov.*

Considerable portions of a cranium of a species of the lesser size of the *E. semianceps* resemble corresponding parts of that species, with certain marked exceptions. These are seen in the flatness of the maxillary bone, and the large size of the inner row of teeth. The inner face of the maxillary is very narrow, by reason of the depression of form. The proximal end of the same is, on the other hand, a little compressed.

A single row of large teeth occupies it, extending along the inner alveolar border; those of the outer row appear to be wanting for a considerable distance, and are at first no larger than those of the outer. On the outer face at the distal end the usual fossa on the upper half is wanting, the face from the alveolus being continuous with that of the rising lamina. The pharyngeal bone is flat and expanded behind. The dentary is acuminate distally, and the mental foramen issues in a groove, which passes around the end. The inferior external fossa commences some distance behind the foramen. External face of dentary striate.

Measurements.

	M.
Length of maxillary (constructed from fragments from opposite sides)	0.118
Width below at middle	.011
Depth of inner face	.004
Depth of outer face	.011
Length of bases of five proximal teeth	.027
Width of pharyngeal bone at middle	.010
Depth of dentary 2^{mm} from end	.012

From the Niobrara epoch of Trego County, Kansas. Discovered by Prof. B. F. Mudge, of the State Agricultural College of Kansas.

STRATODUS, Cope.

Proceed. Amer. Philosoph. Society, 1872, 348.

STRATODUS APICALIS, Cope, *loc. cit.*, 349.

Niobrara epoch of the Smoky Hill River.

APSOPELIX, Cope.

Hayden's Annual Report, 1870, 423.

APSOPELIX SAURIFORMIS, Cope, *loc. cit.*, 1870, 424.

Benton epoch at Bunker Hill, Kansas.

SELACHII.

SPORETODUS, Cope. *Gen. nov.*

Established on teeth resembling the posterior or pavement teeth of *Heterodontus*. Their arrangement cannot be described, as they are only known by separated specimens. Their surface is regularly convex, and covered with a dense layer, which does not exhibit pores, and is thrown into transverse or oblique ridges. No root is preserved in the specimens, but the basis is coarsely porous.

SPORETODUS JANEVAII, *sp. nov.*

A small tooth, probably lateral, is an oval, with its surface thrown into four folds, which traverse it obliquely from border to border. At the base of the outer at one end is a series of adherent tubercles; at the basis of that at the opposite end is a broken fold, with tubercles at its outer base. Length, 0^{m}.0045; width, 0^{m}.0025. A portion of a larger and more central tooth has the surface with an unsymmetrical convexity, and crossed transversely by five folds.

Discovered by Prof. B. F. Mudge, near Stockton, Kansas, in a bed containing many teeth of *Oxyrhina*, *Lamna*, &c., of small size. Dedicated to Dr. John H. Janeway, post-surgeon at Fort Hays, Kansas, who has rendered much important aid to palaeontology and zoölogy in Kansas.

PTYCHODUS, Agass.

PTYCHODUS POLYGYRUS, Agass., Poiss. Foss.
Niobrara epoch, Ellis County, Kansas; Professor Mudge and Professor Merrill.

PTYCHODUS OCCIDENTALIS, Leidy, Proceed. Academy Philadelphia, 1868, 207; Report Geolog. Surv. Terrs., 1873, 398; tab. xvii, 7–8, xviii, 15–18.

Niobrara epoch of the Smoky Hill.

PTYCHODUS MORTONII, Agass. Poiss. Foss.
Niobrara Cretaceous of the Smoky Hill River; Prof. Mudge.

PTYCHODUS WHIPPLEYI, Marcou, Geol. North America, 1858, 33; Leidy, Report, etc, 1873, 300, tab. xviii, 19–20.

Niobrara epoch of the Arkansas River, Kansas, and Galisteo, New Mexico; Professor Merrill.

GALEOCERDO, M. H.

GALEOCERDO CRASSIDENS, Cope, Proceed. Amer. Philos. Soc., 1872, 355.

Niobrara epoch of the Smoky Hill.

GALEOCERDO HARTVELLII, Cope, *loc. cit.*, 1872, 356.
Niobrara Epoch of the Smoky Hill.

GALEOCERDO FALCATUS, Agass., Leidy, Report U. S. Geol. Survey Terrs., I, 301; tab. xviii, 29–43.
Niobrara epoch of the Smoky Hill.

OTODUS, Agass.

OTODUS DIVARICATUS, Leidy, Report, I, 305; tab. xviii, f. 26–28.

Represented by several teeth, of which I select the largest and most perfect as type. The lateral denticles are well developed, though not large. The median cusp is rather narrow and moderately curved antero-posteriorly. The posterior surface is smooth, the anterior coarsely striate at the base. The fangs of the root diverge strongly, but, what constitutes a peculiarity of the species, project far forward and outward at their point of junction below the crown, reminding one of the outline of the Hottentot Venus.
Jewell County, Kansas; Professor Mudge.

OXYRHINA, Agass.

OXYRHINA EXTENTA, Leidy, *loc. cit.* 302; tab. xviii, 23–25.
Niobrara Epoch of the Smoky Hill.

LAMNA, Cuv.

LAMNA, two sp., Leidy, *loc. cit.*, p. 304.

SUPPLEMENTARY NOTICES

OF

FISHES FROM THE FRESHWATER TERTIARIES OF THE ROCKY MOUNTAINS.

RHINEASTES, Cope.

Hayden's Annual Report, 1872, 638.

RHINEASTES PECTINATUS, *sp. nov.*

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 intropérculum, the only lateral cranial bone visible, displays the dermoóssified 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; there 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 large uncini of the pectoral spine.

Measurements.

	M.
Length of head to clavicle (below)	0.0180
Width of head (below)	.0360
Width of scapular arch (below)	.0110
Expanse of modified diapophyses	.0200
Length of modified vertebræ	.0115
Length of pectoral spine	.0210

From the Tertiary shale of the South Park, Colorado.

AMYZON, Cope.

Hayden's Annual Report, 1872, 642.

AMYZON COMMUNE, *sp. nov.*

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 to 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 inturrupted 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 little 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 being 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 38 or 39 vertebræ, of which 9 are anterior to the first interneural spine, and 14 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, 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, *sp. nov.*

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.* humilis, Leidy, which is also found at the same locality, and it has a much longer anal fin. Its radii number 26, 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, 29. Depth at first dorsal ray, 0.0485; depth at last anal ray, 0.0170; length of 29 vertebræ, 0.0780.

ON THE GENERAL CHARACTERS AND THE RELATION OF THE FLORA OF THE DAKOTA GROUP.*

BY LEO LESQUEREUX.

The present article is a *résumé* of the essential characters and the relation of the flora of the Dakota group.

1. Though the Cretaceous formation containing our fossil leaves has been recognized as marine, from the presence in its compounds of a number of species of marine mollusks, no trace of fucoidal plants has been found among the vegetable remains of this group. The one described as *Zonarites* comes from the Benton group, where it was discovered in a kind of limestone, mostly composed of large marine shells, species of deep water.

It has been remarked how the fucoidal vegetation could not be introduced or brought upon the mud-flats and mixed with the red shale of the Dakota group, though the remains of marine plants are found in abundance just at the top of the Cretaceous series, in the lower sandstone of the Tertiary, which, on this account, has been compared to the Eocene, and admitted as its representative. This fact rather confirms the opinion that the Dakota formation is the result of a slow agglomeration of materials along a shore-line of wide extent; mud-flats, where, of course, the marine plants could not live, as their seeds do not take root in the mud; and where even their *débris* could not be preserved, on account of the softness and of the alternance of water over the surface. All the vegetable remains of the Dakota group, preserved either with their substance, or by impressions only, are pieces of hard wood, rootlets, and branches, with leaves of coarse, thick texture. Per contra, the sandstone with fucoids, or the Eocene, being slowly upheaved from deep water, was inhabited by a marine vegetation of long standing, which, though covered by successive sandy deposits, could but thrive, till near the surface of the sea, where we see it intermixed with fragments of exogenous land-plants washed on the shores, and indicating a new period or the beginning of a land formation.

2. That vegetable Permian types should not be represented in the flora of the Dakota group, though both formations are in immediate juxtaposition, is not a matter of concern. But it is not the same when we recognize in these vegetable remains of the Cretaceous a total absence of representatives of the preceding formation, the Jurassic, whose flora is a compound of *Ferns*, few *Equisetaceæ*, some *Conifers*, and especially of a prodigious abundance of *Cycadeæ*. Three-fourths of all the fossil *Zamiæ*, and half of the *Cycadeæ*, known from all the geological formations, belong to the Jurassic. In the lower Cretaceous of Greenland, Heer finds still a marked proportion of species of this family, there being nine *Cycadeæ* in a group of thirty-six species of land-plants, a proportion of

* Conclusion of the report on the flora of the Dakota group, now in progress of publication.

35 per cent. of the land flora of that epoch, as far as it is known. In the Dakota group, the only trace of a vegetable possibly referable to the *Cycadeæ* is the *Pterophyllum (?) Haydenii*, which, as it is remarked in the description, is considered by Schimper as of doubtful affinity. Prof. Heer, too, finds in the upper Cretaceous of Greenland a flora of twenty-eight species, mostly of Dicotyledonous plants without any trace of *Cycadeæ*.*

3. This absence of a predominant antecedent vegetable type in the Dakota group is not more remarkable than that of the Palms, which for the first appear in an extraordinary proportion in the lower Tertiary strata, just above the deep marine formation overlaying or following that of the Dakota group. The section of the cretaceous strata, as copied from Hayden's report, page 2, indicates in ascending a succession of beds of clay of a thickness of about two thousand feet, overlaid by five hundred feet of cretaceous sandstone, over which we find the lignitic formation with its peculiar flora, especially its abundance of Palms. The series of strata between the Dakota group and the Eocene has been uninterrupted as far as can be judged from the compound and the fossil animal remains. This does not indicate a period of long duration, at least comparatively to other more complex geological groups, and nevertheless the Cretaceous flora of ours has not a single species which might be referable to, or is recognized as identical with any of the land-plants of the Eocene, especially no trace of its essential representatives, the Palms. The proportion of Sabal is marked in the lignitic at Golden especially, at Black Butte, &c., not only by the remains of leaves, which in places fill thick strata of sandy clay, but also by fossil wood of the same class of plants, or by their trunks transformed into coal and identified by the characters of their preserved internal structure.

