ENGINEER DEPARTMENT, U. S. ARMY.

REPORT

UPON

UNITED STATES GEOGRAPHICAL SURVEYS

WEST OF THE ONE HUNDREDTH MERIDIAN,

IN CHARGE OF

FIRST LIEUT. GEO. M. WHEELER,
CORPS OF ENGINEERS, U. S. ARMY,

UNDER THE DIRECTION OF

BRIG. GEN. A. A. HUMPHREYS,
CHIEF OF ENGINEERS, U. S. ARMY.

PUBLISHED BY AUTHORITY OF THE HONORABLE THE SECRETARY OF WAR,

IN ACCORDANCE WITH ACTS OF CONGRESS OF JUNE 23, 1874, AND FEBRUARY 15, 1875.

IN SEVEN VOLUMES, ACCOMPANIED BY ONE TOPOGRAPHICAL AND ONE GEOLOGICAL ATLAS.

VOL. IV.—PALEONTOLOGY.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1877.

FORTY-THIRD CONGRESS, FIRST SESSION.

CHAPTER 455.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated, for the objects hereinafter expressed, for the fiscal year ending June thirtieth, eighteen hundred and seventy-five, namely:

* * * * * * *

For engraving and printing the plates illustrating the report of the geographical and geological explorations and surveys west of the one hundredth meridian, to be published in quarto form, the printing and binding to be done at the Government Printing-Office, twenty-five thousand thousand.

* * * * * * *

Approved June 23, 1874.

FORTY-THIRD CONGRESS, SECOND SESSION.

CHAPTER 76.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act entitled "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and seventy-five, and for other purposes," approved June twenty-third, eighteen hundred and seventy-four, be, and the same is hereby amended by adding to the clause of said act relating to the engraving and printing of the plates illustrating the report of the geographical and geological explorations and surveys west of the one hundredth meridian, the following words: and "that two thousand copies of the report shall be printed by the Congressional Printer," after substituting the word "dollars" in lieu of the concluding word of said clause.

Approved February 15, 1875.

FORTY-FOURTH CONGRESS, FIRST SESSION.

"Mr. VANCE, of Ohio, from the Committee on Printing, reported the following resolution; which was read, considered, and adopted:

"*Resolved by the House of Representatives, (the Senate concurring,)* That the following distribution shall be made of the reports of the United States geographical surveys west of the one hundredth meridian, published in accordance with acts approved June 23, 1874, and February 15, 1875, as the several volumes are issued from the Government Printing-Office, to wit: Nine hundred and fifty copies of each to the House of Representatives, two hundred and fifty copies of each to the Senate, and eight hundred copies of each to the War Department for its uses."

March 29, 1876. (See Congressional Record, vol. 4, part 3, p. 2037.)

Agreed to by the Senate May 4, 1876. (See Congressional Record, vol. 4, part 3, p. 2969.)

ERRATA, PART II, VOL. IV.

Page 73, sixth line from bottom, for "*Prototomus*" read *Stypolophus*.

Page 262, third line from bottom, the name "*vasacciense*" is to be removed to the end of the fourth line from the bottom, immediately below the name "*angustidens*". In explanation of Plate XXXVII, first line, for "plate XV" read XXXVI.

Plate LXXX. The interruption in the spongy tissue seen in the section of the horn of *Dicrocerus furcatus*, fig. 7, is due to a slight concavity of the external surface, so that the section reaches the dense tissue at that point.

Plate LXXXIII. At the end of name, *Coryphodon elephantopus*, at the bottom of the plate, for $\frac{3}{8}$ read $\frac{1}{4}$.

NOTE.

Seven volumes, accompanied by one topographical and one geological atlas, embrace reports of Geographical Surveys West of the One hundredth Meridian, as follows:

Volume I.—Geographical Report.
Volume II.—Astronomy and Barometric Hypsometry.
Volume III.—Geology and Mineralogy.
Volume IV.—Paleontology.
Volume V.—Zoölogy.
Volume VI.—Botany.
Volume VII. Ethnology, Philology, and Ruins.

The Topographical Atlas edition, consisting of Title-Page, Legend, and Conventional Signs Sheets, Index, Progress and Basin Maps, and Sheets Nos. 49, 50, 57, 58, 59, 65, 66, 67, 75, 76, 83, 61 (B), 69 (D), 61 (C), 61 (C sub), have been issued at date of sending forward the MS. of this volume. Other sheets will follow as rapidly as they can be prepared, engraved, and printed.

Sheets 61 (B), 61 (C), and 69 (D) are projected upon a scale of 1 inch to 4 miles, while the scale of 1 inch to 2 miles has been used for Sheet 61 (C sub), the latter embracing a part of the San Juan Mining Region, Southwestern Colorado.

Geological sheets, supplementing Volume III, based upon the topographical results, are in an advanced stage of completion.

LETTER OF TRANSMITTAL.

UNITED STATES ENGINEER OFFICE,
GEOGRAPHICAL EXPLORATIONS AND SURVEYS
WEST OF THE ONE HUNDREDTH MERIDIAN,
Washington, D. C., December 15, 1875.

GENERAL: I have the honor to submit herewith a report, in two parts, upon the paleontological results arising from the collections and examinations made during the years 1871, 1872, 1873, 1874, and 1875, in connection with geographical explorations and surveys west of the one hundredth meridian, for publication as Volume IV of the reports authorized by acts of Congress approved June 23, 1874, and February 15, 1875.

Part I is by Dr. C. A. White, on the collection of invertebrate fossils, numbering one hundred and eighty-three distinct species, of which fifty are new to science.

A preliminary report, with descriptions of new species, by the same author, was, with your sanction, published in December, 1874, the substance of which is embodied in the present volume.

The attainments and the experience of Dr. White in this branch of science are a guarantee that his work has been well done.

Part II is comprised of a similar treatment of the vertebrate fossil collections, by Prof. E. D. Cope, who has given to this subject years of study. Professor Cope was connected with the expedition during the season of 1874, in which he made collections himself, and, in addition, was enabled to prosecute geological researches. A portion of his results were published in preliminary form in a "Report upon the Vertebrate Fossils discovered in New Mexico, with description of new Species," November 28, 1874; and a "Systematic Catalogue of the Vertebrata of the Eocene of New Mexico, collected in 1874," April 17, 1875. His geological deductions appear in my annual report, Appendix LL, Annual Report of the Chief of Engineers, 1875, Several members of the expedition not engaged upon paleontological work have made collections of interesting specimens, evincing a hearty co-operation in this as well as other allied branches of the survey.

The whole number of specimens have become the property of the War Department, and will be carefully preserved.

The plates illustrating the invertebrate fossils were drawn by Mrs. H. M. Martin, of Albany, N. Y., and engraved and printed by Julius Bien, of New York City. The vertebrate-fossil plates have been prepared from the natural objects, engraved and printed by Messrs. Thomas Sinclair & Son, of Philadelphia.

A merited recognition is hereby tendered to all those who have contributed to the results as shown by this report.

Very respectfully, your obedient servant,

GEO. M. WHEELER,

Lieutenant of Engineers, in charge.

Brig. Gen. A. A. HUMPHREYS,

Chief of Engineers, United States Army.

U. S. GEOGRAPHICAL SURVEYS WEST OF THE ONE HUNDREDTH MERIDIAN,

1ST LIEUT GEO. M. WHEELER, CORPS OF ENGINEERS, U. S. ARMY, IN CHARGE.

REPORTS

UPON

THE INVERTEBRATE FOSSILS COLLECTED IN PORTIONS OF NEVADA, UTAH, COLORADO, NEW MEXICO, AND ARIZONA, BY PARTIES OF THE EXPEDITIONS OF 1871, 1872, 1873, AND 1874,

AND

THE EXTINCT VERTEBRATA OBTAINED IN NEW MEXICO BY PARTIES OF THE EXPEDITION OF 1874,

BY

CHARLES A. WHITE, M. D.,

AND

PROF. E. D. COPE.

IN TWO PARTS.

ILLUSTRATED BY EIGHTY-THREE PLATES AND ONE WOOD-CUT.

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PART I.

PART II.

LIST OF PLATES.

PART I.

PART II.

The plates in Part I were furnished by Julius Bien, of New York City; and those in Part II, by Messrs. Thomas Sinclair & Son, of Philadelphia, Pa.

U. S. GEOGRAPHICAL SURVEYS WEST OF THE ONE HUNDREDTH MERIDIAN.
1ST LIEUT. GEO. M. WHEELER, CORPS OF ENGINEERS, U. S. ARMY, IN CHARGE.

PART I.

REPORT

UPON

THE INVERTEBRATE FOSSILS COLLECTED IN PORTIONS OF NEVADA, UTAH, COLORADO, NEW MEXICO, AND ARIZONA, BY PARTIES OF THE EXPEDITIONS OF 1871, 1872, 1873, AND 1874,

BY

CHARLES A. WHITE, M. D.

COMPRISING

LETTER OF TRANSMISSION.

UNITED STATES ENGINEER OFFICE,
GEOGRAPHICAL EXPLORATIONS AND SURVEYS
WEST OF THE ONE HUNDREDTH MERIDIAN,
Washington, D. C., June 10, 1875.

SIR: I have the honor herewith to transmit my final report upon the invertebrate fossils collected by the exploring parties under your command during the years 1871, 1872, and 1873.*

The collections were placed in my hands in July, 1874,* and I at once commenced a critical examination of them, followed by the work of preparing the whole for publication; which work I have continued uninterruptedly to the present time. A preliminary investigation of these collections showed that quite a large proportion of the species were new to science, and, for the purpose of securing to your expedition due credit for priority of discovery, I wrote out descriptions of the new species then recognized, and sent them to your office, with the request that they be immediately published, for the purpose of securing the object named. This publication was made from the Government Printing-Office in December, 1874, and is the one referred to in the synonymy accompanying a republication of those species in this final report, together with additions and illustrations. Another object of this preliminary publication was the announcement of important geological conclusions from paleontological evidence. Among the most interesting of these may be mentioned the distinct recognition of the fauna of the Canadian period in Nevada and Utah; that of the Trenton period in Utah and New Mexico; and that of the Subcarboniferous period in Arizona, Nevada, and Utah.

Besides the new species described in the preliminary report, a full

* Collections of 1874 have since been placed in my hands for investigation, and the results have been incorporated into the following report.

examination of the collections has shown that a few others are also new. Descriptions of these form a part of the present report, with which they wi be published for the first time. The whole number of species recognized in the collections and described or noticed in this report is one hundred and eighty-two, of which fifty species were new.

As I have not been personally engaged in any of the field-explorations, my report is necessarily a paleontological one only, confined to a zoölogical description and classification of the invertebrate fossils, a reference of them to geological periods already well established, and a discussion of the character of the evidence afforded by the fossils upon which such reference is made.

My especial acknowledgments are due to those able paleontologists, Messrs. F. B. Meek and R. P. Whitfield, for generous counsel and assistance, and to Prof. Joseph Henry, Secretary of the Smithsonian Institution, for extending to me freely all the facilities possessed by that Institution to aid me in the work.

I am, sir, your obedient servant,

C. A. WHITE.

First Lieut. GEO. M. WHEELER,
Corps of Engineers, U. S. Army,
In Charge of Geographical Explorations and
Surveys West of the One Hundredth Meridian.

CHAPTER I.

GENERAL OBSERVATIONS UPON THE COLLECTIONS AND THE PERIODS THEY REPRESENT.

The critical investigation of fossils collected in newly-explored regions, distant from those in which the stratigraphical relations of the rocks have been accurately determined, especially if the relative position of the strata of those regions has been obscured by disturbance, it is often difficult and sometimes impracticable to assign each collection to its proper geological horizon. The difficulty is greatly increased to the paleontologist if he must prepare his report before those of the field-geologists are available, or if he has not himself visited the regions in question and obtained by personal observation a knowledge of the strata and their relative positions.

This difficulty has been met in the present instance, so far as any person could do it, by Mr. G. K. Gilbert, geologist of the expedition, by whose patient and clear oral and epistolary explanations I have greatly profited. If the collections were abundant in every case, it would be a comparatively easy task to assign them to their proper horizons; but it is often necessary to make some such assignment of a meager and uncharacteristic collection, or to pass it by in silence. This alternative has been presented to me in some instances by the collections that form the basis of this report; and I have chosen to make some assignment of them in all cases according to the best evidence presented, indicating at the same time such doubts as I have entertained.

The accompanying table of the subdivisions of geological time, which are more or less familiar to American geologists, is introduced here for the purpose of showing at a glance what periods and epochs are represented by the fossils of the collections, as well as the relative positions of the strata from which they were obtained. The names of the periods are those used by Dana in his new Manual of Geology (1874), and will be found to differ slightly from those formerly in use.

Table of the subdivisions of geological time.

AGES.	PERIODS.		EPOCHS.
Cenozoic.	*TERTIARY.	PLIOCENE.	
		MIOCENE.	
		EOCENE.	
Mesozoic.	* CRETACEOUS.		
	* JURASSIC.		
	TRIASSIC.		
Carboniferous.	?* PERMIAN.		
	* CARBONIFEROUS, OR COAL-MEASURES.		Upper Coal-Measures.
			Middle Coal-Measures.
			Lower Coal-Measures.
	* SUBCARBONIFEROUS.		Chester Limestone.
			Saint Louis Limestone.
			Keokuk Limestone.
			Burlington Limestone.
			* Kinderhook Group.
Devonian.	CATSKILL.		
	CHEMUNG.		
	HAMILTON.		
	CORNIFEROUS.		
Upper Silurian.	ORISKANY.		
	LOWER HELDERBERG.		
	SALINA.		
	NIAGARA.		
Lower Silurian.	* TRENTON.		* Cincinnati.
			?* Utica.
			Trenton.
	* CANADIAN.		Chazy.
			* Quebec.
			Calciferous.
	* PRIMORDIAL.		* Potsdam.
			Acadian.
ARCHÆAN.			

* The presence of the asterisk indicates that the period or epoch, as the case may be, is represented by fossils in the collections.

LOWER SILURIAN.

The Lower Silurian age is represented in these collections by fossils referable to all three of its periods, namely, the Primordial, Canadian, and Trenton.

PRIMORDIAL PERIOD.

The collections contain fossils of the Primordial period that were obtained in Western Utah, Southeastern Nevada, and Western Arizona, all of which are probably referable to the Potsdam epoch of that period. The most conspicuous feature of the fauna of the period, as represented by these collections, consists in the preponderance of the Articulate over all other forms of life, and which is represented by Trilobites alone, with the probable exception of the tracks described on a subsequent page. This apparent preponderance, however, is likely to be greatly modified by future discoveries.

The genera of Trilobites which these localities have afforded are *Olenellus*, *Conocoryphe*, *Agnostus*, and *Asaphiscus;* the latter being a new genus, recently proposed by Mr. F. B. Meek, probably allied with the *Asaphidæ*, while the others, as well as the geological horizon they are understood to characterize, are well known.

The discovery of two species of *Olenellus* at Pioche, Nev., is especially important and interesting, since that genus has hitherto been regarded as distinctively characteristic of a well-defined Primordial horizon in America. The interesting nature of the discovery is increased by the fact that, in their general characteristics, these two Nevada species of *Olenellus* respectively represent two other well-known species of that genus similarly associated in strata of the same period in Vermont and Canada. While all the other strata herein referred to the Primordial period have been so referred almost wholly upon paleontological evidence, the Tonto shale of the Grand Cañon of the Colorado River has been referred to that period by the geologists of the expedition largely upon stratigraphical evidence. The only indications of life that these last-named strata have afforded to the collections consist of two species of *Cruziana*, besides the tracks that have just been referred to It is true that the presence of *Cruziana* in those strata does not prove their Primordial age; but, as such forms are rarely found in strata of other periods, they may be regarded as adding considerable weight to the conclusions drawn by the field-geologists from other data. As these plants were the only recognizable species furnished by those strata, holding as they do so important a stratigraphical position, I have added descriptions of them to the others, although it was originally proposed that this report should be confined to invertebrate fossils alone. The existence of strata of the Primordial period at several localities in the Rocky Mountain region has been heretofore announced by different explorers; but the discoveries made by the Explorations West of the One hundredth Meridian constitute a material addition to our knowledge of the rocks of that period in the western part of the continent.

CANADIAN PERIOD.

Small collections made at a few localities in the House range, Western Utah, and in the Schell Creek range, Southeastern Nevada, I have referred to the Canadian period. The collections are not only small, but they comprise in all only twelve species. A part of these, however, are regarded as quite characteristic of the Quebec epoch of that period, to which I have assigned them with very little hesitation. Small as they are, these collections present a much greater zoölogical diversity than those of the Primordial period do, and there is not among them that preponderance of one zoölogical type over the others that has been mentioned as occurring among the collections of Primordial fossils, which consist very largely of Trilobites. The subkingdoms *Protozoa*, *Radiata*, *Mollusca*, and *Articulata* are all represented among the fossils referred to the Canadian period; the species and higher groups to which they belong being compactly shown in the systematic table on a following page. Among the more important of the characteristic forms of this period contained in the collections, the species of *Phyllograptus* deserves especial notice as being the first species of the genus yet discovered in the Rocky Mountain region, and also because the genus is regarded as peculiarly characteristic of the Quebec epoch. The discovery of strata of this period in Nevada and Utah is important from the fact that, with the exception of Professor Bradley's discovery in Idaho, their existence throughout the great Rocky Mountain region was heretofore unknown.

The discovery derives additional interest also from the fact that the period as such, and as distinct from the Primordial on the one hand and the Trenton on the other, has not, until lately, been fully recognized.

So far as known to me, neither the Calciferous nor Chazy formation of this period has been recognized in connection with the Quebec strata referred to, nor indeed anywhere in the Rocky Mountain region. It is too early to say or suggest what bearing this fact may have upon the opinion understood to be entertained by the Canadian geologists that the Quebec strata are deep-sea representatives of those of the Calciferous and Chazy formations.

TRENTON PERIOD.

The localities at which fossils belonging unquestionably to the Trenton period have been collected are Silver City and Upper Mimbres Mining Camp, N. Mex. A few other species have been collected at other localities in Arizona and Nevada, which localities are more specifically designated in connection with descriptions of the species on following pages. These species I have also referred to the Trenton period, but the intrinsic evidence they afford as to their stratigraphical position is not so entirely satisfactory as that presented by the collections from the two first-named localities. Besides all these, four species of Graptolites were collected from partially metamorphosed shale near Belmont, Nev. No other fossils were found associated with the Graptolites that might aid in indicating their exact stratigraphical position; but I have referred them provisionally to the same period with those already mentioned.

As regards the epochs of the Trenton period to which the fossils of these localities respectively belong, those from Silver City and Upper Mimbres Mining Camp are referred without hesitation to the Cincinnati epoch. This is done not only because of the general similarity of faunal characteristics, but also because of the identification of four species from the strata there that are characteristic ones of the strata of that epoch at the typical localities. The four species referred to are *Favistella stellata* Hall, *Strophomena filitexta* Hall, *Orthis biforata* Schlotheim (var. *lynx*), and *O. occidentalis* Hall.

Associated with these, there are some other species that, if not identical with associates of those species just named elsewhere, are very closely allied to them. Indeed, it is worthy of remark that there is so large a proportion of the species here referred to the Trenton period that are very closely allied to well-known species, and yet present such minor differences from typical forms, that I have felt obliged to append an interrogation-point to the names of the species I have referred them to. The Graptolites probably belong to the Utica epoch of the Trenton period, and I have made that provisional assignment of them.

Two of the Nevada species, *Graptolithus ramulus* White and *G. hypniformis* White are allied to two species, *G. ramosus* Hall and *G. Whitfieldi* Hall, that are found in the shales at Norman's Kill near Albany, N. Y., the exact stratigraphical position of which shales has hitherto been in doubt. One, *G. pristis* Hall? (not Hisinger), is apparently identical with a species from the Utica slate of New York; the other Nevada species is probably identical with *G. quadrimucronatus* Hall, the type-specimens of which were obtained from strata of the Utica epoch near Lake Saint John in Canada. While the exact stratigraphical position of the shales at Norman's Kill has not yet been demonstrated, the strata referred to at Lake Saint John are, upon published evidence, referred without hesitation to the Utica epoch. I am not aware that any species found in strata of that epoch at the last-named or at any other locality are identical with any found at Norman's Kill; but the relations of our Nevada species of Graptolites are very close with some of those found at both of the eastern localities just mentioned. It does not seem improbable, therefore, that this far western locality may be found to furnish important evidence of the equivalency of the strata at Norman's Kill with the Utica slate. (See note at end of chapter.)

It is not unfrequently the case that Graptolites constitute the only organic remains found in shales of Silurian age. This is doubtless due to the fact that the physical conditions of the sea, in which that kind of sedimentary material which now constitutes the shale was deposited, were favorable to the existence of such forms of life, and at the same time made the habitat an uncongenial one for other forms. The fact, therefore, that the Belmont shales have furnished almost no other fossils besides Graptolites is not remarkable; but it is worthy of remark that the collections from Silver City and Upper Mimbres Mining Camp, with the exception of one Conchifer, contain only arthropomatous Brachiopods and corals; the molluscan classes *Polyzoa*, *Gasteropoda*, and *Cephalopoda*, and the whole subkingdom *Articulata*, being unrepresented. The corals belong to families common in strata of that age, namely, *Favositidæ*, *Cyathophyllidæ*, and *Thecidæ;* but the Brachiopods, with the exception of one, *Rhynchonella*, all belong to the family *Strophomenidæ*.

Peculiar interest attaches to this discovery of strata of the Trenton period in New Mexico, Nevada, and Arizona, as well as to the discoveries concerning the other Lower Silurian periods, from the fact that so little has hitherto been known of their existence in that part of North America. Indeed, with the exception of the discovery of strata of this period by Jenney in Western Texas, and that of a similar one by Dr. G. G. Shumard in Southern New Mexico, I am not aware that the existence of any besides those here announced has been recognized in that part of the continent.

UPPER SILURIAN.