4. The essential and more numerous vegetable remains in the Da-

*Since the above was written I have received from Professor Heer a most interesting pamphlet *on the Sweden expeditions for the exploration of the high North.* In this paper the celebrated professor gives, first, an abridged narrative of the progress and casualities of these explorations, and then sums up in a masterly manner the results obtained for vegetable paleontology, as far, at least, as they were recognized from a preliminary examination of an immense amount of materials collected and sent to him.

From the Lower Cretaceous of the northern side of Noursoak Peninsula, and in a bed of black shale overlaying the gneiss, which form the essential bulk of the land, he finds a flora of sixty-eight species, of which seventeen belong to Conifers, nine to Cycadeæ, thirty-eight to Ferns, three to Equisetaceæ, and only one to Dicotyledonous; this is a peculiar kind of poplar. On the south side of the same peninsula, near Atanekerdluk, on another formation of grayish black shale, Professor Nordenskiöld, director of the expedition, discovered a quantity of well-preserved vegetable remains at a higher stage, or of the Upper Cretaceous. The specimens represent sixty-two species, viz, ten Conifers, among them a *Salisburia* found with leaves and fruits; two Cycadeæ; thirteen species of Ferns; and thirty-four dicotyledonous species distributed in sixteen families and eighteen genera. Among these he mentions leaves of *Ficus, Sassafras, Diospiros, Magnolia, Myrtus, Leguminosæ*, &c., and remarks that some of the species are known already from the Quader sandstein of Saxony, Bohemia, Moletin, (Moravia.) Only five of these species, three Ferns and two Conifers, are identical with those of the first locality, or of the Lower Cretaceous. Eight hundred feet above this formation they still found strata of clay and sandstone filled with a prodigious quantity of remains of fossil plants, which, according to Heer, represent a flora of the Lowest Miocene, and where he identifies one hundred and thirty-three species, fifty of which are also found in the Miocene of Europe. This flora is totally different from that of the Cretaceous of the same country, and no species are identical. This Tertiary formation is covered like the whole land by immense deposi to flava.

This description corresponds in many points with what we know of the Upper Cretaceous of Kansas and the Lower Tertiary formations of the Rocky Mountains, and we shall probably find, when the species of Greenland are published, a number of them identical with those of the Dakota group.

kota group are leaves of Dicotyledonous, representing the three di visions of this class, and, what is more remarkable, the genera to which belong most of the living arborescent plants of this country and of our present climate. If what may be called positive characters of the genera—the flowers and the fruits—are not ascertainable from fossil fragments, it is at least impossible to deny the intimate relation of most of the leaves of the Dakota group to the genera to which they have been referred in their descriptions.

Beginning by the Apetalous, we have first *Liquidambar* leaves so similar to those of our sweet-gum tree, *L. styracifluum*, by form and nervation, that in comparing the fossil leaves with those of our living species, no difference whatever can be remarked but in the entire borders of the fossil ones. They are more or less serrate-crenulate in the living species, as also in *L. Europeum* of the Miocene of Europe. But some species of the same formation, and considered by authors as referable to this genus, have leaves with entire borders. Even Gaudin, in his memoirs on the fossil leaves of Tuscany, figures as *L. Europeum*, three leaves, one of which, with entire borders, Pl. V, Fig. 3, looks like a counterpart of our Fig. 2, of Pl. III, the lateral nerves being marked as branches of the second pair of nerves, just as it is in our Cretaceous leaves, and not emerging from the top of the petiole as in the leaves figured by Heer under the same name. Gaudin accounts for the entire borders of this leaf by the supposition that the denticulation cannot be remarked on account of the coarseness of the stone where the leaves are imbedded. We could give the same reason or admit such a supposition, but the forms of the leaves of this genus are so distinct that the difference in the more or less serrate borders cannot prevent their generic identification. The leaves of the Cretaceous species are, especially by their truncate base and their general outline, rather related to those of our *L. styracifluum*, than to those of the Asiatic form, *L. orientale*. These are the two only living species of *Liquidambar*, with palmately-lobed leaves.

The history of this Genus, its origin, and the present distribution of its species, offer with that of *Platanus* a coincidence worth remarking. Both appear first in the Dakota group; both pass through the Tertiary formations of Europe in different modifications, and both, too, have each for essential representatives of the present flora an oriental and an occidental form. In Asia, *Liquidambar orientale* and *Platanus orientale;* in our country, *L. styracifluum* and *P. occidentalis*, of which the Mexican forms are mere derivations. No species of *Liquidambar* has been as yet recognized in our North American Tertiary formations. Two species widely distributed are described with numerous varieties from the Tertiary of Europe.

The numerous leaves which are referred to the genus *Populites* are comparable to those of the different species of poplars now inhabiting the north part of this continent. The relation is not positive, however. They essentially differ by the peculiar disposition of the secondary veins to run straight to the borders, a kind of nervation (*craspedodrome*) remarked in the leaves of the beech, and in very few indeed of the leaves, with entire borders of our present arborescent vegetation. Leaving out this difference and considering the apparent affinities, we have *Populus Haydenii*, referable to the section of the *Marginate* to which belong our *P. monilifera*, and some of its numerous varieties, *P. canadensis*, *P. angulata*, &c., and related also by its nervation and its peculiar denticulation to *P. candicans* of ours, and *P. balsamoides* of the Miocene. *Populites cyclophylla* and *P. lancastriensis* have typical affinity by their nervation and the enlarged form of the leaves with *Populus latior*, while *Populites elegans*

is referable to some forms of *Populus attenuata*, both these of the Miocene and to the living *P. nigra*. *Populites ovata* may be compared to *Populus mutabilis*, also of the Miocene. On account of the thick texture of the leaves it is placed in the section marked *Coriaceous*, of which there is no American representative at our present time. The thickness of the leaves of this last fossil *Populites* is not much more marked than in the other species of the genus. Scales of buds and seeds of poplars have generally been found in the Miocene of Europe, in connection with leaves referable to the genus. None of these vegetable organs have been discovered as yet in the shale of the Dakota group. The relation is, as remarked above, indicated merely by the form of the leaves, and this character is scarcely reliable to prove specific or even perhaps generic affinity.

It is not the same case, however, with the leaves of *Salix* and of *Fagus*, the willow and the beech. Their generic relation is positively indicated by the form of the leaves and by their nervation. Our *Salix candida*, Willd., as widely distributed as a shrub as the beech is as a tree, is the living willow most intimately related to the Cretaceous form. Its type is also represented in the Upper Tertiary or the Pliocene of California, especially. The species of *Fagus* of the Cretaceous is, by its entire, undulate leaves, rather referable to the present *F. sylvatica* of Europe than to our *F. ferruginea*. Both these species, however, are so similar that they were formerly considered by botanists as mere continental varieties, and are still admitted as such by many. They have on both continents the same wide and general distribution, being essential constituents of the forests of our present time. The beech has representatives in far distant countries, but its types are local, and all the exotic ones differ from that of our fossil species. Japan has one species with leaves cordate at base and borders obtusely crenate, the secondary nerves tending to the sinuses. Chili has five, with leaves obtuse, truncate at base, and borders mostly doubly serrate. South Central America has one of very wide distribution; it has small coriaceous dentate leaves. New Zealand has four, all with doubly serrate leaves and the lower surface white tomentose; and Tasmania has for its share two species of a still more distant type, with obtuse, truncate, and dentate leaves. *Per contra*, most of the species described as yet from the Tertiary are referable to the European or the North American types. *F. pristina* is related to our *F. ferruginea*. *F. antipofi*, from the Miocene of Alaska, is related to the same by the slightly dentate borders, but differs indeed by the larger size of the more taper-pointed leaves. *F. macrophylla* of the same formation and country has the leaves entire, like the European spices, but still of a far larger size, the specimen figured by Heer representing a leaf 16 to 18 centimeters long, and 10 centimeters wide. *F. deucalionis*, *F. feroniæ*, *F. horrida* have borders of leaves more or less dentate, and therefore more like the North American type. It is only when out of the geographical limits of the north occidental flora or in the Grecian Archipelago that we find a fossil species of *Fagus* related to an exotic form with doubly dentate small leaves: *F. dentata*, from Eubea, a species which Unger compares to the Chilian *F. obliqua*.

After this we find described from our Cretaceous flora: *Betula beatriciana*, comparable by the form of its leaves and its nervation to our *B. nigra*, so widely distributed from the northern shores of Lake Superior to Florida; seeds of *Myrica*; at least these which we have figured under this name, are undistinguishable from Heer's seeds of *Myrica* described from the Cretaceous flora of Quedlinburg, but indeed more flattened than the seeds of any of our present species; then leaves of oaks *Quercus primordialis*, of the type of the so widely distributed and variable *Q.*

prinus, the chestnut oak; *Q. ellsworthianus* and *Q. anceps*, types of our *Q. phellos* and *Q. imbricaria*, species with entire borders of leaves.

It would be hazardous to pursue further a typical comparison of the Cretaceous species of oaks, on account of the few materials found as representatives of this genus in the shales of the Dakota group. The few specimens, however, represent distinct, well-preserved leaves, from which at least we know that the oaks were already present in the Cretaceous flora of our continent. They appear few, in a modest way, though already of two distinct types; but soon the forms become more numerous and the genus takes an important place in the arborescent vegetation of the world. In the Eocene flora of the Rocky Mountains six species have been discovered already, among which one representing the third essential type of our oaks, marked with deeply pinnately-lobed leaves, as in the numerous species of the section of the North American black oaks. The Elk Creek specimens, which seem to represent two horizons of the Tertiary, have eight species; the Washakie group, and Carbon have six, and in the Pliocene of California the representatives of this genus are still more numerous and their types still more intimately related to those of the living species. The flora of the California chalk bluffs has six species of oaks, under only thirty-four species.

The three last genera of the Apetaleæ represented in the flora of the Dakota group are *Platanus*, *Laurus*, and *Sassafras*. Though no fruit of *Platanus* has been found till now with the leaves, these are, by their form and nervation, positively typified as representatives of this genus. Heer had already recognized *P. Newberrii*, in his *Phyllites du Nebraska*. To this I have added *P. Heerii*, far different from the former, as seen in the description; and *P. primæva*, which, from its likeness to *P. aceroides*, I was formerly induced to consider as a mere variety. Though, from the form of other mostly entire leaves, the Cretaceous species is apparently distinct, the analogy or similarity, as indicated by the characters of the leaves, is not the less remarkable. It is the type of the species later represented by acutely lobed and dentate leaves, which we recognize in the Eocene of the Rocky Mountains as *P. Haydenii*, in the Miocene of the same country and of Europe as *P. aceroides*, in the Pliocene of California as *P. dissectus*, and especially now as *P. occidentalis*.—*P. aceroides* was already considered by European authors as the ancestor of our *P. occidentalis* before the Cretaceous species had been discovered. Now, we have to refer the origin of our noble tree to a more ancient epoch.