The collections contain no fossils of Upper Silurian age, nor has the existence of any strata of that age in the region over which the explorations have extended been ascertained, as far as I am aware.

DEVONIAN.

Among the collections are a few fossils, the locality for which is given as "between San Antonio and Silver Peak, Nevada."

All of them are too imperfect for satisfactory specific description; but, judging from their general characters, they seem to be of Devonian age. The genera, so far as they are recognizable, are *Favosites*, *Acervularia?*, and *Zaphrentis*. There are also some fragments, probably of *Atrypa reticularis*, and part of an undetermined Trilobite.

CARBONIFEROUS.

Nearly half of all the species contained in the collections are referable to the Carboniferous age, mainly to its middle period Among them are some very characteristic fossils of the Subcarboniferous period; but the Permian has only doubtful representation.

SUBCARBONIFEROUS PERIOD.

The physical conditions that prevailed during the Subcarboniferous period over what is now the North American continent were quite various; but the rocks of the period possess general distinctive characters in their fossil fauna, by means of which they may be separated with little difficulty from those of the next succeeding period. It is in the valley of the Mississippi that they are most characteristically developed, and where five distinct formations, marking as many epochs, are found. The names of these formations in the ascending order are the Kinderhook group, Burlington limestone, Keokuk limestone, Saint Louis limestone, and Chester limestone. Each formation has its own characteristic fauna; but through all of them a few species are continuous, even into the strata of the next period, the Carboniferous. Taking these Subcarboniferous formations together as the standard for the group, it has been found more or less difficult to recognize their respective equivalents among the rocks of the same period, either eastward or southward from that region, or, at best, the order of succession is nowhere so well shown as it is in the region referred to. In the Rocky Mountain region, it has been found that there is, at many localities, a greater or less mingling of Subcarboniferous with Carboniferous types; but at quite a number of localities, collections have been made that are regarded as distinctively Subcarboniferous. Only a very few of these collections, however, exhibit a fauna clearly referable to any particular one of the formations of the period that have just been named. Perhaps the most remarkable of the collections of this character is the one made by Professor Bradley in Idaho, the fossils of which Mr. Meek has found to be strikingly characteristic of the Saint Louis limestone as developed in some parts of Indiana.

The collections of the expedition contain fossils from only three localities that I have definitely referred to the Subcarboniferous period. These localities are Mountain Spring, Old Mormon road, Nevada; Ewell's Spring, Arizona (upper horizon); and a place below Ophir City, Utah. The collection made at the first-named locality is the most characteristic and important one of all, and is referred to the horizon of the Kinderhook formation, to which horizon it is not improbable the others also belong. As the recognition of distinct epochs of the Subcarboniferous period in the Rocky Mountain region is a matter of considerable importance, I give the following detailed statement of the relations of these fossils to the typical fauna of the period, and especially to that of the epoch to which I have referred them. It is well known that in America several species of fossils are known to range through all the formations of the Subcarboniferous into those of the Carboniferous period, especially into the limestones of the latter. The discovery of any of these species alone in any given strata would not, therefore, enable us to refer the strata containing them to one of these periods rather than the other. On the other hand, certain genera occur in strata of each one of these periods that are not known to occur in the other, in which latter case the generic character becomes of greater value than the specific in the former. It is upon evidence of the latter kind that I have referred the fossils of the three localities named to the Subcarboniferous period.

The following list contains the names of the genera represented in the collections from those localities :—

Favosites.	*Syringopora.*
Granatocrinus.	*Zaphrentis.*
Platycrinus.	*Productus.*
Actinocrinus.	*Hemipronites.*
Strophomena.	*Orthis.*
Spirifer (*Syringothyris* type).	*Spirigera.*
Conocardium.	*Spirifer* (*Trigonotreta* type).
	Terebratula (*Dielasma*).
	Enomphalus.

Those genera of the left-hand column are not known to occur in strata of later date than the Subcarboniferous, while those of the right-hand column are known to range both above and below it. The generic value of the latter genera in this case is only to add weight to the evidence afforded by the others, which is of itself, however, very decisive. Here are seven genera, that are known to occur in Subcarboniferous strata elsewhere, but are known in no strata of later date; and as they are found at the localities named associated with types peculiar to the Carboniferous age, the propriety of referring the species which represent those genera in the collections to the Subcarboniferous period seems unquestionable.

Although I entertain no doubt of the Subcarboniferous age of the fossils from the locality below Ophir City and the one at Ewell's Spring (upper horizon), I am not able to assign them definitely to either of the epochs of that period that are represented by the formations before named in the Mississippi Valley and elsewhere to the eastward of that region. The case is far different, however, with the collection from the Mountain Spring locality, which I refer without hesitation to the Kinderhook group.

This reference is made in consequence of the identification of no less than five of the species known to exist in rocks of that epoch in the States of the great valley and eastward. The following is a list of those species, together with the localities that furnished either the types or authentic specimens:—

Strophomena rhomboidalis Wilckins.—Kinderhook group, Burlington, Iowa.

Spirifer (*Martinia*) *peculiaris* Shumard.—Kinderhook group, Missouri and Iowa.

Spirifer centronata Winchell.—Waverly sandstone, Cuyahoga Falls, Ohio.

Spirifer (*Syringothyris*) *extenuatus* Hall.—Kinderhook group, Iowa and Missouri.

Terebratula (*Dielasma*) *Burlingtonensis.*—Kinderhook group, Burlington, Iowa.

Associated with these and other species at Mountain Spring, there is a small *Productus* that I have identified with *P. parvus* Meek and Worthen, the type-specimens of which were obtained from the Chester limestone of Illinois. This might seem to throw some doubt upon the proper identification of the strata at Mountain Spring with the Kinderhook group, were it not for the fact that other species of *Productus* are known to range through the whole Carboniferous series. Indeed, more species of this genus are known to have this great range than of all other genera of invertebrates put together.

It is a well-known fact that crinoidal life was eminently characteristic of the Subcarboniferous period; but, in the Mississippi Valley, it is the Burlington and Keokuk limestones that are more especially characterized by a great preponderance of these forms. Although some crinoidal remains exist in those Subcarboniferous strata that have been discovered in the Rocky Mountain region, in none of them have they been found in so great profusion as they exist in the two formations in the Mississippi Valley that have just been named. In this respect, the collections from those western localities accord more nearly in faunal characteristics with the other three formations of the Mississippi Valley series.

It could not be expected that collections of Subcarboniferous fossils so meager as those made by the expedition are should afford any very complete indication of the relative prevalence in that region of the different forms of marine life of the period; but it may be well to note that they contain no remains of fishes, no Articulates, and no Cephalopods, arthropomatous Brachiopods being the prevailing forms. Such deficiencies as those noticed are, however, not uncommon in much larger collections from typical Subcarboniferous strata.

CARBONIFEROUS PERIOD.

The accession, in the Carboniferous age, of the conditions necessary to the formation of coal was not simultaneous in all those parts of North America over which deposits of that age were made; nor were these conditions sooner or later co-extensive with all parts of the area in which those deposits exist, not even with those of the Carboniferous, or so-called Coal-Measure, period. It is also known that these conditions, even during the period of their greatest prevalence, occasionally ceased by shifting elsewhere, and were resumed again; alternating thus with conditions similar to those that prevailed at the beginning of the age, before the first coal-deposits were formed. In what are now portions of Pennsylvania, Virginia, Kentucky, and Indiana, these coal-making conditions began before the close of the Subcarboniferous period. Although their prevalence became general during the deposition, in the eastern half of North America, of the strata of the first and second epochs of the Carboniferous period, especially the first, the strata of the third epoch of the last-named period are usually as destitute of coal as those of the Subcarboniferous period are.

Indeed, the conditions that prevailed during the Upper Coal-Measure epoch were essentially a repetition of those which prevailed during the Subcarboniferous period. Bearing this in mind, it is easy to understand that those species which are found in both Subcarboniferous and Carboniferous strata may have reached the latter position merely by continuous geographical distribution during the progress of the two periods. Geologists generally divide the strata of the Carboniferous period, in the eastern part of North America, into Upper and Lower Coal-Measures; but, in Iowa and Missouri, they are more or less naturally divided into three formations, as before indicated. Westward from those States, the strata of the Carboniferous period have not been separated into corresponding epochal divisions, and are perhaps not capable of such separation. In the Rocky Mountain region, the strata of this period are widely distributed, and attain a very great thickness compared with that of those in the Mississippi Valley. Those far western Carboniferous strata probably represent in the aggregate the whole Carboniferous period, but in their general lithological and paleontological characters they are all much more nearly like the strata of the Upper Coal-Measures as developed in Iowa, Missouri, and Nebraska than they are like the Middle and Lower Coal-Measures. So far as known to me, no considerable deposit of coal has been found in any strata of the Carboniferous age in the Rocky Mountain region. The accession and cessation of the physical conditions necessarily attendant upon the formation of coal seem to have constituted the principal means of marking, in the accumulating strata, the epochal divisions of the period in Eastern North America. Those conditions of coal-making not having prevailed in the Far West, and, so far as known, the physical changes that occurred there during the period not being coincident with those farther eastward, its epochs were not there marked off in the same manner.

The collections contain a greater number of species from strata of this period than from those of any other; and they were also found more abundant than those of any one of the older periods that have just been noticed.

Of the sixty-two species that have been described or noticed in this report and assigned to this period, one is a Rhizopod; six, Actinozoa; two, Echinodermata; three, Polyzoa; twenty-nine, arthropomatous Brachiopoda;

ten, monomyarian Conchifera; two, dimyarian Conchifera; six, Gasteropoda; and three, Cephalopoda. The two species of Echinodermata do not, however, correctly represent the relative prevalence of that class, because the geologists of the expedition report the presence of scattered joints of Crinoids at almost all the localities, but which, being of little value for classification, were not collected. Of these sixty-two species, thirty-nine are more or less frequently met with in strata of the Carboniferous period in the States bordering upon the Mississippi River.

Although the faunal characteristics of the period are so clearly and fully shown in the collections, the flora of the period, so abundant in the States eastward, has very slight representation among them. Indeed, the collection contains only a single specimen each of *Sigillaria* and *Neuropteris;* the former from White Pine, Nev., and the latter from Cedar Creek, Maricopa County, Ariz.

PERMIAN PERIOD.

The collections contain no fossils that I have definitely referred to the Permian period. A few imperfect specimens were collected from a porous, apparently magnesian, limestone, near Jacob's Pool, Arizona, which is probably at the very summit of the Carboniferous series. One of the species only was satisfactorily recognized, and that is referred to *Bakevellia parva* Meek and Hayden. The collections also contain specimens apparently identical with that species from strata near Camp Wingate, N. Mex. The strata are probably equivalent at the two localities.

MESOZOIC.

TRIASSIC PERIOD.

So far as can be determined, none of the invertebrate fossils contained in the collections are properly referable to the Triassic period.

JURASSIC PERIOD.

The collections contain only eight species in all that I have referred to the Jurassic period. All of these were nowhere found associated together in the same strata; consequently the fauna of the period was nowhere found fully represented. The collections were made at somewhat widely-separated localities in Nevada and Utah. I have referred the species to the Jurassic period without hesitation in all cases where they were identical, or associated with species hitherto described by Mr. Meek, or Meek and Hayden, and referred by them to that period. With the exception of one crinoidal species, the fauna of the collections is wholly molluscan.

CRETACEOUS PERIOD.

Next to the Carboniferous period, the Cretaceous is represented in the collections by the greatest number of species. These were obtained at various points in New Mexico, Utah, and Colorado. For want of available data, no attempt has been made to refer them respectively to the different subdivisions of the Cretaceous group that have been recognized in Western North America by various geologists; but they are all regarded as clearly referable to the Cretaceous period. Although individuals of most of the species are numerous, it is interesting to observe the restrictions of zoölogical diversity which the collections, consisting of thirty-two species, present. For example, the *Protozoa* and *Radiata* are entirely wanting; the *Articulata* represented by a single species of *Serpula* only; and all the remainder are *Mollusca.* Of these, the *Molluscoidea* are represented by a single species of *Lingula;* thirteen species are monomyarian *Conchifera;* five, dimyarian *Conchifera;* nine, *Gasteropoda;* and four, *Cephalopoda.*

CENOZOIC.

TERTIARY PERIOD.

The collections contain fifteen species from strata at different localities in Utah that I have assigned to the Tertiary period, all of which, except one species of *Cypris,* are either fresh-water or land mollusks, mostly the former. Three species are *Conchifera,* and of the remaining eleven species five are pulmonate Gasteropods, an order that is not represented in any of the other collections.

If I were left to rely upon the zoölogical types alone which the fossils of this small collection present, I should have no hesitation in referring them all to the Tertiary period. In view of the fact, however, that strata at some localities in that Territory, containing a fauna as suggestive of the Tertiary period as these fossils are, have been found to underlie strata containing true Cretaceous types, I prefer at present to regard the reference of at least the greater part of them to the Tertiary period as provisional.

NOTE.—After writing the foregoing, I learned that my friend, Mr. R. P. Whitfield, the well-known paleontologist, had been making some special studies of the Graptolite slates of Norman's Kill, and wrote to ask his opinion upon the subject, to which inquiry I have received the following reply. I insert it here because of its important bearing upon the question of the age of the shales at Belmont, Nev.:—

"ALBANY, N. Y., *February* 18, 1875.

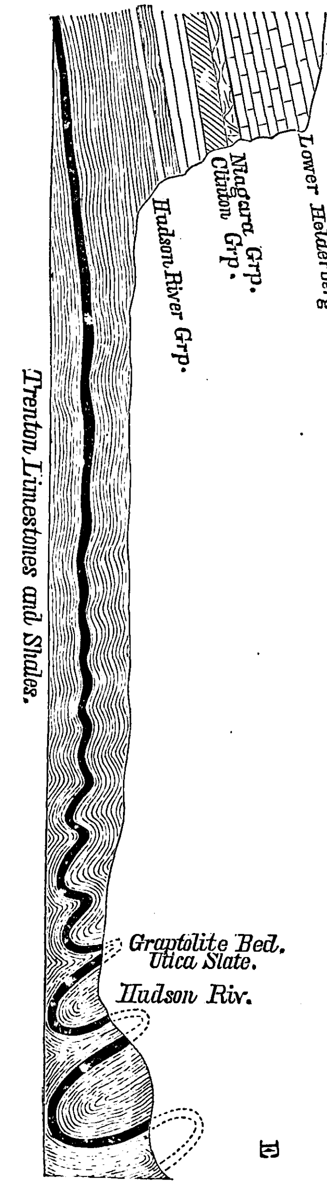
"DEAR SIR: Your inquiry in regard to the geological age of the Graptolite slates of Norman's Kill near Albany, N. Y., involves a question of considerable complexity, and is one to which I have given much thought and labor during several years past. The rocks in that vicinity are so altered and disturbed that their relative position is not easily determined from stratigraphical evidence. I have sought diligently at all points for fossil remains, but with only limited success thus far, except as to Graptolites. From the evidence furnished by these fossils, I have reached the conclusion that the Graptolite-bearing layers there are of the age of the *Utica slate*, the following being a summary of the facts I have observed:—

"I have found the following species common to both the Graptolite layers at Norman's Kill and those of the Utica slate formation at the mouth of Oxtungo Creek near Fort Plain, N. Y.:—*Graptolithus (Monograptus) serratulus* Hall; *G. (Diplograptus) pristis* Hall (not Hisinger); *G. (Climacograptus) bicornis* Hall; and *G. (Dicranograptus) ramosus* Hall.

"At Ballston, N. Y., *G. bicornis* Hall is very abundant in the Utica slate; and at Barker's Falls, near Sandy Hill, N. Y., *G. pristis* is equally abundant in the same formation. On the island of Orleans in the Saint Lawrence River, and in the valley of the Saint Anne River in Canada, three of the forenamed species are known to occur, viz, *G. pristis, G. ramosus,* and *G. bicornis* Hall, in beds known to be of the age of the Utica slate (see Geological Report of Canada, 1863, page 200). I think that *G. (Dicranograptus) sextans* Hall also occurs in the same layers with the above-mentioned species, but I will not be positive,

"I am confident that if all these localities were as thoroughly examined as that at Norman's Kill has been, many more species would be found to be common to two or more of them; but the evidence already given is quite sufficient to warrant the conclusion that the slates of the several localities named are of the same geological age, especially when we consider the fact that Graptolites have a very limited geological range. Although only four species are positively known to be common to two or more of the localities named, some of them are found at widely-separated characteristic localities of the Utica slate, which shows the great geographical range of the species. None of the Norman's Kill species have been recognized in any other formation than the Utica slate, which, while it demonstrates their equivalency of geological age, also shows the limited geological range of this family of fossils.

"Besides the foregoing evidence, the following facts are worthy of consideration in this connection. The lithological features of the Norman's Kill Graptolite beds are peculiar, quite different from the other beds near by, easily recognized at distant localities, and evidently as near like the Utica slate as a metamorphic slate can be like an unaltered one. At a locality of these slates near Cohoes, I found specimens of *G. pristis* undistinguishable from Norman's Kill specimens, and in another layer not many feet from the first, but of somewhat different lithological characters, I collected *Orthis testudinaria, Leptæna sericea, Bellerophon bilobatus,* and *Trinucleus concentricus,* also an *Orthoceras* and several small lamellibranchiate shells. In another layer, a short distance from the first and in a direction opposite the second, but nearly in the strike of the beds, I found specimens of an *Orthis* closely like, if not identical with, *O. subquadrata* Hall. On the opposite side of the Hudson River, near the base of the hills just above and back from Lansingburgh, a mile or more from the river, I obtained *G. pristis* and *G. furcatus,* another Norman's Kill species. Just south of Troy, in the shaly partings between layers of metamorphic limestone, I have found a species of Graptolite in great abundance undistinguishable from *G. amplexicaule* Hall, from the Trenton limestone of Herkimer County, New York. The same species was also found abundantly in the yard of the arsenal at Watervliet by Capt. C. E. Dutton, U. S. A. At Norman's Kill,



only a few hundred yards from the Graptolite beds, in arenaceous layers, I found a species of Graptolite closely resembling and probably identical with one figured in vol. i, Palæontology of New York, plate 72, fig. 1 *a*, found at Turin, Lewis County, N. Y., in the Hudson River group, and at that time identified with *G. pristis*, but probably distinct.

"From the foregoing facts, I infer that the slates below Troy and in the arsenal-yard, together with the associated metamorphic limestones, are the equivalents of the Trenton limestone; and that those at Norman's Kill, which bear the Lewis County species of Graptolites, are probably a continuation of the arenaceous limestones and shales seen in the ravines and railroad cuttings in the town of Knox, Albany County, and of those layers quarried near Schenectady, N. Y., known as the 'bluestone'; and also that they are the equivalents of the Lorraine shales of Central and North Central New York. All the physical peculiarities of the Hudson River beds, as seen at the localities just mentioned, are so exactly repeated in the disturbed and nearly vertical layers within a few hundred yards of the Graptolite beds, that it is difficult to believe they are not geologically identical. One peculiar feature, often noticed on the rocks at Schenectady and elsewhere, is very common at Norman's Kill: it is the appearance as of flowing mud suddenly fixed and hardened on the harder layers; the depressions between the folds and wrinkles being filled with fine mud-shale partings, upon which the layers separate with clean surfaces.

"The beds at Norman's Kill are so much disturbed and contorted that it is impossible to trace a given layer to any considerable distance. There are also many slight faults of a few inches, or sometimes several feet; but I have seen no evidence of any greater one in the vicinity, neither do I think it probable there is one, or that a proper explanation of the condition of the strata makes it necessary to infer that one exists there. The position of the beds there, and the appearance of the Utica slate and of Trenton limestone in the vicinity, can be more reasonably explained by assuming the presence of a series of folds or overlappings, increasing in strength from the vicinity of the nearly horizontal beds of the Hudson River group only a few miles westward from the river, which thus bring up these lower formations, as shown in the accompanying ideal section. You will find this section similar to one given by one of the best and most reliable geologists on page 234, Geological Report of Canada, 1863, for these same formations at another locality.

"Very truly, yours,

"R. P. WHITFIELD.

"Dr. C. A. WHITE."

CHAPTER II.

CLASSIFICATION.

If fossils were to be regarded as merely medals or tokens of geological formations, to serve the purpose only of distinguishing the latter from each other, a knowledge of their biological relations among themselves and to existing forms would be unnecessary, and their classification, beyond the application of convenient names, a useless and cumbersome labor. As our knowledge of paleontology increases, however, the great value and importance which the higher groups possess in the solution of geological problems, not to mention their bearing upon purely biological subjects, are more and more recognized. The custom that has been prevalent of recording only the generic and specific names of the fossils described has long been felt by the best paleontologists to be insufficient to give full expression to the significance they possess. Consequently, a more or less complete zoölogical grouping of them has of late become more common. There seems to be no rational ground between a full classification on the one hand and the mere mention of the name of each species in connection with its description on the other. I have, therefore, compiled a full zoölogical classification of the collections that form the basis of this report. In doing so, I have generally adopted the system used by the best specialists in each department; and their use here is merely one of present convenience, and not necessarily an expression of full approval. For example, an obvious reason for the adoption of Dr. Gill's arrangement of the families of *Mollusca* may be found in the fact that the collections by law go to the Smithsonian Institution, where that arrangement has been adopted for its cabinet. This should not be understood as an expression of my own views as to the systematic position of the *Brachiopoda*, any more than the use of Edwards and Haime's classification of corals implies an approval of the assignment of *Chætetes* and related corals to the *Zoantharia*, &c.

Following is a tabular view of the classification I have adopted for the collections, repeated for each of the geological periods they represent.

Systematic table of the invertebrate and other fossils.

LOWER SILURIAN AGE.

PRIMORDIAL PERIOD.

PLANTÆ.

CRYPTOGAMIA.