Like that of *Fagus* and *Liquidambar*, the Cretaceous type of Platanus has not widely varied and multiplied, and also it does not appear to have changed its habitat in a marked degree, at least not in latitude. One species only, *P. aceroides*, and its variety, *P. guillelmæ*, is abundantly distributed in the Miocene of Europe, from Greenland as far south as North Italy, over an area of about twenty-six degrees of latitude, while the range of *P. occidentalis* is from the great lakes to the Gulf of Mexico, passing still farther south into Mexico by its analogous *P. Mexicana*. From Europe it has passed eastward as *P. orientalis*, in the same way as it has gone west from our country as represented by *P. racemosa* of California.

In the *Laurineæ* we have leaves referable by their form and nervation to the genus *Laurus* or *Persea*, and a well-preserved fruit, *Laurus macrocarpa*, which, comparable also to the fruits of *Cinnamomum* and *Sassafras*, is, from its association in the same localities with leaves of *Laurus*, admitted as belonging to this genus. It seems a southern type in comparing it to the other species of the Dakota group, but it is rather, I think, a shore type. Our *Laurus (Persea) caroliniana* extends in following the

shores from Virginia to Louisiana, and farther west in Texas. It is a meager remnant of a number of species of the same genus which inhabited our North American continent and that of Europe during the Tertiary period. We find some of them already in our Eocene, especially in Mississippi. Eight species of *Laurus* and two of *Persea* have been described from the Miocene of Europe. The genus enters by three species into the Miocene flora of the Baltic, but it has as yet no representative farther north. None has been described from the Arctic regions.

Sassafras belongs to the same family. The leaves of *Sassafras* are found in such great proportion in the southern area of the Dakota group, especially in Kansas, that the genus seems to have represented there a large part of the land vegetation. Our *S. officinalis* is, by its leaves, scarcely distinguishable from some of the varieties of forms of the leaves of the Cretaceous species, which, like the present one, seems to have had a remarkable disposition to variability. I have explained with the description of the fossil leaves what reasons have induced me to separate as species some of the more peculiar forms. I must say, however, that considering merely the outlines of the leaves of our present sassafras, it would be as convenient, if they were found distributed per groups and in a fossil state, to separate, as species, as large a number of these forms, as it has been done for the sassafras leaves of the Dakota group.

No species of sassafras has yet been recognized in the more recent geological formations of this continent. Three species are described from the Tertiary of Europe, one of which, *S. Ferretianum*, is in the Miocene of Greenland, as also in the same formation of Italy. The wide range of distribution of *S. officinalis*, the only living species, also limited to this continent, is well known. It extends from Canada to Florida, and over the same latitude, from the borders of the Atlantic to the Western prairies, even as far west as the region of the Dakota group, along the banks of the Missouri River near Omaha. The distribution of this beautiful, odorant and sanative shrub, which in good situations becomes a tree of moderate size, is as remarkable as its exclusive affection for the land of its origin.*

The division of the Gamopetaleæ is not as positively and evidently represented in this Cretaceous flora as the former. Heer, however, has recognized in the *Phyllites du Nebraska* leaves referable to *Andromeda* and *Diospiros*, two genera still present in the flora of this country. The leaves are fragmentary. But the celebrated author considers the reference as certain. There is in the Tertiary of Europe and of this continent a number of species of the same genera. No less than twenty-four *Diospiros* species are described from the Miocene; among them, two from Alaska and Vancouver Island. Of nearly one hundred of species known of the flora of our time, *D. virginiana*, the persimon, is the only one which has been left in the temperate regions of the North American continent. None belongs to Europe. Of the two species more intimately allied to the North American one, *D. Lotus*, a native of China, is often cultivated in the south of Europe; the other, *D. Kaki*, is from Japan; both have eatable fruits.

Proceeding further and coming to the division of the Apetalœ, we find among the fossil leaves of the Dakota group an *Aralia* leaf similar in its essential characters to one described by Heer from the Cretaceous of Europe. There is a slight difference which may be considered a specific, but generic identity is undoubtful; an *Hedera* whose affinity is marked

*Like that of our *Cornus florida*, the acclimatization of this species has not succeeded in foreign countries.

by the outline of its coriaceous leaves and still more by their nervation; two species of *Magnolia*, represented by a large number of leaves and recognized already in the *Phyllites* by Heer, and three species of *Liriodendron*, the tulip tree, whose form of leaves like that of the *Sassafras* sufficiently proves the generic reference.

Considering these genera separately in regard to their relations and to their present and past distribution, we find *Aralia* still represented in our flora by six species, all of different characters of leaves. For indeed the relation of the fossil form is rather to an old section of the Aralia with compound palmate leaves, now referred to the *Hedera* like *H. Xalapensis* of the mountains of Mexico. This type is still represented by large leaves in the Pliocene flora of California. *Hedera helix*, the ivy to which our Cretaceous species *H. ovalis* is closely allied, is indigenous of Europe, where its origin is confirmed by paleontology, the species having been recognized in the Pliocene of Italy. It is, however, of so easy acclimation with us that it looks like an old wanderer returned home after a long absence. In the temperate zone of the United States, it invades walls and stone-dwellings as it covers the ruins of the European castles of old. The genus *Aralia* is not represented yet in the fossil Tertiary flora of Europe.

But evidently these two most admirable genera of trees, *Magnolia* and *Liriodendron*, belong to North America by origin, succession, and presence. Of the eight species of true *Magnolia*, (*Magnoliastrum*,) now known to botanists, seven belong to the western slope of the temperate zone of North America, and the other *M. Mexicana*, is either a variety of *M. glauca*, or *M. grandiflora*, or even is referable to a different genus. We have seen that already two species of *Magnolia* have been recognized by Heer in the Dakota group. I have added two species to the number, one of which, however, is of uncertain affinity. In our lower Tertiary, the Eocene, we have still seven species; five of them in the Mississippi Eocene, one at Carbon, and one at Black Butte. Of the Mississippi species, two have been found in the Raton Mountains, New Mexico, marking thus the genus with the same climatic distribution as it has now; or with wandering representatives far from the limits of its area of general distribution. Thus, one of the species *M. Inglefeldi*, found at Black Butte, is described by Heer from the flora of Greenland, just as we find now groups of *M. glauca* and *M. umbrella*, isolated in deep gorges of Pennsylvania, far out of their mean range of habitat. In the Pliocene of California the genus has two species. In the Tertiary formations of Europe it has none. As remarked above, however, one species is described from Greenland, and two from the Cretaceous formation of Moletin, these of a type different from that of the Dakota group species.

Liriodendron, the tulip tree, has in its characters, its distribution, and its life a great degree of affinity with *Magnolia*. The American species is the only one known now in the vegetable world, and its habitat is strictly limited to this country. It does not ascend higher than the fortieth degree of latitude, except, perhaps, casually, like *Magnolia* under the protection of favorable local circumstances. The genus does not appear to have any disposition to modifications of its type and to migrations. We have not as yet any fossil remains of it in our Tertiary formations. In that of Europe it is represented from Greenland to Italy by one species only. The leaves of different forms described from the Dakota group as four species, may perhaps be referable to a single one, as the characters, especially the size of the leaves, may be local and result from climatic circumstances. It has thus passed

a solitary life. Even now by the singular and exclusive form of its pale-green glossy leaves, by its large cup-shaped yellow flowers, from which it has received its name, by its smooth exactly cylindrical stem, gracefully bearing an oblong pyramidal head of branches, grouped with perfect symmetry, it stands widely apart from the other denizens of our forests, as a beautiful stranger, or rather as a memorial monument of another vegetable world. Either considered in its whole or in its separate characters, the tulip tree is an universal and constant subject of admiration and wonder. It could be named, not the king, it is not strong enough for that, but the queen of our forests, if the *Magnolia* was not there with him to dispute the prize of perfection by the still grander majesty of its stature, the larger size of its foliage, the elegance and the perfume of its flowers. Our sense of admiration for these noble trees is heightened still by the dignity of their ancient origin.

I have referred to the family of the *Menispermaceæ* under the generic name of *Menispermites*, a large number of leaves related by their form and nervation to those of the American species of *Menispermum*. *M. Canadense* and *M. Smilacinum*. The relation appears to me as positive as it can be established from a single kind of vegetable organs, the leaves. This relation may be searched for in plants of a far distant country and of a different climate, and there perhaps found as evident with another class of vegetables. But I can not admit that we have to look to foreign types for analogy of a vegetation whose essential characters are recognized in the species of this country. *Menispermum canadense* is now the consort of our *Platanus*, *Magnolia*, *Tulip-tree*, &c. It grows under the same climatic circumstances, and has the same habitat. As the leaves of the Dakota group compared to this species are like it, peltate, round or cordate, obtusely angular, of the same nervation and consistence, there is reason, indeed, to refer it to this family rather than to any other without any representative among us.

No species of *Menispermum* or *Menispermites* has been recognized from the geological formations except the species of the Dakota group. One-leaf, however, is described by Unger as *Acer obtusilobum*, which appears to me a true *Menispermites*. It has the secondary nervation of *Menispermum*, (*Cocculus Carolinus*,) and the basilar veins comes out from the borders of a round notched base, as in a peltate leaf. Unger doubtfully considers this leaf as a species of *Acer*. Till now we have not seen any appearance of organs of this last genus, either leaves or seeds, in the Dakota group, as we have none also in the Eocene. The maple seems to be of more recent origin, as it is remarked hereafter. However, one Cretaceous leaf, or the fragments of a double leaf, are referred with doubt to the genus *Negundo*. As the leaf is not complete, its outline indefinite, it is useless to argue upon its possible affinity, and for this, as for some others, we have to wait for the discovery of more perfect materials.