Class.	Subclass.	Order.	Suborder.	Family.	Genera and species.
Thallogens					Cruziana Linnarssoni White.
Do					Cruziana rustica White.
		ANIMALIA.			
		MOLLUSCA.			
		Molluscoidea.			
Brachiopoda		Lyopomata		Discinidæ	Acrotreta? subsidua White.
Do		do		do	Trematis pannulus White.
		Mollusca vera.			
Gasteropoda	Pteropoda	Thecosomata		Hyolithidæ	Hyolithes primordialis Hall (?).
		ARTICULATA.			
Crustacea		Trilobita		Agnostidæ	Agnostus interstrictus White.
Do		do		Conocoryphidæ	Conocoryphe Kingii Meek.
Do		do		Asaphidæ	Asaphiscus Wheeleri Meek.
Do		do		Paradoxidæ	Olenellus Gilberti Meek.
Do		do		do	Olenellus Howelli Meek.
Do					Vestigia.

CANADIAN PERIOD.

		PROTOZOA.			
Rhizopoda	....	Foraminifera	....	....	Receptaculites ——— (?).
		RADIATA.			
Hydrozoa	....	Hydroida	....	Graptolitidæ	Phyllograptus Loringi White.
		MOLLUSCA.			
		Molluscoidea.			
Brachiopoda	....	Lyopomata	....	Lingulidæ	Lingula manticula White.
Do	....	..... do	....	Discinidæ	Acrotreta pyxidicula White.
Do	....	Arthropomata	....	Strophomenidæ ...	Strophomena fontinalis White.
Do	....	..... do	....	..... do	Orthis Electra Billings (?).
		Mollusca vera.			
Gasteropoda	Diœca	Rhiphidoglossa ...	Dicranobranchiata.	Bellerophontidæ ..	Bellerophon allegoricus White.
Cephalopoda	....	Tetrabranchiata ...	....	Orthoceratidæ	Orthoceras colon White.
Do	....	..... do	....	Cyrtoceratidæ	Cyrtoceras ——— (?).
		ARTICULATA.			
Crustacea	....	Ostracoda	....	Cypridinidæ	Leperditia bivia White.
Do	....	Trilobita	....	Asaphidæ	Megalaspis belemnurus White.
Do	....	..... do	....	(?)	Dicellocephalus? flagricaudus White.

Systematic table of the invertebrate and other fossils—Continued.

LOWER SILURIAN AGE—Continued.

TRENTON PERIOD.

RADIATA.

Class.	Subclass.	Order.	Suborder.	Family.	Genera and species.
Hydrozoa		Hydroida		Graptolitidæ	Graptolithus ramulus White.
Do		do		do	Graptolithus hypniformis White.
Do		do		do	Graptolithus pristis Hall (?).
Do		do		do	Graptolithus quadrimucronatus Hall (?).
Actinozoa		Zoantharia		Favositidæ	Monticulipora Dalii Edwards and Haime.
Do		do		do	Favosites ——— (?).
Do		do		Thecidæ	Favistella stellata Hall.
Do		do		Cyathophyllidæ	Zaphrentis ——— (?).
MOLLUSCA. *Molluscoidea.*					
Brachiopoda		Arthropomata		Strophomenidæ	Strophomena filitexta Hall.
Do		do		do	Leptæna sericea Sowerby (?).
Do		do		do	Orthis occidentalis Hall.
Do		do		do	Orthis plicatella Hall (?).
Do		do		do	Orthis testudinaria Dalman (?).
Do		do		do	Orthis biforata Schlot. var. lynx.
Do		do		Rhynchonellidæ	Rhynchonella argenturbica White.
Mollusca vera.					
Conchifera		Heteromyaria		Mytilidæ	Modiolopsis ——— (?).
Gasteropoda	Diœca	Rhiphidoglossa	Podophthalma	Maclureidæ	Maclurea ——— (?).
Do	do	do	do	Pleurotomariidæ	Raphistoma trochiscus Meek.

CARBONIFEROUS AGE.

SUBCARBONIFEROUS PERIOD.

RADIATA.

Actinozoa		Zoantharia		Favositidæ	Favosites divergens White and Whitfield.
Do.		do		do	Syringopora Harveyi White.
Echinodermata		Blastoidea		Pentremitidæ	Granatocrinus lotoblastus White.
Do.		Crinoidea		Platycrinidæ	Platycrinus ——— (?).
Do.		do		Actinocrinidæ	Actinocrinus viaticus. White.

MOLLUSCA.

Molluscoidea.

Brachiopoda		Arthropomata		Productidæ	Productus parvus Meek and Worthen.
Do.		do		Strophomenidæ	Strophomena rhomboidalis Wilckins.
Do.		do		Spiriferidæ	Spirifer centronatus Winchell.
Do.		do		do	Spirifer striatus Martin (?).
Do.		do		do	Spirifer (Syringothyris) extenuatus Hall.
Do.		do		do	Spirifer (Martinia) peculiaris Shumard.
Do.		do		do	Spirigera monticola White.
Do.		do		do	Spirigera obmaxima McChesney.
Do.		do		Terebratulidæ	Terebratula (Dielasma) Burlingtonensis White.

Mollusca vera.

Conchifera		Dimyaria		Cardiidæ?	Conocardium ——— (?).
Gasteropoda	Diœca	Rhiphidoglossa	Podophthalma	Euomphalidæ	Euomphalus luxus White.

CARBONIFEROUS PERIOD.

PROTOZOA.

Rhizopoda		Foraminifera			Fusulina cylindrica Fischer.

Systematic table of the invertebrate and other fossils—Continued.

CARBONIFEROUS AGE—Continued.

CARBONIFEROUS PERIOD—Continued.

RADIATA.

Class.	Subclass.	Order.	Suborder.	Family.	Genera and species.
Actinozoa		Zoantharia		Favositidæ	Chætetes milleporaceus Edwards and Haime.
Do		do		do	Rhombipora lepidodendroides Meek.
Do		do		do	Syringopora multattenuata McChesney.
Do		do		Cyathophillidæ	Zaphrentis excentrica Meek.
Do		do		do	Lophophyllum proliferum (var.) McChesney.
Do		do		do	Lithostrotion Whitneyi Meek.
Echinodermata		Echinoidea		Archæocidaridæ	Archæocidaris ornatus Newberry.
Do		do		do	Archæocidaris trudifer White.
			MOLLUSCA.		
			Molluscoidea.		
Polyzoa		Gymnolæmata		Myriaporidæ	Glauconome nereidis White.
Do		do		do	Synocladia biserialis Swallow.
Do		do		do	Polypora stragula White.
Brachiopoda		Arthropomata		Productidæ	Productus costatus Sowerby.
Do		do		do	Productus Prattenianus Norwood.
Do		do		do	Productus punctatus Martin.
Do		do		do	Productus Nebrascensis Owen.
Do		do		do	Productus longispinus Sowerby.
Do		do		do	Productus muricatus Norwood and Pratten.
Do		do		do	Productus semireticulatus Martin.
Do		do		do	Productus Mexicanus Shumard.
Do		do		do	Chonetes granulifera Owen.
Do		do		do	Chonetes mesoloba Norwood and Pratten.

Do.		do		do	Chonetes platynota White.
Do.		do		Strophomenidæ	Orthis Pecosii Marcou.
Do.		do		do	Hemipronites crinistria Phillips.
Do.		do		do	Meekella striatocostata Cox.
Do.		do		Rhynchonellidæ	Rhynchonella Uta Marcou.
Do.		do		do	Rhynchonella Rockymontana Marcou.
Do.		do		do	Rhynchonella Wasatchensis White.
Do.		do		do	Rhynchonella metallica White.
Do.		do		Spiriferidæ	Spirifer cameratus Morton.
Do.		do		do	Spirifer Rockymontanus Marcou.
Do.		do		do	Spirifer striatus Martin (?).
Do.		do		do	Spirifer (Martinia) planoconvexus Shumard.
Do.		do		do	Spirifer (Martinia) glaber var. contracta Meek and Worthen.
Do.		do		do	Spiriferina Kentuckensis Shumard.
Do.		do		do	Spiriferina octoplicata Sowerby.
Do.		do		do	Retzia Mormonii Marcou.
Do.		do		do	Spirigera subtilita Hall.
Do.		do		do	Spirigera planosulcata Phillips.
Do.		do		Terebratulidæ	Terebratula (Dielasma) bovidens Morton.
Mollusca vera.					
Conchifera.		Monomyaria		Pectinidæ	Aviculopecten occidentalis Shumard.
Do.		do		do	Aviculopecten Coreyanus White.
Do.		do		do	Aviculopecten interlineatus Meek and Worthen.
Do.		do		do	Aviculopecten McCoyi Meek and Hayden.
Do.		do		Pinnidæ	Pinna peracuta Shumard (?).
Do.		do		Pteriidæ	Monopteria Marian White.
Do.		do		do	Myalina recurvirostris Meek and Worthen (?).
Do.		do		do	Myalina? Swallovi McChesney.
Do.		do		do	Bakevellia parva Meek and Hayden.
Do.		Dimyaria		Trigonidæ	Schizodus Wheeleri Swallow.
Do.		do		Anatinidæ	Allorisma subcuneata (var.) Meek and Hayden.
Gasteropoda	Prosopocephala	Solenoconcha		Dentaliidæ	Dentalium canna White.
Do.	Diœca	Rhiphidoglossa	Dicranobranchia	Bellerophontidæ	Bellerophon crassus Meek and Worthen.
Do.	do	do	Podophthalma	Euomphalidæ	Euomphalus pernodosus Meek and Worthen.
Do.	do	Pectinibranchiata	Tænioglossa	Naticidæ	Naticopsis nana Meek and Worthen.

Systematic table of the invertebrate and other fossils—Continued.

CARBONIFEROUS AGE—Continued.

CARBONIFEROUS PERIOD—Continued.

Mollusca vera—Continued.

Class.	Subclass.	Order.	Suborder.	Family.	Genera and species.
Gasteropoda	Diœca	Pectinibranchiata	Tænioglossa	Capulidæ	Platyceras Nebrascense Meek.
Do	do	do	do	Macrocheilidæ	Macrocheilus anguliferus White.
Cephalopoda		Tetrabranchiata		Goniatitidæ	Goniatites ——— (?).
Do		do		Nautilidæ	Nautilus latus Meek and Worthen (?).
Do		do		do	Nautilus Springeri White and St. John (?).

MESOZOIC AGE.

JURASSIC PERIOD.

RADIATA.

Class.	Subclass.	Order.	Suborder.	Family.	Genera and species.
Echinodermata		Crinoidea		Pentacrinidæ	Pentacrinus asteriscus Meek and Hayden.

MOLLUSCA.

Mollusca vera.

Class.	Subclass.	Order.	Suborder.	Family.	Genera and species.
Conchifera		Monomyaria		Ostreidæ	Ostrea strigilecula White.
Do		do		Pectinidæ	Camptonectes stygius White.
Do		do		do	Camptonectes bellistriatus Meek and Hayden.
Do		do		Ptereidæ	Inoceramus crassalatus.
Do		Dimyaria		Trigonidæ	Myophoria ambilineata.
Do		do		do	Trigonia ——— (?).
Gasteropoda	Diœca	Rhiphidoglossa	Podophthalma	Neritidæ	Neritina (?) phaseolaris White.

CRETACEOUS PERIOD.

MOLLUSCA.

Molluscoidea.

Brachiopoda		Lyopomata		Lingulidæ	Lingula subspatula Hall and Meek.
Mollusca vera.					
Conchifera		Monomyaria		Ostreidæ	Ostrea cortex Conrad.
Do.		do		do	Ostrea prudentia White.
Do.		do		do	Gryphea Pitcheri Morton.
Do.		do		do	Exogyra ponderosa Roemer.
Do.		do		do	Exogyra læviuscula Roemer.
Do.		do		do	Exogyra costata Say, var. fluminis White.
Do.		do		Pectinidæ	Camptonectes platessa White.
Do.		do		Limidæ	Lima Wacoensis Roemer.
Do.		do		Pteriidæ	Inoceramus problematicus Schlot.
Do.		do		do	Inoceramus deformis Meek.
Do.		do		do	Inoceramus fragilis Hall and Meek,
Do.		do		do	Inoceramus Barabini Morton.
Do.		do		do	Inoceramus dimidius White.
Do.		do		do	Inoceramus flaccidus White.
Do.		do		Pinnidæ	Pinna petrina White.
Do.		Dimyaria		Arcidæ	Idonearca depressa White.
Do.		do		Lucinidæ	Lucina subundata Hall and Meek.
Do.		do		Glossidæ	Veniella goniophora Meek.
Do.		do		Mactridæ	Mactra? incompta White.
Do.		do		Anatinidæ	Leiopistha (Psilomya) Meekii White.
Do.		do		do	Leiopistha (Cymella) undata Meek and Hayden.
Do.		do		Corbulidæ	Corbula nematophora Meek.
Gasteropoda	Diœca	Riphidoglossa	Podophthalma	Neritidæ	Neritina (Velatella) carditoides, Meek.
Do.	do	Pectinibranchiata	Tænioglossa	Aporrhaidæ	Anchura? fusiformis Meek.
Do.	do	do	do	do	Lispodesthes nuptialis White.
Do.	do	do	do	do	Lispodesthes lingulifera White.

Sytematic table of the invertebrate and other fossils—Continued.

MESOZOIC AGE—Continued.

CRETACEOUS PERIOD—Continued.

Mollusca vera—Continued.

Class.	Subclass.	Order	Suborder.	Family.	Genera and species.
Gasteropoda	Dicœa	Pectinibranchiata	Tænioglossa	Tecturidæ	Anisomyon borealis Morton.
Do	do	do	do	do	Anisomyon centrale Meek.
Do	do	do	do	Turritellidæ	Turritella uvasana Conrad.
Do	do	do	do	do	Cassiope Whitfieldi White.
Do	do	do	do	do	Eulimella? funicula Meek.
Do	do	do	do	Pyramidellidæ	Turbonilla (Chemnitzia) melanopsis Conrad.
Do	do	do	Toxoglossa	Admetidæ	Admetopsis gregaria Meek.
Cephalopoda		Tetrabranchiata		Baculitidæ	Baculites ovatus Say.
Do		do		do	Baculites ovatus var.
Do		do		Schaphitidæ	Schaphites Warreni Meek and Hayden.
Do		do		Ammonitidæ	Buchiceras Swallovi Shumard.
Do		do		do	Ammonites Lœvianus White.
Do		do		do	Ammonites placenta DeKay.
Do		do		Turrilitidæ	Helicoceras Pariense White.
ARTICULATA.					
Vermes		Tubicola		Serpulidæ	Serpula intrica White.

CENOZOIC AGE.

TERTIARY PERIOD.

MOLLUSCA.

Mollusca vera.

Class.	Subclass.	Order	Suborder.	Family.	Genera and species.
Conchifera		Dimyaria		Unionidæ	Unio vetustus Meek.
Do		do		Cyrenidæ	Cyrena (Veloritina) Durkeei Meek.

Do.		do		do	Sphærium ——— (?).
Gasteropoda	Pulmonifera	Pulmonata	Basommatophora	Limnæidæ	Planorbis Utahensis Meek.
Do.	do	do	do	do	Planorbis ——— (?).
Do.	do	do	do	Physidæ	Physa Bridgerensis Meek.
Do.	do	do	do	do	Physa pleromatis White.
Do.	do	do	Geophila	Helicidæ	Helix Leidyi Hall and Meek.
Do.	Diœca	Pectinibranchiata	Tænioglossa	Melaniidæ	Goniobasis tenuicarinata Meek and Hayden.
Do.	do	do	do	do	Goniobasis Nebrascensis Meek and Hayden.
Do.	do	do	do	do	Goniobasis tenera Hall.
Do.	do	do	do	Viviparidæ	Viviparus trochiformis Meek and Hayden.
Do.	do	do	do	do	Viviparus Ionicus White.
Do.	do	do	do	do	Viviparus? ——— (?).
			ARTICULATA.		
Crustacea		Ostracoda		Cypridinidæ	Cypris ——— (?).

CHAPTER III.

LOWER SILURIAN AGE.

PRIMORDIAL PERIOD.

PLANTÆ.

CRYPTOGAMIA.

CLASS THALLOGENES.

GENUS CRUZIANA D'Orbigny, 1842.

Cruziana Linnarssoni White.

Plate I, fig. 2 *a*, *b*, and *c*.

Cruziana Linnarssoni White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 5.

Body not much flattened, oblong or subelliptical in outline, but narrowed and more or less pointed at the ends, one of which is a little more acutely pointed than the other; median furrow traversing the whole length of the body, the greater part of it being deep and distinct, but a part of it is usually more shallow.

Surface marked by few or no transverse rugæ, but upon the more pointed end of some of the specimens there is a secondary furrow upon each side of the median furrow; these converge to the point where they join the median furrow, but they disappear in the opposite direction before reaching the middle of the body. Upon others, an incipient furrow is sometimes seen at each side of the half of the body that is more acutely pointed These are near to, and their direction is parallel with, the sides of the body. This character is shown in figure 2 *a* and *b*, Plate I. Stipe rather small, attached about midlength of the body in the bottom of the median furrow, but it is, however, rarely preserved.

Length of body from two and a half to seven and a half centimeters.

It is not improbable that the form represented by figure 2 *b* and *c* is specifically distinct from the form represented by figure 2 *a*, especially as the first-named form is quite a constant one among the specimens of the collections. I have, however, not felt fully warranted by the collections yet made in separating them under a different specific name, but I have selected the form represented by figure 2 *a* as typical of the species here described.

Compared with *C. dispar* Linnarsson, from the Primordial rocks of Vestergotland, it differs in being more pointed at the extremities and otherwise of different outline, and also in having few or none of the transverse rugæ that so distinctly mark that species. From *C. grenvillensis* Billings (Palæozoic Fossils of Canada, vol. i, page 101), it differs in outline, in having few or no transverse rugæ or wrinkles, and in having a median furrow traversing its whole length instead of occupying only a part of its length as the furrow does in that species.

It is thought possible that the specimens of this species in the collection may have been denuded of rugæ before they became imbedded, because the surface of some of the slabs upon which they are found are strewn with small bodies that resemble detached rugæ. On the other hand, such a supposition seems untenable, because some of those slabs are found to contain both *C. Linnarssoni* and the following described species; the former being nude as usual, and the latter having their abundant rugæ in place.

The specific name is given in honor of Prof. J. G. O. Linnarsson, the able Swedish geologist.

Position and locality.—Tonto shale, probably of the Primordial period, Grand Cañon of the Colòrado River, Mohave County, Arizona.

Cruziana rustica White.

Plate I, fig. 1 *a* and *b*.

Cruziana rustica White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 5.

Body more or less elongated, flattened, more or less distinctly bilobed, the lobes being depressed-convex and the ends blunt; median furrow extending the whole length of the body and comparatively shallow throughout; transverse rugæ numerous, some of them interrupted, but others extending from the outer borders to the middle of the median furrow, arching slightly as they cross the lobes.

Length of the body in proportion with the width variable; in some specimens (perhaps broken ones) the length and width being about equal, while in others the length is two or three times as great as the width. The width varies in different specimens from three and a half to more than four centimeters. It is not improbable that this species reached a much greater length than is indicated by any of the specimens in the collection, and that even the longest of these are only fragments. No indications of a stipe arising from the median furrow, such as is seen in *C. Linnarrsoni* and other species, have been observed.

This species is larger than *C. Linnarrsoni*, with which it is associated; of very different aspect and of different and more variable proportions. It somewhat resembles *C. bilobata* (*Fucoides bilobatus* Vanuxem, Geology of the Third District of New York, page 79) of the Clinton group; but the proportions of the body and of the lobes, respectively, are different.

Position and locality.—Tonto shale, probably of the Primordial period. Grand Cañon of the Colorado River, Mohave County, Arizona.

ANIMALIA.

MOLLUSCA.

MOLLUSCOIDEA.

CLASS BRACHIOPODA.

ORDER LYOPOMATA.

FAMILY DISCINIDÆ.

GENUS ACROTRETA Kutorga, 1848.

Acrotreta? subsidua White.

Plate I, fig. 3 *a*, *b*, *c*, and *d*.

Acrotreta? subsidua White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 6.

Shell thin, corneus, discoid, subcircular or somewhat suboval in outline, the transverse diameter being a trifle greater than the longitudinal;

sides regularly, and front broadly, rounded; posterior margin slightly straightened, forming a comparatively short, slightly convex, or nearly straight hinge-line.

Dorsal valve flattened; beak marginal or nearly so, not prominent; interior surface having a slightly-elevated median ridge, beginning beneath the beak and extending to about the middle of the valve, where it disappears.

The condition of all the specimens of this species which the collections contain is such that the muscular impressions are not distinctly shown, but those of the posterior adductors appear to be small, and placed nearly beneath the beak, one on each side of the median ridge just mentioned; between these muscular impressions and the posterior margin there is, at each side, an obscure diverging ridge, or fold, which seems to blend with the postero-lateral margin.

Ventral valve moderately convex in the umbonal region, but more flattened anteriorly and laterally; beak excentric, somewhat prominent, and minutely perforate. Some of the specimens show what appear to be small adductor impressions placed in the apex, close to the foramen, one at each side of it. One specimen shows a slight flattening of the space upon the outer surface, between the apex and the hinge, producing the appearance there of an indistinctly-defined cardinal area.

The inner surface of both valves of all the specimens of this species contained in the collections has been more or less exfoliated by weathering, whereby some of the principal characters have been obscured. Consequently, the foregoing description is not only incomplete, but it is probable that the discovery of more perfect specimens may show necessity for modifying it. The cast of a single valve found associated with those used in this description, showing large and distinct muscular impressions, already suggests such a modification; but its characters are not embodied in the description, because that specimen is not certainly known to belong to the species. The specimen referred to is illustrated by figure 3 *d*, Plate I. The other specimens all show fine radiating lines in the structure of the shell, and also concentric laminæ of growth. They are all compressed in dark shale, and show only the interior surfaces of the valves, none showing the external surface. The latter is supposed to be lamellose or otherwise so roughened as to have caused it to adhere to the shale, while the smooth interior surface has readily separated in the plane of fission.