The relation of other leaves of the Dakota group to the genera *Paliurus*, *Rhamnus*, *Juglans* or *Rhus*, and even *Prunus* appears sustained by sufficient evidence. The character of leaves of *Paliurus* and *Rhamnus* are not likely to be mistaken. Both these genera have identifiable remains in the Tertiary of the Rocky Mountains; one *Paliurus* is found in the Eocene of Golden and Black Butte, and another in the Miocene of Carbon and Washakie. This last is an arctic species, also recognized by Heer in the Miocene of Greenland and Spitzberg. *Rhamnus* is especially well represented in our lower Tertiary. Eight species are described from Golden, Black Butte, and the Raton Mountains, four of which are in the Miocene of Europe, where the genus has fourteen species. It is therefore an old type well established at the beginning of our Tertiary period;

and it is not surprising to find it already in the upper Cretaceous flora. Its present distribution is mixed. The genus preserves its predominance in Europe by the number of its species; it has there more than a dozen, while North America has only four or five.

It is remarkable that the next closely allied genus, *Ceanothus*, has not yet been recognized in the Dakota group, though now an exceptional American type. It has one species in the Eocene of Golden, another, very fine, in the same formation of the Mississippi, and many more in the upper Tertiary of the Rocky Mountains, and especially in the Pliocene of California. The ten living species of true *Ceanothus* described in the D. C. Prodromus, belong to the United States, especially to the southern zone, and a number of them are added to the list by the as yet unpublished flora of California. The absence of the type in the Cretaceous of the West is in accordance with the fact remarked upon in describing the general character of the leaves of the Dakota group, viz, the absence in this group of any kind of serrate leaves.

It is uncertain whether the compound leaves of which a number of separate leaflets have been figured in this memoir as *Juglans Debeyana*, represent a species of *Juglans*, or of *Rhus*. I am inclined now to refer them to this last genus, especially on account of the nervation more analogous to that of the present *Rhus metopium*, of Florida,* whose leaves also resemble somewhat the fossil ones; but there is as yet no sufficient evidence on this account. In considering the distribution of the species of both *Rhus* and *Juglans*, in the subsequent formations, we do not find any difference pointing out to a predominance of one of these types at any time. From the Dakota group, two other kinds of leaves are referable to *Rhus*. In the upper Tertiary of the Rocky Mountains we have four, and it is well proved now that the relation of our vegetable Cretaceous types is not with Eocene species, but rather with those of the upper Tertiary and of the present flora. On another side, *Juglans acuminata* and *J. rugosa* which by their somewhat coriaceous entire leaves are distantly related to the Cretaceous species, have been recognized at most of the localities where Tertiary fossil plants have been found; they are at Carbon and also in the Eocene at Golden, the Raton, Black Butte, &c., and thus seem to indicate by their general distribution the origin of *Juglans* in the Cretaceous group as evidently as that of *Rhus*. From the Miocene of Europe about twelve species of this last genus have been described, two from the Arctic regions; and from the same formation as many species of *Juglans*, with six species of *Carya*. At our time *J. regia*, so generally known and cultivated for its large fruit, is of Asiatic origin, while of the other four species known, three belong to the middle zone of the United States, which has also for its share all the living species of *Carya*. Of the living species of *Rhus*, Austral Europe has two; one of which, *R. cotinus*, has been compared by the form of its leaves to *R. emarginata* of the Dakota group. We have in North America, besides *R. metopium*, which is rather a tropical form, six species of the section of the pinnately-divided leaves, with the trifoliate *R. toxicodendron* and *R. aromatica*, both extremely variable, all types already represented in the Pliocene of California.

Except an *Amelanchier*, described by Dr. Newberry in his Notes on Extinct Floras, &c., from the Tertiary beds of the Yellowstone, we do not know as yet any fossil species of Rosaceæ from the western Tertiary measures. This is not a reason why *Prunus* should be excluded from

* The species is indigenous in Cuba. I have specimens from South Florida, but it may be there cultivated.

the list of the genera of the Dakota group. By their present distribution, our *P. serotina* and *P. Virginiana* indicate an extreme power of life, or of resistance to climatic changes, both being the only arborescent species of this continent, with a range of 30° to 35° in latitude, and both, too, being found everywhere, on every kind of ground; the one as a shrub along the banks of streams, the other as a fine tree in our woods. And, also, we have in our *P. Caroliniana*, a shore tree of the South, a species whose coriaceous entire leaves recall the essential characters of those of the Dakota group. Three species of this genus are described from the Tertiary of Europe, none as yet from ours; but it is probable that fossil remains referable to it will be found hereafter, as it has in our present flora a larger number of species than in that of Europe, or of any other part of the world. Of the species described by De Candolle, fourteen are North American, five European; four species belong to Japan, &c.

Resuming in a few sentences the above remarks, we find: That the Dicotyledonous flora of the Dakota group represent species referable to the genera *Liquidambar*, *Populus*, *Salix*, *Betula*, *Myrica*, *Quercus*, (in two of its principal types,) *Ficus*, *Platanus*, *Laurus*, *Sassafras*, *Cinnamomum*, *Diospiros*, *Aralia*, *Magnolia*, *Liriodendron*, *Menispermum*, *Negundo or Acer*, (?) *Paliurus*, *Rhus or Juglans*, (?) and *Prunus*; or, merely considering the affinities to our present flora, of twenty genera, seventeen of which are those to which belong the species of our trees and shrubs which have the more general and the widest range of distribution. Indeed, all our essential arborescent types are there, except those which are marked by serrate or doubly-serrate leaves: *Tilia*, *Æsculus*, all the serrate *Rosaceæ*; *Hamamelis*, *Fraxinus*; the *Urticineæ*; *Planera*, *Ulmus*, *Celtis*, *Morus*; and of the *Amentaceæ*, the serrate *Betula*, *Alnus*, *Ostrya*, *Carpinus*, *Corylus*, *Carya*, *&c.*

This enumeration exposes the general facies of the leaves or of the flora of the Dakota group, viz, integrity of the borders and coriaceous consistence of the leaves. The borders, if not perfectly entire, are merely undulate or obtusely lobed. There is only one exception to this in that peculiar short denticulation with outside turned teeth, which is marked, exactly of the same kind, in *Populites Haydenii*, *P. flabellata*, *Platanus Newberryi*, *Quercus Mudgii*, and the fragments described as *Phyllites betulæfolius*. This mode of division of the borders of leaves is very rare in species of our present times, except, perhaps, in some leaves of poplars. A single of the leaves of the Dakota group *Quercus primordialis* has the borders distantly serrate or marked by teeth turned upward. There is also in the flora of the Eocene of the Rocky Mountains a marked preponderance of leaves with entire borders. The serrate leaves appear in the Miocene, with *Acer*, *Alnus*, *Corylus*, and become predominent in the Pliocene of California, where *Ulmus*, *Planera*, *Celtis*, *Carya* abound, though these genera are not more in the flora of the Pacific slope.

But of the detailed correlation of the flora of the Dakota group with that of the subsequent geological epochs of this continent, I will say nothing more now until the materials on hand are definitely described and figured for comparison.

There is little to say on the analogy of this Cretaceous flora of ours with that of any of the Cretaceous groups of other countries. Of the Ferns, we have a *Gleichevia Kurriana* (?) apparently identical with the form described under this name from Moletin. Of the Conifers, there is a specimen doubtfully referable to *Geinitzia* and of the Dicotyledonous, an *Aralia* leaf, also closely allied to species of the same locality. With the flora of the Quader Sanstein of the Hartz, that of the Dakota group

is related by *Pterophyllum (?) Ernestinæ* and *Quercus Mudgii*, and to that of the same formation of Niedershœna, as described by Ettinghausen by a *Cunninghamites*, a *Glyptostrobus*, (*Frenelites*,) and *Ficus Halliana*. And, too, we have to admit an uncertain relation with Australian types by the species described by Heer as *Proteoides*, and by one leaf of Conifer, *Phyllocladus*, a type extinct on this continent.

This is sufficient to prove, relatively to our present knowledge, at least, the truth of the assertion, that the flora of the Dakota group, without affinity with any preceding vegetable types, without relation to the flora of the lower Tertiary of our country, and with scarcely any forms referable to species known from coeval formations of Europe, present in its whole a remarkable and as yet unexplainable case of isolation.

DESCRIPTIONS OF SOME NEW ORTHOPTERA, AND NOTES ON SOME SPECIES BUT LITTLE KNOWN. BY CYRUS THOMAS.

Minorissa alata, sp. nov.

Corresponds very closely with Walker's description of *M. pustulata*, except that the wings are fully developed and nearly as long as the elytra.

The sides of the pronotum are not tuberculate except the slight tubercles along the lower margin. Color uniform pale-green.

The following additions may be made to Walker's generic characters: Posterior femora shorter than the abdomen, triangular; head slightly ascending.

The anterior and middle transverse lines of the pronotum are nearly obsolete in the single specimen I have examined.

Dimensions.— ♀, Length, 1.4 inches; elytra, 1 inch; posterior femora, 0.52 inch; posterior tibia, 0.50 inch.

Habitat unknown; the specimen, which is somewhat mutilated, found in the collection at the Agricultural Department, without any mark indicating the place where it was obtained. It is probably from some part of South America.

Opomala mexicana, Sauss., Rev. et Mag. Zool., XIII (1861), 156.

Slender, cylindrical elongate.

Female.—Occiput somewhat elongate, slightly ascending, with a shallow punctured sulcus each side, the two approaching in front. Vertex narrow between the eyes, expanding in front of them, rounded in front, this portion being about as broad at the base as it is long; a shallow channel along the middle; margin not raised. Eyes very oblique, oblong, ovate. Face very oblique; the middle pair of carinæ distinct above, somewhat fading below; lateral pair indistinct. Antennæ rather short, enlarged at the base, but somewhat thick and but slightly flattened; edges rounded. Pronotum a little longer than the head, cylindrical, without carinæ; sides parallel; transverse incisions minute and indistinct; the posterior one about two-thirds the length from the front; posterior margin obtusely rounded; its entire surface, as also the top of the head, minutely granulose. Elytra elongate, passing the abdomen about one-third their length; very narrow and lanceolate; wings nearly the same length. Posterior femora reach the tip of the abdomen

Color (dried).—Pale olive-brown, with a yellow stripe commencing at the lower angle of the eye and running along the lower margin of the side of the pronotum to the insertion of the posterior leg; this yellow margin or fascia each side is very distinct and marked; otherwise the color is somewhat uniform, except the posterior tibiæ, which are blue.