This shell is not only specifically different from any other known to me; but in its want of a well-defined area and in its discoid, instead of pyramidal, form, it differs perhaps generically from those *Discinidæ* that are usually referred to the genus *Acrotreta*. I have referred it to that genus provisionally, because the combination of its characters renders its reference to any other established genus known to me equally inconsistent, and because the specimens are not complete enough to base a new generic description upon which the species may or may not possess.

Length of the largest specimen in the collection, six millimeters; width of the same, seven millimeters.

Position and locality.—Strata of the Primordial period, probably of the epoch of the Potsdam sandstone, Antelope Spring, House range, Utah.

GENUS TREMATIS Sharpe, 1847.

Trematis pannulus White.

Plate I, fig. 4 *a* and *b*.

Trematis pannulus White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 6.

Associated with *Olenellus Gilberti* Meek, a single imperfect specimen of *Trematis* has been discovered, which, although consisting only of a single valve, possesses such characteristic surface-markings as to indicate its specific separation from all other known forms of the genus.

The diameter of the specimen is about three millimeters; outline apparently subcircular or a little broader than long; apex moderately prominent and situated near the posterior margin. Surface marked by a very fine net-work of oblique raised lines, dividing it up into minute, four-sided, pore-like pits, which cause it to resemble, under the lens, the texture of finely-woven cloth.

In the character of its surface-markings, this species is nearly related to *T. punctata* Sowerby, sp., as figured by Davidson in his Monograph of British Fossil Brachiopoda, part vii, No. 1. That species, however, reaches a much larger size than our shell, and the small pits that similarly mark its surface are six-sided, instead of four-sided as in ours. The surface of *T. siluriana* Davidson, another allied species, has the pits arranged in radiating instead of oblique lines.

Position and locality.—Shales of the Primordial period and probably of the Potsdam epoch, Pioche, Nevada.

MOLLUSCA VERA.

CLASS GASTEROPODA.

SUBCLASS PTEROPODA.

ORDER THECOSOMATA.

FAMILY HYOLITHIDÆ.

GENUS HYOLITHES Eichwald, 1840.

Hyolithes primordialis Hall (?).

Plate I, fig. 5 *a*, *b*, *c*, *d*, and *e*.

Theca primordialis Hall, 1861, Geol. Surv. Wisconsin (pamph.), 48.
Theca primordialis Hall, 1862, Geol. Surv. Wisconsin, i, 21.
Theca primordialis Hall, 1863, Sixteenth Ann. Reg. Rep. N. Y. State Cab., 135.
Hyolithes primordialis Hall and Whitfield, 1873, Twenty-third Ann. Reg. Rep. N. Y. State Cab., 242.
Hyolithes primordialis ?, White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 6.

Shell slender, acutely pointed; test rather thin; transverse section subsemicircular or subtrihedral; edges or longitudinal angles nearly or quite straight, meeting at an apical angle, varying in different specimens from fifteen to twenty degrees; dorsal side slightly convex or nearly flat along the middle; ventral side forming a nearly semicircular arch in transverse section, but it sometimes shows an obtuse, rounded angle, extending from apex to aperture along the median line; the lateral angles, formed by the junction of the dorsal and ventral sides, sharply rounded; margin of the aperture at the flattend side extended and broadly rounded; that of the convex side nearly transverse, but sometimes showing a slight emargination at the middle. Upon the flattened or dorsal side of the solid stony core of one of the specimens, from which the test is removed, there appears a very slightly raised longitudinal ridge, the width of which at all parts of its length is about one-quarter that of the whole width of the shell. This, of course, indicates the existence of a shallow, tapering, longitudinal groove upon the inner surface of the shell; but, so far as observed, there is no external indication of its presence. Surface marked by lines and undulations of growth, which are apparently strongest upon the flattened side.

Length, from fifteen to eighteen millimeters.

In the case of simple forms like these, it often seems necessary to take into careful consideration differences that, in more complex forms, would be considered as merely individual, or slightly varietal modifications, and therefore disregarded. The difference between our specimens and those of Professor Hall, as represented by his figures and description, seems to be of this slight character; and it is only in view of the fact just stated that doubt is felt as to the specific identity of our shell with *H. primordialis.* The principal external differences (the internal characters of Professor Hall's shell have not been made known) are that our forms are a little more robust, a little less flattened upon the dorsal side, and the convexity of the lines of growth and of the margin of the aperture at that side are a little greater. From *H. gregaria* Meek and Hayden, it differs in its greater size, its concentrically-marked surface, and in the outline of its aperture.

Position and locality.—Strata of the Primordial period, and probably of the Potsdam epoch, Pioche, Nevada.

ARTICULATA.

CLASS CRUSTACEA.

ORDER TRILOBITA.

FAMILY AGNOSTIDÆ.

GENUS AGNOSTUS Brongniart, 1821.

Agnostus interstrictus White.

Plate II, fig. 5 *a* and *b*.

Agnostus interstrictus White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 7.

Head and pygidium of almost exactly equal size and general shape and otherwise closely resembling each other.

Head a trifle broader than long, regularly rounded in front; sides at the postero-lateral regions subparallel; postero-lateral angles truncated; the whole exterior margin, including the truncated portions just named, provided with a narrow, raised rim, the elevation of which forms a linear depression, or groove, between it and those portions of the head which it incloses; space between this marginal depression and the glabella a little wider posteriorly than it is in front, convex throughout, and its surface apparently smooth. Glabella conical, widest posteriorly, moderately convex, sides nearly straight, well defined by the dorsal furrows, abruptly rounded in front; a minute tubercle situated on the median line near the posterior end, and a shallow groove or furrow extending across near the front end, defining a frontal lobe of moderate size.

Thorax narrower than the head and pygidium, giving the body the appearance of being constricted at the middle; axial lobe broad, consisting of two segments, both of which are tumid at the ends adjoining the dorsal furrows; lateral lobes very narrow; pleuræ almost as wide as long; each pleura tumid, and rounded at its exterior end.

Pygidium having an outline like that of the head, and is also provided with a similar elevated marginal rim and linear depression within it; axial lobe a little longer than the glabella, and consequently that lobe reaches a little nearer the posterior margin of the pygidium than the glabella does to the anterior margin of the head, moderately convex in elevation and also in each lateral outline; a minute tubercle is situated on the median line near the anterior end, corresponding in size and relative position with the one on the glabella before mentioned; space between the dorsal furrows and the margin convex, its surface apparently smooth; upon the outer edge of the border of the pygidium, at each side and a little nearer to the axial extremity than to the antero-lateral angles, there is a minute protuberance, suggestive of an incipient spine. Besides the slight differences between the head and pygidium, already referred to, the pygidium differs also in having a faint appearance of segmentation of its axis and in a slight folding-backward of the marginal rim at the antero-lateral angles.

Length of body, eight millimeters; width of head and also of the pygidium, five millimeters; width of thorax, four millimeters.

This beautiful *Agnostus* is quite unlike any described American species, and is more nearly related to *A. integer* Beyrich, from the Primordial strata of Europe, than any other known to me. Compared with that species, it is found to reach a larger size; its glabella is narrowed in front instead of having its sides nearly parallel; the axial lobe of the pygidium is narrower behind than in front, instead of being of nearly the same width at each end, and has the sides of that lobe convex instead of nearly straight, as they are in *A. integer.*

Position and locality.—Shales of the Primordial period, probably of the Potsdam epoch, Antelope Spring, House range, Utah, where it is associated with *Conocoryphe Kingii* Meek, and other fossils of Primordial type, and where three entire specimens have been obtained, besides a number of fragments.

FAMILY CONOCORYPHIDÆ.

GENUS CONOCORYPHE Corda, 1847.

SUBGENUS PTYCHOPARIA Corda, 1847.

Conocoryphe (Ptychoparia) Kingii Meek.

Plate II, fig. 2 *a*, *b*, and *c*.

Conocoryphe (*Conocephalites*) *Kingii* Meek, 1870, Proc. Acad. Nat. Sci. Phila., 63.
Conocoryphe (*Ptychoparia*) *Kingii* Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, & Utah, 487.

Outline of body ovate; the width compared with the length being about as two to three. Head semicircular, or nearly so; the exterior margin regularly rounded, and bordered by a narrow marginal rim, which is nearly of uniform width throughout, but is sometimes a little stronger in front of the glabella than elsewhere; posterior margin very slightly concave in adult specimens, but a little more concave in young ones; near the postero-lateral angle of the head, this margin bends abruptly backward, terminating in cheek-spines of moderate length; these spines in the adult extend backward to a point about opposite the second segment of the thorax, but in the young the spines are proportionally longer, and the whole head larger compared with the remainder of the body. Glabella slightly elevated above the cheeks, clearly defined by the shallow dorsal furrows; its anterior end reaching a point about one-half its own length from the front margin of the head; width at the base, compared with its full length, about as seven to eight; sides straight or nearly so; anterior end abruptly and posterior end very broadly rounded; occipital furrow well defined, and continuous with a similar but rather broader furrow at each side, that extends across the cheek parallel with and near the posterior margin of the head, giving that margin a raised border; lateral furrows absent or very indistinct in adult specimens, but in well-preserved young ones there are indications of four pairs of lobes. Facial sutures curving outward and forward from the anterior ends of the eyes, or from a point a little forward of their anterior ends, reaching the marginal groove within the raised border of the head at points a little wider apart than the eyes are at their anterior ends, then, bending somewhat abruptly inward, they cut the anterior margin; posteriorly, the sutures extend almost directly outward from the posterior ends of the eyes, then, by broad backward curves, which become more abrupt as they proceed, they cut the posterior margin of the head not far from its postero-lateral angles and just inside the bases of the cheek-spines.

Eyes rather small, slightly arching outward, placed well back toward the posterior margin of the head; visual surfaces narrow, our specimens showing no reticulations; other portions of the head apparently without surface-markings or ornamentation, except that some specimens show a very faint ridge extending transversely from the anterior end of each eye toward the anterior portion of the glabella, but ending at the dorsal furrows before reaching it.

Thorax longer than the head, measuring seventeen millimeters in a specimen having a head thirteen millimeters long, the same thorax measuring twenty-five millimeters wide at its widest part; axial lobe depressed, narrow; sides straight, about two-thirds as wide as one of the lateral lobes at the anterior end of the thorax, about one-third wider at its anterior than it is at its posterior end; segments thirteen in number, passing nearly or quite straight across the lobe; a slight transverse prominence usually seen at each end of every axial segment near the bottom of the dorsal furrows, producing the appearance there of a corrugated, raised line along the whole length of each furrow; lateral lobes slightly convex, a little widest about midlength; pleuræ nearly transverse with the axis of the body, nearly straight, but arching a little backward at their outer ends; extremities abruptly pointed, the points directed obliquely backward, and also bent a little horizontally outward, so as to produce the appearance of a slightly-flattened, serrated border along each side of the thorax, each pleura having a well-defined groove, which is widest and deepest about the middle, and extends from the inner end to near the outer extremity, where it becomes obsolete and ends at the flattened tip.