Male.—Differs from the female in being smaller, slenderer, and as follows: The vertex is more pointed; the transverse incisions of the pronotum almost wholly obliterated; the elytra almost linear; the subanal plate elongate, pointed, curved upward; the pinnæ of the posterior femora dim, and scarcely V-form; the posterior femora scarcely as long

as the abdomen; the lateral marginal stripe white; the abdomen a shining dark-brown.

Dimensions.— ♀, Length, 1.25 to 1.5 inches. Specimens were received from Mus. Comp. Zool., Cambridge, and from the Agricultural Department, Washington.

Pyrgomorpha brevicornis, Walk.

Male.—Sides of the head, pronotum, and of the closed elytra perpendicular, flat, compressed. Top of the head slightly ascending to the tip of the vertex; the vertex between the eyes rather broad, slightly convex; the portion in front of the eyes short, scarcely exceeding its width, rounded at the apex; a very slight median carina in the front portion; margins scarcely raised; no foveolæ. Face quite oblique, straight, narrow above and expanding below, quadricarinate; the carinæ minute but distinct, moderately divergent, reaching to the clypeus. Antennæ longer than the head and thorax, enlarged at the base, triquetrous. Eyes placed high and well forward, oblique, ovate, acuminate at the apex. Pronotum a little longer than the head; sides parallel; tricarinate, the three carinæ distinct but not elevated, the lateral consisting of the angle formed by the perpendicular sides with the nearly flat disk; one minute transverse incision a little behind the middle. Elytra and wings extend about one-third their length beyond the extremity of the abdomen; the former obliquely truncate at the tip. Posterior femora slender, nearly as long as the elytra. Subanal plate conical.

Color.—Brown and green. Face, and the entire dorsal surface, uniform bright green; the entire sides fuscous brown; anterior and middle legs and posterior femora green; posterior tibiæ dusky; spines white, tipped with black; antennæ brown.

Dimensions.—Length, 0.91 inch; length to tip of elytra, 1.25 inches; elytra, 0.86 inch; posterior femora, 0.64 inch.

Remark.—This specimen, which is from Texas, received from Mus. Comp. Zool., is evidently Pal. Beauvois' *Truxalis notochlorus*. I am now very strongly inclined to the opinion that my *P. punctipennis* is but a variety of this species. I am also well satisfied that this is the species I saw at Murphysboro, Illinois, which produced such a loud crackling noise in leaping. (Rept. Ills. St. Agl. Soc., vol. v.)

Gomphocerus simplex, Scudd.

I have a specimen of what I am inclined to think is Mr. Scudder's *G. simplex*, which was collected by Mr. Uhler in Maryland, and communicated to me by Prof. T. Glover; but as it varies somewhat from Mr. Scudder's description, I give here a full description:

Male.—Back part of the head ascending, tricarinate; these three carinæ minute, but distinct and close together; the lateral ones bend suddenly outward at the upper angle of the eyes and connect with the raised margins of the vertex; the median carina continues to the tip of the vertex; vertex slightly ascending and rounded in front; no lateral foveolæ. Face quite oblique and slightly arcuate; frontal costa rather broad, of equal width throughout, and sulcate; lateral carinæ distinct, divergent. Antenna about as long as the head and thorax; the club very distinct, commencing at the thirteenth or fourteenth joint. Pronotum with the sides nearly parallel; the lateral carinæ curving inward slightly about the middle; the three slight carinæ of the head are continued with equal distinctness along the middle of the pronotum, parallel, and preserving the same distance from each other as on the head; the lateral

carinæ though minute are distinct; the disk shows one minute transverse incision a little beyond the middle; posterior margin obtusely rounded.

Elytra extend beyond the abdomen; lower (costal) border somewhat expanded about the middle, and diaphanous; wings as long as the elytra. Posterior femora extend to the tip of the elytra. Subanal plate subconical.

Color,(dried).—Face pale, testaceous; mouth-parts whitish. Upper surface of the head and pronotum testaceous brown along the central portion, with a black stripe each side extending from the vertex to the posterior extremity of the pronotum, filling the space between the outer median and lateral carinæ, though at the curve of the lateral carinæ it shows a slight dash exteriorly; lateral carinæ bright yellow; sides testaceous, darkest along the middle portion, paler below. Elytra testaceous-brown, with two or three irregular fuscous and pale spots along the disk. Wings (not opened) fuscous at the apex. Posterior femora dull-yellow; upper carinæ slightly touched with fuscous; tibiæ dull-white (probably bluish when living); spines tipped with black. Basal portion of the antennæ testaceous; club fuscous.

Dimensions.— ♂, Length to tip of elytra, 0.64 inch; elytra, 0.48 inch; posterior femora, 0.40 inch; posterior tibiæ, 0.37 inch.

Gomphocerus carpenterii, sp. nov.

Male.—Anterior tibiæ enlarged; disk of the pronotum gibbous; very similar to *Stenobothrus sibiricus*, Fisch.

Vertex triangular in front, the carinate margins forming a right angle at the apex, scarcely expanding in front of the eyes, horizontal; lateral foveolæ distinct, linear. Face somewhat oblique; frontal costa rather broad, flat, not sulcate, and only very slightly indented at the ocellus, above which it is punctured, and below which it extends but a short distance; lateral carinæ subdistinct, diverging. Antennæ little longer than the head and thorax; club flat, ovate, commencing about the sixteenth or seventeenth joint. Pronotum of nearly uniform width throughout; the sides and disk gibbous, the swell of the sides being chiefly on the anterior portion of the middle lobes, the swell of the disk on the middle lobes, but is distinctly limited by the posterior transverse incision; the posterior incision cuts all the carinæ, but does not notch them; it is situated considerably behind the middle; the middle transverse incision is somewhat distinct, but on the sides only; two punctures on the disk appear to represent the anterior transverse incision (in my unique specimen); the three carinæ distinct minute, the lateral strongly curved inward near the middle, posterior extremity obtuse-angled. Elytra a little longer than the abdomen; narrow at the base and expanding a little more than usual in the middle; nervules of the costal margin distant, parallel; nervules of the middle field somewhat distant, mostly transverse and scalariform. Wings about same length as the elytra. Posterior femora a little longer than the abdomen; anterior tibiæ considerably enlarged; middle tibiæ of the usual form. Posterior part of the pronotum minutely tuberculate.

Color (after immersion in alcohol).—Brown, shaded with black. Face pale cinereous; cheeks mottled with fuscous; top of the head black, with a palish stripe along the middle of the occiput. Middle and anterior lobes of the pronotum dark-brown, with some paler markings on the sides; the posterior lobe, with the upper portion of the sides, including the lateral carinæ and a middle stripe, dull rufous; the interspaces of

the disk and middle portion of the sides black. There is a paler irregular stripe on the sides. Sides of the meso and metathorax black. Elytra brownish, semi-transparent; an indistinct rufous stripe along the interno-median nerve, most distinct near the base. All the legs purplish brown; the under side of the posterior femora yellowish. Venter and pectus yellowish.

Dimensions.—Length, 0.70 inch; elytra, 0.50 inch; posterior femora, 0.35 inch; posterior tibiæ, 0.35 inch.

Named in honor of Lieut. W. L. Carpenter, who discovered it near the Mountain of the Holy Cross, in Colorado, at an elevation of 8,000 to 10,000 feet above the sea.

Remarks.—This species is exceedingly interesting, as showing the strong tendency of similar conditions to produce similar forms. The *Stenobothrus (Gomphocerus) sibiricus* is a peculiar form occuring only in the higher mountains of Europe and extreme northern portions of Europe and Asia. Here we find the same abnormal characters (enlarged front tibiæ and gibbous pronotum) occurring under exactly similar conditions; *i. e.*, in the higher mountain-portions of Colorado in the vicinity of perpetual snow.

Thrincus californicus, sp. nov.

♀. Small size, bright reddish-brown, with fuscous dots. Head very short, drawn back in the pronotum nearly to the eyes; occiput very short, a slight tubercle each side near the upper canthus of the eye. Vertex rather broad, but not transverse, very slightly deflexed, not expanded in front of the eyes; margins elevated, sharp, parallel between the eyes, meeting in a subacute angle in front; lateral foveolæ minute, triangular. Frontal costa narrow at the apex, expanding at the ocellus, but solid immediately above the ocellus margins carinate above the ocellus; lateral carinæ distinct, bending forward somewhat angularly opposite the antennæ; lower portion diverging toward the corners of the face.

Pronotum short, expanding rapidly posteriorly, rugose, tuberculate; median and lateral carinæ indistinct except on the front part of the posterior lobe, and there they are obtuse; the transverse incisions are not distinguishable except the posterior one, and this only on the sides, where it forms an irregular tortuous indentation; a somewhat prominent and slightly elongate tubercle on the front margin immediately behind each eye; two somewhat prominent tubercles on the disk close together at the front margin of the posterior lobe; the disk of the posterior lobe, although flattened, is somewhat elevated, and covered with elongate tubercles; posterior margin right-angled, rounded at the tip, marginate.

Elytra extend a short distance beyond the tip of the abdomen; rounded and curved upward at the extremity. Posterior femora short, not reaching the extremity of the abdomen, considerably inflated, and thick toward the base, but the upper and lower carinæ not prominent; disk convex; pinnæ prominent and minutely hairy. Antennæ rather short, not reaching the extremity of the pronotum, not subacuminate (as shown by Fischer) but slightly flattened toward the apex, filiform.

Color.—A bright reddish-brown, with but few fuscous dots and markings as follows: Four or five spots along the disk of the elytra; a few smaller ones in the lower field; and two double short bands across the upper field. (Wings not spread, but appear to be yellowish at the base and fuscous at the apex). Posterior tibiæ greenish or pale-blue; tarsi

dull-white. The pectus, which is very broad, even slightly transverse, is an ashy-green.

Male.—Is much smaller and differs otherwise as follows: More slender in its proportions; back of the head more elevated, and eyes more prominent; pronotum less rugose, and not expanding so rapidly posteriorly; median and lateral carinæ of the pronotum more distinct; color, especially of the pronotum and posterior femora, a darker brown. Anterior and middle tibiæ twice distinctly banded with black.

Dimensions.— ♀, Length to tip of elytra, 1 inch; from tip of the vertex to tip of pronotum, 0.27 inch; width of thorax at middle legs, 0.28 inch; elytra, 0.80 inch; posterior femora, 0.50 inch; posterior tibiæ, 0.40 inch. ♂, Length to tip of elytra, 0.70 inch; elytra, 0.56 inch; posterior femora, 0.30 inch.

Collected in Southern California by Mr. Crotch, and obtained by me from the Museum of Comp. Zool., Cambridge, Mass.

This very interesting species is the first, so far as I am aware, that has been found in the United States belonging to this genus.

Ommatolampis brevipennis, sp. nov.

Elytra and wings shorter than the abdomen, green; dorsum rufous or reddish-brown, and a black stripe on the sides of the pronotum.

Female.—Tip of the vertex prominent in front of the eyes, diamond-shaped and slightly indented in the middle; eyes closely approximate above, prominent; face suboblique; frontal costa deeply sulcate throughout, reaching to the clypeus, parallel; lateral carinæ subdistinct and nearly parallel. Pronotum subcylindrical, scarcely expanding posteriorly; sides nearly parallel; median carinæ subdistinct; lateral carinæ obliterated; posterior transverse incision distinct, situated behind the middle, about two-thirds the distance from the front; apex obtuse-angled, rounded at the point. Elytra and wings extend over about two-thirds of the abdomen.

Color.—General color green, with the following markings: Fastigium, a central spot in the face, a stripe along the middle of the pronotum; the dorsal portion of the elytra (closed) and a dorsal stripe on the abdomen rufous; a narrow stripe along the external margin of the posterior femora, and the entire anterior and middle femora bright coral-red. A black stripe on each side of the pronotum extending back only to the posterior transverse sulcus; it is sometimes interrupted by a yellowish and reddish spot near the posterior end, and is usually bordered below by a narrow yellowish or orange stripe. Antennæ bright rufous except the basal joint, which is green. Posterior tibiæ green; spines same color, except the tips, which are black.

Male.—Differs from the female only as follows: Is smaller; the anterior and middle transverse incisions of the pronotum more distinct; elytra and wings nearly as long as the abdomen; subanal plate strongly curved upward and somewhat pointed at the apex. Prosternal spine in both sexes robust, somewhat conical.

Dimensions.— ♀, Length, 0.90 inch; elytra, 0.48 inch; posterior femora, 0.52 inch; posterior tibiæ, 0.48 inch. ♂, Length, 0.70 inch; elytra, 0.37 inch; posterior femora, 0.44 inch.

Taken in New Jersey in August, and communicated to me from Professor Uhler, through Professor Glover. A specimen in Lieutenant Wheeler's collection from Nevada resembles this somewhat closely; but as it is alcoholic, I cannot compare colors.

Caleoptenus flavolineatus, sp. nov.

Male.—Similar in appearance to *C. spretus;* ground-color yellow, with brownish markings, as in *C. spretus;* tibiæ blue.

Vertex rather narrow between the eyes, distinctly channeled, strongly deflexed; frontal costa broad and flat between the antennæ, fading and obliterated below; lateral carinæ distinct and diverging to the corners of the face. Antennæ of medium length. Eyes rather prominent, not docked in front. Pronotum comparatively short; median carinæ distinct on the posterior lobe, obliterated or indistinct on the other lobes; lateral carinæ subdistinct; the three transverse incisions very distinct, the third a little behind the middle, the first and second close together; posterior extremity obtusely rounded. Elytra and wings extend beyond the abdomen. Tip of the abdomen turned up but scarcely enlarged; cerci rather short, somewhat broad at base, but near the extremity tapering suddenly to a tooth-like apex; subanal plate rather narrow and very slightly (if at all) notched at the tip. Posterior femora extend beyond the abdomen; rather more than usually enlarged near the base. Prosternal spine robust and somewhat transverse.

Color.—Antennæ yellow; face orange-red; mouth-parts and a stripe in front of and below the eyes, yellow; pronotum pale orange-brown, with a front marginal yellow line; a yellow stripe from the base of the wings to the base of the posterior legs. Abdomen same color as the pronotum, with yellowish rings on the margins of the segments. Posterior femora pale-yellow along the margins of the disk, on the lower carinæ; under and internal surface reddish except the lower yellow carinæ; external face with three irregular oblique dark bands; pinnæ yellowish; knees black above. Posterior tibiæ blue; tarsi pale. Pectus and venter yellowish.

Dimensions.—♂, Length, 1 inch; elytra, 0.78 inch; posterior femora, 0.58 inch; posterior, tibiæ, 0.50 inch.

Collected in Southern California by Mr. Crotch, and received from Museum of Comparative Zoology, Cambridge, Mass.

This belongs to that section of the genus of which *C. fermur-rubrum* may be considered the type, and is somewhat closely allied to *C. spretus.*

Caloptenus floridianus, sp. nov.

Female.—Rather large size; dark grayish-brown, with a dark stripe each side.

Vertex slightly and somewhat angularly expanded in front of the eyes; the channel broad and distinct. Frontal costa somewhat broad, solid above the ocellus, somewhat sulcate below it, expanding at the ocellus. Pronotum about as broad as the head and uniform in width throughout; median carina minute yet distinct; posterior sulcus distinct, situated much behind the middle. First and second transverse incisions indistinct and much nearer together than second and third; disk of anterior lobes nearly smooth; disk of the posterior lobe thickly punctured; apex rounded. Elytra nearly as long as the abdomen, narrow and slightly lanceolate in form, with comparatively few transverse nervules. Wings about same length as elytra, rather narrow. Posterior femora extend to the tip of the abdomen. The corniculi of the ovipositor very prominent and sharp-pointed; the lower pair without any apparent lateral tooth or prominence.

Color.—An olive-brown slightly mixed with gray. A broad stripe of shining black or very dark-brown extends from the eyes along the sides of the head and pronotum to the posterior extremity of the latter; below

this stripe the pronotum is grayish or dull-white, somewhat mottled. Elytra almost uniformly olive-brown, without any distinct spots, though some dim dots of black are sometimes visible along the disk. Wings transparent, tinged with greenish-yellow. Abdomen a shining brown; valves of the ovipositor dull-white. Posterior femora with the under edge and inner face dull-yellowish, with an indistinct greenish-brown band near the knee; upper carinæ bluish or greenish; posterior tibiæ dark-blue; tarsi blue.

Dimensions.— ♀, length, 1.50 inches; elytra, 0.95 inch; posterior femora, 0.87 inch; posterior tibiæ, 0.77 inch.

Add.—Lateral carinæ of the face distinct, slightly divergent; frontal costa reaches the clypeus. Antennæ a little longer than the head and thorax; joints subdistinct. Pronotum rather longer than usual.

Florida. Received from the Agricultural Department. Specimen quite fresh in color.

Caloptenus keelerii, sp. nov.

Vertex quite narrow between the eyes, slightly and somewhat hexagonally expanding in front. Frontal costal moderately broad and of nearly uniform width throughout, slightly indented at the ocellus, otherwise in no way sulcate, fading or becoming obsolete before reaching the clypeus; lateral carinæ diverging toward the corners of the face. The pronotum regularly but very slightly expanding posteriorly, the front being just the same width as the head; the median carina minute but distinct throughout; the three transverse incisions moderately distinct, the posterior one a little behind the middle; the posterior extremity forms nearly a right angle, rounded at the apex. Elytra passing the abdomen, somewhat narrow and elongate-lanceolate, the lower (costal) margin not dilated at any point. Wings nearly the same length as the elytra. Posterior femora passing the abdomen. Antennæ a little longer than the head and thorax. The prosternal spine robust, subcylindrical, slightly bent backward, obliquely truncate at the apex, slightly transverse.

Color.—Brown, varied with purplish red. Face, disk of the pronotum, and upper edges of all the femora purplish-red. The black stripe behind the eye broad and indistinct, the lower edge not well defined, reaching only to the posterior sulcus of the pronotum. An oblique, pale, narrow stripe extends from the base of the elytra to the insertion of the posterior legs. Elytra brownish, with minute fuscous dots and somewhat cellular spots along the disk; these spots and dots are somewhat indistinct and run together. Wings transparent, tinged with yellow. Posterior femora with two oblique black bands on the exterior face, and two transverse bands; a basal and apical spot of black on the inner face; the lower margin of the internal face olive or olive-red. Posterior tibia brick-red; base yellowish, with a black ring just below it.

Dimensions.— ♀, Length, 1.12 inches; elytra, 0.88 inch; posterior femora, 0.70 inch; posterior tibiæ, 0.63 inch.

Collected in Florida by Mr. Keeler, and by him forwarded to the Agricultural Department, where they are now deposited. Although the description would seem to indicate that this species is very closely allied to the common *C. femur-rubrum*, yet this is not the case, as it is quite distinct.

Xiphocera pygmea. Sauss., Rev. et Mag. Zool., XIII (1861), 156.

Female.—Occiput subtricarinate; these carinæ minute. Vertex horizontal, advanced in front equal to the space behind the eyes; sides for

a little distance parallel, then rounding to the somewhat pointed apex; margins raised, subacute; on the inner surface two short minute carinæ. Face somewhat oblique, curved inward opposite the lower margin of the eyes; frontal costa prominent and projecting above the ocellus, deeply sulcate throughout, forming two carinæ, subparallel, except at the ocellus, where they suddenly approximate each other; lateral carinæ distinct, subparallel.

Antennæ rather short, scarcely reaching the tip of the pronotum, ensiform, and subtriquetrous. The eyes are somewhat inflated, but less so than in the male. Pronotum with the sides parallel except near the posterior extremity, where they are slightly divergent, granulose, and somewhat rugose; median carina slight; lateral carinæ indistinct, almost obliterated; posterior transverse sulcus subdistinct, situate behind the middle; posterior extremity obtusely rounded. Elytra a little longer than the abdomen; wings about the same length. The posterior femora do not reach the extremity of the abdomen; legs pilose; there is very little difference in the length of the outer and inner rows of the spines of the posterior tibiæ.

Color.—General color brown, with dim fuscous dots. Inside of the posterior femora bright coral-red; posterior tibiæ red; spines tipped with black.

Male.—Similar to the female except as follows: It is smaller. Eyes large, much inflated, and approximate above; antennæ slender and but slightly enlarged at the base; occiput and disk of the pronotum occupied by a broad, double, dull-yellow stripe; a broad stripe of the same color along the lower part of the sides of the pronotum; posterior femora indistinctly trifasciate with fuscous; face a little more oblique.

Dimensions.— ♀, Length, 0.94 inch; elytra, 0.61 inch; posterior femora, 0.45 inch; posterior tibiæ, 0.39 inch. ♂, Length, 0.61 inch; elytra, 0.56 inch.

Remark.—This species belongs to the second division of this genus as given by Saussure, and agrees with the second division of *Xiphicera* as given by Serville, except that the cerci are short and not curved.

Specimens were received of Mr. Scudder; they were collected by Sumichrast in Mexico.

I have given the description in full, as that of Saussure is so brief as to render it difficult to determine specimens not in color.

Machærocera sumichrasti, sp. nov.

Vertex slightly deflexed, broadly channeled; the channel apparently connecting with the narrow sulcus of the frontal costa; portion in front of the eyes about equal in length to that behind them, ovate-lanceolate in form; margins elevated, acute. Face moderately oblique, indented opposite the lower margin of the eyes, resembling *Xiphocera* in this respect; quadricarinate, the median pair close together above, regularly diverging below, reaching the clypeus; lateral carinæ distinct, diverging to the corners of the face. Eyes prominent, slightly inflated, ovoid. Antennæ elongate, reaching beyond the tip of the pronotum, slender, somewhat ensiform, flattened. Pronotum somewhat compressed on the sides, which are nearly parallel, diverging slightly at the posterior extremity; disk slightly arched transversely; median carina distinct, but not elevated; lateral carinæ obtuse and irregular on the front lobes in the form of obtuse ridges, converging posteriorly and becoming obsolete at the posterior sulcus, while on the posterior lobe, as they extend forward, they descend obliquely upon the sides as obtuse ridges, thus

showing two obtuse carinæ on each side directed forward and obliquely downward; the three transverse incisions subdistinct, each severing the median carina; the anterior lower angle of each side is distinctly and squarely notched; posterior margin obtuse-angled; entire surface granulose. Elytra and wings extend beyond the extremity of the abdomen, (the abdomen of my only specimen is much shriveled).

Color (dried).—Almost uniform brown; some dim fuscous dots on the elytra; femora pale externally, black internally, with yellow bands; posterior tibæ pale (probably rufous when living), with a broad dusky ring near the base. Wings (not spread) fuscous at the apex.

Dimensions.— ♀, Length to tip of elytra, 1.35 inches; elytra, 1.06 inches; posterior femora, 0.68 inch.; posterior tibiæ, 0.54 inch.

Remark.—In the form of the head and antennæ this resembles *Xiphocera*, but its general appearance is that of *Œdipoda*, especially the male of *Œ. carolina.*

Specimen received of Mr. Scudder, collected by Sumichrast in Mexico.

Acanthacara acuta, Scudd.

The top of the head to the tip of the vertex is nearly horizontal; tip of the vertex mucronate; the point of the spine bent downward; the under side of the cone is separated from the face by a deep upward notch, and has a short spine on this part pointing downward. Face very oblique, smooth, transversely convex. Maxillary palpi nearly twice as long as the labial; antipenultimate and final joints nearly equal in length and about one-third longer than the penultimate, terminal joints of all the palpi enlarged at the apex. Pronotum cylindrical, a little longer than the head, nearly straight on the dorsum; sides nearly parallel, subtruncate in front, squarely truncate behind, without carinæ; surface somewhat rugose. Mesonotum and metanotum similar to the abdominal segments.

Abdomen sub-cylindrical, about equal in width to the pronotum, continuing this width to the sixth segment, where it begins rapidly to decrease. Ovipositor somewhat broad at the base, tapering, curving moderately upward toward the extremity; apex pointed; about as long as the abdomen. Posterior femora rather short, not extending beyond the tip of the abdomen, about equal in length to the ovipositor; minutely dentate below on both the inner and outer margin. Antennæ about as long as the body, exclusive, of the ovipositor. Prosternum furnished with two rather long, slender, pointed spines. Posterior lateral margins of the meso- and metasternum elevated into sharp curved ridges.

Color.—Pale yellowish-brown, with a single broad fuscous stripe extending along the middle of the dorsum from the vertex to the extremity of the abdomen. Face, sides of the head, and prontum, and the femora a honey-yellow. The upper and lower spines of the cone of the head black; a narrow ring round the base of the antennæ and a half-ring around the inner side of the basal joint, black. The lower margin of the face (clypeus and mandibles) black; labrum white; palpi whitish. Antennæ with alternate rings of brown and white. The little globular (mouse-like) eyes dark-brown. Ovipositor yellowish-brown, pale at base, darker at the tip.

Dimensions.— ♀, Length from tip of vertex to extremity of the abdomen, 1.62 inches; from tip of vertex to tip of ovipositor, 2.26 inches; pronotum, 0.37 inch.; posterior, 0.77 inch.; ovipositor, 0.64 inch.

NOTES ON THE ROCKY MOUNTAIN RANGES IN COLORADO TERRITORY.

The Cordilleras of North America—the mountain-system of its western coast—are one with the Cordilleras of the southern continent, in having their general axis, a prolongation of the Andes, both as respects direction and actual topographical connection by the ranges and plateaus of Central America; while the fact that both are due to a common cause is shown by their bearing the same relations to the great basin of the Pacific Ocean, whose subsidence is undoubtedly connected with their origin.

The Cordilleras of North America consist of several chains and many ranges and table-lands, forming a system, because they are but the features and minor dependencies of one great general uplift of Western America—an elongated plateau upon whose face they are arranged in lines parallel with the axis or along the western side.

The two leading mountain-chains of the plateau are the chain of the Sierra Nevada and Cascade ranges and the chain of the Rocky Mountains; one standing directly upon its western edge; the other, the Rocky Mountain chain, forming the true crest of the great continental wave of upheaval, which, taken as a whole, is the Cordillera system. Between these chains, and even outside of them, are lesser chains, groups, and ranges.

The system has its greatest expansion between the thirty-sixth and forty-first parallels, where the breadth is about 1,350 miles, including the Coast ranges on the Pacific shores and the eastern slope of the plateau that descends from the foot of the Rocky Mountains to the proper basin of the Missouri, about 150 miles west of that river. The mountains alone are about 950 miles broad. This measurement is perpendicular to the general axis of this part of the system, whose direction may be taken at about north 15° to 20° west.

As this is the region of greatest breadth of the Northern Cordilleras, it is also the zone of greatest elevation, containing the highest peaks in the United States and the larger part of the area above 12,000 feet. The most powerful force of upheaval seems to have acted across the system in a belt 300 miles broad, whose central line runs west-southwest from Denver, Colo., to Monterey, 100 miles south of San Francisco. In crossing California it includes the highest parts of the Sierra Nevada, the Mount Whitney cluster of peaks, and those near the Yosemite; in Utah the highest parts of the Wasatch chain; while in Colorado the eastern end of the belt crosses the great meridional chain of the Rocky Mountains. In this Territory, therefore, we have the grandest uplifts of the chain.

Approaching Colorado from the east, rising gradually up 500 miles of monotonous plain, the mind is well prepared for the sensation that awaits one on reaching Denver. The South Platte River here flows nearly north. Denver, situated on its eastern bank, slopes toward the mountains.

Standing on the highest terrace of the city, one looks westward over its busy streets and crowded houses, and the green valley of the river, to the foot-hills twelve miles away, the beginning of the first range of the Rocky Mountains; then up at once 9,000 feet over 25 miles of rocky and pine-clad slopes and summits, to the great crest-peaks above all timber, shining, if it be early summer, with fields of snow, and stretching out far to the north and south, a procession of sharp, bright peaks 130 miles long.

This is the most eastern of the grand meridional ranges which together make up the Rocky Chain. The abruptness with which it rises from the plains—9,000 feet in 20 to 25 miles—the great length and height of its serrated crest, overlooking the sea of prairie for 200 miles, make it one of the most imposing mountain-façades in the world, a magnificent front to the Rocky Mountains. Being unnamed, we have called it the Front or Colorado range. Ascending this first ridge to one of its highest summits, Gray's Peak, still looking westward, it is at once evident that the great mountain-wave, whose face is so impressive from the plain, is but one of a number of parallel upheavals, with snow-capped crests, 20 to 30 miles apart. Between these ranges are great depressed troughs, sometimes developed as longitudinal river-valleys in the chain; sometimes cut by cross-ranges of lower elevation into basins known as "parks." The general depression west of the Front Range is divided into the South, the Middle, the North, and the North Platte Parks. Several sub-ranges, or minor upheavals, run north-northwest across the Middle Park. The South contains a number of very low ridges, while the North Park is in general a plain.

From Gray's Peak one looks across this trough of the "park" basins at the Park Range, so called, because it is the western wall of all the great "parks" stretching along them for 240 miles. Many parts of this range are capped with clusters of snowy peaks; the Mount Lincoln group, the best known, and the Blue River group, are the most remarkable.

Beyond this range only twenty miles west is the most elevated of all the upheavals, the Sawatch Range, set with a whole line of 14,000 ft. peaks. The deep valley between it and the Park range is occupied by the Eagle River, running north in deep cañons, and the Arkansas, flowing south through valleys. Where the Arkansas turns eastward across the chain, the Park range ends, and only twelve miles off to the southwest commences the Sangre de Christo range, whose lofty and sharp summits are everywhere visible from the plains of Southern Colorado. Its southern extension is not yet determined. Between the Sangre de Christo and the Sawatch is a long plain, known as the San Luis Valley.

West of the Sawatch Range, in the latitude of the South Park, are several short but very elevated northwesterly lines of upheaval, so crowded together as to form a group known as the Elk Mountains. It covers the region between the Grand and Gunnison Rivers. North of the Grand River, between it and the White, is a very high escarped plateau, separated from the Park Range by a long depression, the northern extension of that of the Eagle and Arkansas Rivers.

From these, the most elevated features of the Rocky Chain, high table-lands slope west to the great basin of Green River, which, in a succession of remarkable plateaus, extends from the mouth of the San Juan River 400 miles northward, its western side bounded by the Wasatch chain of mountains.

We see, therefore, that in crossing the Rocky Chain in Colorado from the plains westward, one generally finds in the first one hundred miles,

two or three long, prominent, well-defined ranges, with intervening depressions, bearing from north to north 25° to west; then, in the next seventy-five miles, shorter ranges and very elevated groups of mountains and tables, which fall off to the Green River basin.

The chain may be considered at from one hundred and seventy-five to two hundred miles broad.

Several cross-elevations connect the great ranges, and turn the continental divide or water-shed from one to another.

The Front or Colorado Range, beginning about twenty-five miles south of Pike's Peak, in latitude 38° 30′, longitude 105°, runs north 35° west ninety miles to the Mount Evans and Gray's Peak group, thence northward fifty miles to Long's Peak, and fifty miles farther to the Laramie Plains. Between Pike's Peak and Mount Evans the range is depressed and divided longitudinally, and the South Platte River cuts it. It has six peaks of the first order, that is, about 14,000 feet high. The southern end of the Medicine Bow is spliced onto the north end of the Front Range, overlapping it on the west side as far south as Long's Peak, where the well-defined dividing depression disappears. The North Park and the North Platte Park lie west of the Medicine Bow, between it and the Park range; while the South and Middle Parks lie between the Front and Park ranges.

The Park Range commences in latitude 38° 35′, longitude 105° 53′; runs north 25° west thirty miles to Buffalo Peak, thence north twenty-five miles to the Mount Lincoln group; then north 20° west to Mount Powell in the Blue River group. Here it loses its serrated crest, and falls off to an elevation of about 2,000 feet above the Middle Park; continuing north 17° west, with low, even outline (except at Rabbit-Ear's Peak) about sixty miles, when it again rises into groups of lofty rugged peaks overlooking the North and North Platte Parks at its eastern foot. The range is cut in one place by the Grand River passing through in a narrow cañon. It has only four peaks of the first order, all in the Mount Lincoln group; but a large number that are about 13,000 feet high. Its southern end is separated from the Sangre de Christo Range by the depression of the Arkansas Valley.

The axis of the Sangre de Christo is not a continuation of that of the Park Range, but lies parallel with it, and about twelve miles off to the southwest. Commencing in latitude 38° 26′, longitude 106, it runs south 30° east, in a continuous line of high sharp peaks, forming the eastern rim of the San Luis Valley. Between it and the plains on the east lies the well-defined, parallel, but lower Wet Mountain Range. Commencing in latitude 38° 22′, longitude 105° 20′, it runs south 30° east, with rounded outlines, for forty-five miles. The depression between it and the Sangre de Christo Range is the Wet Mountain Valley and the Huerfano Park.

West of the San Luis, Arkansas, and Eagle River Valleys is the Sawatch Range, ending at the north in the Holy Cross group, whose granite peaks burst abruptly through the surrounding sheets of sandstone. From this point, latitude 39° 30′, longitude 106° 33′, it extends south 20° east, a lofty precipitous range, having sixty to eighty miles of its crest elevated to 13,000 feet and set with many of the 14,000 ft. class. This highest part of the range rises directly from the Arkansas Valley 6,000 feet, in a distance of six miles.

On the west side of the Sawatch the depression parallel with it is drained to the south by Taylor's Fork of the Gunnison, and to the north by the Roaring Fork of the Grand River.

West of these valleys, and connected with the Sawatch by a high

cross-ridge, is the Snow-Mass Range of the Elk Mountain group. Beginning in latitude 39° 15′, longitude 107° 10′ near Sopris Peak, it runs south 45° east 50 miles. In the first thirty miles are five 14,000 ft. peaks. There are parallel, trough-like depressions on either side of this range throughout its entire length—the Roaring and Taylor's Fork Valleys on the east, and those of Rock Creek and East River on the west.

The western part of the Elk Mountain group has not been surveyed, nor the southern part of the Sangre De Christo and Sawatch ranges.

These are but notes on a mountain-region, in many respects the most interesting in America, which is at present the field of operations of this Survey.

Several permanent barometric stations, at high altitudes, have been established; one at 14,000 feet on Mount Lincoln, and one at Fairplay nearly 10,000 feet, and one at Cañon City about 5,000 feet above the sea; while the United States Signal-Service has in this Territory one station at 5,000 feet, one at 6,000 feet, and one at 14,000 feet on Pike's Peak. These are connected by spirit-level lines with the sea, and make, therefore, admirable bases for the hypsometrical survey of the region, which we are carrying on by mercurial barometer, trigonometric work, and aneroid observations on minor stations. The important points are measured with one or more mercurial barometers made by James Green.

The geological and topographical surveys were extended during the summer of 1873 over about 21,000 square miles. These surveys are based on a system of large primary and smaller secondary triangles expanded from measured bases, the whole resting upon four points along the foot of the mountains, Sherman, Denver, Colorado Springs, and Trinidad, whose latitudes and longitudes have been carefully determined for us by the United States Coast Survey. The positions of the trigonometric stations on the peaks have been deduced from these.

The maps of these mountains, now in progress, are on a scale of two miles to one inch, and drawn in horizontal contour-lines 200 feet apart.

In the following tables are given the approximate heights and geographical positions of some of the principal peaks of the mountain-ranges and points in the valleys of the region surveyed last summer. The final results of our computations will be published in the Annual Report of the Survey.

JAMES T. GARDNER.

Approximate elevations and geographical positions of prominent points.

Location.	Latitude.	Longitude.	Elevation above sea.
ON THE PLAINS AT THE EASTERN FOOT OF THE MOUNTAINS.	° ′ ″	° ′ ″	*Feet.*
Denver K. P. R. R. Depot	39 45 0.67	104 59 23.40	5,084
Denver U. S. sig. service barometer			5,132
Colorado Springs, D. & R. G. R. R. depot	38 50 0.28	104 49 7.65	5,872
Pueblo			4,600

Approximate elevations, &c.—Continued.

Location.	Latitude.	Longitude.	Elevation above sea.
IN THE FRONT OR COLORADO RANGE.	° ′ ″	° ′ ″	*Feet.*
Long's Peak	45 15 19	105 36 37	14,150
Mount Audubon			13,172
Mount Parry			13,212
Arapahoe Peak	40 1 13	105 38 39	13,412
James's Peak	39 51 10	105 41 9	13,262
Torrey's Peak	39 38 37	105 49 0	14,249
Gray's Peak	39 38 5	105 48 46	14,254
Mount McClellan, (near Gray's)			13,332
"Chief"	39 40 34	105 31 7	11,716
Mount Evans	39 35 21	105 38 20	14,270
Mount Rosalie	39 35 20	105 39 0	14,260
Platte Mountain	39 15 0	105 6 0	9,201
Plateau north of latter			8,041
Plateau south of latter			8,525
Tarryall Mountain	39 14 0	105 30 0	12,354
Pike's Peak	38 50 26	105 2 22	13,985
Cameron's Cone			11,408
Cheyenne Mountain			9,896
IN THE CROSS RANGE, BETWEEN MIDDLE AND NORTH PARKS.			
Parkview Mountain	40 19 51	106 7 51.7	12,232
IN THE MIDDLE PARK SUB-RANGE.			
Mount Byers	39 51 55	105 56 33	12,776
Ute Peak			11,866
IN THE MIDDLE PARK.			
At the Hot Springs			7,660
Grand Lake, (head of park)			8,000
Junction of Blue and Grand Rivers			7,060
IN THE CROSS RANGE, BETWEEN MIDDLE AND SOUTH PARKS.			
Mount Guyot	39 28 0	105 56 0	13,452
Mount Silver-Heels	39 20 0	106 0 0	13,794
IN THE PARK RANGE.			
Mount Powell	39 45 40	106 20 8	13,282
Quandary Mountain	39 24 0	106 6 0	14,047
Mount Lincoln	39 21 8	106 6 25	14,183
Buckskin Mountain	39 20 0	106 8 0	13,951
Station 52	39 14 0	106 10 0	14,055
Horse-Shoe Mountain	39 12 0	106 10 0	13,780
Buffalo Peak	38 59 0	106 7 0	13,482
IN THE WET MOUNTAIN RANGE.			
Greenhorn Mountain	37 52 52	105 0 33	12,117
IN THE SANGRE DE CHRISTO RANGE.			
Hunt's Peak	38 23 0	105 56 29	12,333
Mount Rito Alto	38 13 7	105 45 7	12,876
Christone Peaks	37 58 19	105 34 43	14,120
Station 16	37 48 0	105 39 0	13,425

Approximate elevations, &c.—Continued.

Location.	Latitude.	Longitude.	Elevation above sea.
IN THE SOUTH PARK.	° ′ ″	° ′ ″	*Feet*,
Fairplay	39 25 31	106 19 0	9,854
Salt Works	38 57 0	105 56 0	8,800
Head of the Platte Cañon	38 54 0	105 27 0	8,050
IN THE SAWATCH RANGE.			
Holy Cross Mountain	39 28 4	106 28 37	13,540
Massive Mountain	39 11 0	106 28 0	14,213
Mount Elbert	39 7 0	106 26 0	14,222
La Plata Mountain	39 2 0	106 28 0	14,188
Grizzly Peak	39 2 0	106 36 0	13,848
Mount Harvard	38 55 31	106 19 0	14,270
Station 75	38 49 20	106 22 30	12,981
Mount Yale	38 50 40	106 18 50	14,041
Mount Princeton	38 44 59	106 14 18	14,057
Station 38	38 41 11	106 37 4	13,049
Mount Ouray	38 25 24	106 13 16	13,930
Mount Shavano	38 37 21	106 14 6	13,980
Station 45	38 35 37	106 18 0	13,584
Mount Antoro	38 40 35	106 14 30	14,132
ON THE ARKANSAS RIVER.			
Tennessee Pass, (head of river)	39 21 0	106 20 0	10,223
Twin Lakes, (foot of lower lake)	39 4 0	106 19 0	9,219
Near mouth of Chalk Creek	38 45 0	106 04 0	7,901
IN THE ELK MOUNTAIN GROUP, SNOW-MASS RANGE.			
Sopris' Peak	39 15 54	107 09 50	12,308
"Black Pyramid"	39 9 0	107 04 40	13,884
Snow-Mass Mountain	39 7 12	107 03 44	13,853
Maroon Mountain	39 4 30	106 59 20	13,892
"Sta. E."			13,699
Castle Peak	39 0 30	106 38 40	13,995
Italian Peak	38 56 35	106 45 0	13,101
White Rock Mountain	38 58 30	106 55 10	13,517
Teocallé	38 57 40	106 53 0	12,944
Gothic Mountain	38 57 30	107 00 30	12,378
Crested Butte	38 53 0	106 56 20	11,903
Uncompahgre Peak	38 4 25	107 27 30	14,540
Station 33	38 1 30	106 55 15	13,783
Station 34	38 16 28	106 51 49	12,150
IN SAN LUIS VALLEY.			
S. E. corner of township 44, N. R. 8 E. meridian and base of New Mexico	38 01 28	106 1 16	
Saguache			7,632