Pygidium subsemicircular, comparatively small, only a little more than one-third as long as the thorax, regularly rounded behind, where it has a narrow, flattened border of nearly uniform width all around; axial lobe ending at the marginal border; segments indistinct, but five or six in number are recognizable in some specimens; lateral lobes much depressed, twice the width of the axial lobe at the anterior end of the pygidium; segments indistinct, but may be distinguished by their grooves, which are deeper than those that mark the limits of each; grooves curving backward, and, like those of the pleuræ, becoming obsolete upon reaching the flattened marginal border.

The whole surface is apparently smooth, except that there are some faint indications of radiating striæ upon the exterior portions of the head of well-preserved specimens, discernible only by means of a lens.

Length of the largest specimen in the collections, five centimeters; breadth of the same across the thorax, thirty-three millimeters.

Although this species resembles an *Olenus* in general outline and aspect, the possession of blunt and shortened, instead of extended and pointed, pleuræ, the presence of faint elevated lines between the eyes and glabella, the radiating lines upon the surface of the head, together with the other characters above described and shown in the figures, leave no doubt as to the propriety of referring it to the genus *Conocoryphe.* The presence of only thirteen thoracic segments instead of fourteen (the number attributed to the genus by Corda) is not regarded as of generic importance in this case.

A number of entire and more or less perfect specimens of this fine *Trilobite* are contained in the collections, but they have all been a little flattened by compression. The finer details of structure of most of them have also been obscured by contact with a peculiar accumulation of calcite or arragonite in the form of a layer from two to four millimeters in thickness beneath the whole crust; the crystalline prisms being vertical to the plane of the fossil and also to that of the layer of shale in which it was imbedded.

Position and locality.—Shales of the Primordial period, probably of the Potsdam epoch, Antelope Spring, House range, Utah.

FAMILY ASAPHIDÆ.

GENUS ASAPHISCUS Meek, 1872.

Asaphiscus Wheeleri Meek.

Plate II, fig. 1 *a*, *b*, *c*, *d*, *e*, and *f*.

Bathyurellus (*Asaphiscus*) *Wheeleri* Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, & Utah, 485.

Body oblong-ovate in outline; surface smooth. Head depressed-convex; front margin regularly rounded; postero-lateral angles abruptly rounded, without cheek-spines; exterior margin bent shortly upward all around, producing a raised border of considerable width, and also a rather deep linear depression, or groove, parallel with that border and between it and the remainder of the cheeks. Glabella conical, much wider behind than in front, depressed; space between its anterior end and the marginal groove about equal to the width of the raised marginal rim in front of it; outline well defined by the narrow dorsal furrows; sides nearly straight; anterior end abruptly and posterior end broadly rounded, without lateral furrows, or at least they are hardly discernible; occipital furrow shallow, broad, but somewhat distinct and uniform, extending entirely across the glabella, and continuous with furrows similar to itself that extend to the postero-lateral angles of the head; the latter furrows lie parallel with and near to the posterior margin of the head, giving that margin also a raised border, somewhat like the one upon the exterior margin. Eyes comparatively small, crescentic, situated nearly opposite the mid length of the glabella, and nearly equidistant from it and the posterior margin.

Thorax having nine segments; its length not quite so great as that of the head; axis broadest anteriorly, more strongly convex, and about one-third narrower than the lateral lobes are; segments extending straight across the lobe; lateral lobes depressed, their greatest convexity along the middle;

pleuræ bluntly pointed at their outer ends, the points not being directed very strongly backward; their inner ends so joined to the axial segments that they have the appearance of lapping a little upon them just inside the dorsal furrow; grooved, the groove being deepest about midlength, where the outer and inner portions of its front border meet at a distinct but very obtuse angle; grooves extending from the dorsal furrow nearly to the extremity of the pleuræ, where they disappear.

Pygidium somewhat semicircular in outline, distinctly trilobate; segmentation indistinct, so much so in some of the specimens that the surface appears nearly as plain as that of an *Asaphus*, but the segmentation is usually more distinctly shown upon surfaces from which the crust has been removed; axis prominent, especially at its distal end, where it terminates abruptly at the inner edge of the broad marginal border; segments of axial lobe eight or ten; lateral lobes much depressed, a little wider than the axial lobe at the anterior end, and narrowing to an incurved point at the end of the axis; the whole exterior margin having a broad, flat border of nearly uniform width throughout; the under surface of this border marked by fine, somewhat irregular, longitudinal striæ, such as are usually seen upon corresponding parts of *Asaphus*.

The largest specimen in the collections is about seven centimeters long.

These specimens are the same that were used by Mr. Meek in his description of this species, and upon which he also based his genus *Asaphiscus*.

Position and locality.—Strata of the Primordial period, probably of the Potsdam epoch, near Antelope Spring, House range, Utah.

FAMILY PARADOXIDÆ.

GENUS OLENELLUS Hall, 1861.

Olenellus Gilberti Meek.

Plate II, fig. 3 *a*, *b*, *c*, *d*, and *e*.

Olenellus Gilberti Meek, 1874 (manuscript).
Olenellus Gilberti White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 7.

Head subsemicircular or semi-oval, the length being to the breadth at the posterior border about as four or five to seven; both the external and posterior margins bordered by a narrow, continuous, slightly-raised rim, that of the external margin being placed a little within its edge, that of the posterior margin continuous across the occipital lobe of the glabella; the postero-lateral angles produced into slender spines, which are terete, very slightly incurved, not much widened at their bases, and in our specimens are about equal in length to one-fourth of the transverse diameter of the head at its base. The posterior margin of the head, near each postero-lateral angle, bends abruptly forward a little, forming a kind of notch or small retreating angle with the backward-projecting spine, and also giving the outer corner of the movable cheek the appearance of being rounded. Eyes narrow, broadly arching outward, narrowness and convexity of curve both increasing posteriorly; their outer margins nearly equidistant from the center and the outer margins of the head, which distance is also about equal to the length of the eye. Glabella distinctly lobed, the furrows extending nearly or quite to its center; frontal lobe much larger than the others, subcircular in outline, prominent, tumid, regularly rounded in front, and a little wider than the remainder of the glabella; anterior, middle, posterior, and occipital lobes of nearly uniform size.

The remainder of the body is unknown, with the exception of single specimens each of the long third pleura of the right side, and one of the others, probably belonging behind the third segment. The long one is broadly and somewhat deeply grooved upon the surface of its inner portion, where the anterior edge of the groove is elevated, the groove becoming shallower and narrower upon the outer portion, and finally disappearing toward the point of the pleura; outer portion of the pleura bending strongly but not very abruptly backward, and ending in a strong, flattened, spine-like point. The other pleura mentioned is grooved like the long one, but the anterior edge of its inner portion is not turned upward, as it is in the other.

The specimens of the collection are all imperfect, consisting only of flattened impressions in shale. Consequently, the character of the crust, the surface-markings or ornamentation, if any existed, and the original convexity of the head are all unknown; but there are indications that the convexity of the head must have been considerable, and that the specimens have been much flattened by pressure. When perfect specimens shall be discovered, they may probably necessitate a modification of the foregoing description, but it is believed that such discovery will not necessitate material change. The specimens of the collection are of various sizes, due to difference in age; the transverse diameter of the head being from one and a half to five and a half centimeters.

This species is nearly allied to *O. Vermontana* Hall, from strata in Northern Vermont, generally referred to the Potsdam epoch; but it differs in many respects, the following being among the more important differences that appear upon comparing our specimens with the figure and original description of that species:—

The frontal lobe of the glabella of our species does not reach the anterior margin of the head by a space nearly equal to one-third the length of that lobe, instead of coming in contact with the frontal margin as in *O. Vermontana*. The anterior ends of the eyes of our species reach forward nearly into contact with the anterior lobe of the glabella, being considerably farther forward than they are represented to reach in the figures of the Vermont species. In our species, the raised marginal rim of the posterior border of the head extends continuously across the occipital lobe of the glabella, but the figure and description of *O. Vermontana* represent no such raised rim. The posterior margin of the head of our species is rounded forward at the postero-lateral angles, while the figure of *O. Vermontana* represents the posterior border of the head as curving backward, and forming sharp, spine-like angles with the lateral margins. The short cheek-spines of that species are represented as widening at the base; in ours, the cheek-spines are longer, more slender, and do not thus widen. The long third pleura of *O. Gilberti* is not bent backward so abruptly as it is in *O. Vermontana*, and the former species seems also to have reached a larger size than the eastern one.

Position and locality.—Strata of the Primordial period, probably of the Potsdam epoch, Pioche, Nevada, and at Ophir City, Oquirrh range, Utah.

Olenellus Howelli Meek.

Plate II, fig. 4 *a* and *b*.

Olenellus Howelli Meek, 1874 (manuscript).
Olenellus Howelli White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 8.

Head massive, semi-oval in outline, strongly convex, the length on the median line being to the greatest breadth about as three to five; exterior margin having a strong, raised border, of nearly uniform width all around, and which is also continuous with the moderately strong spines of the postero-lateral angles of the head; length of the spines about equal to one-half the length of the head on the median line; posterior margin also having a raised border extending on each side from the occipital segment to the base of the spines, but not crossing the glabella upon the occipital lobe; width of this border not uniform like that of the exterior margin, but is widest a little beyond the midlength at each side, and narrowest near the base of each spine, toward which it again suddenly widens, blending with both the spine and the exterior raised border; this widening of the border there rounds the angle between the posterior margin and the spine, and also rounds the postero-lateral angle of that portion of the cheek which is inclosed within the raised borders. A shallow, linear depression extends around the head just within the raised border, giving the broad cheek-surfaces the appearance of being slightly inflated.

Eyes large, very prominent, extending from opposite the anterior furrow of the glabella to nearly opposite the middle of the occipital lobe; the palpebral lobe of each eye blending with the outer ends of the anterior, middle, and posterior lobes of the glabella.

Glabella large, very prominent, distinctly lobed; the furrows, while they are distinct at the sides, are only slightly impressed at the median line; occipital and posterior lobes of about equal size; frontal lobe large, tumid, well defined, extending forward to the shallow, linear depression just within the raised border of the anterior margin of the head, regularly rounded in front, a little wider than the remainder of the glabella, but not higher than the others of its lobes.

Surface apparently smooth but the condition of the specimen is such that this character is not clearly shown. Remainder of the body unknown, the only specimen discovered consisting of a well-preserved head alone. Associated with it, however, the spinous extremity of a pleura was found that possesses the characteristics of similar parts of *Olenellus*, and which probably belonged to an individual of this species.

This species is apparently related to *O. Thompsoni* Hall, from rocks in Northern Vermont referred to the Potsdam epoch, where it is associated with *O. Vermontana;* but it differs in general outline and proportions, and also in many details, as shown by comparison with the figures and original description of that species by Professor Hall. The frontal lobe of the glabella in *O. Howelli* is wider than those behind it, instead of being narrower than the hinder ones, as they are represented to be in *O. Thompsoni.* The details of the exterior and posterior raised margins are different, and the postero-lateral spines are not proportionally so strong in our species as they are represented to be in that one. The occipital furrow in ours does not extend so distinctly across the glabella as it does in *O. Thompsoni*, and the occipital lobe is proportionally wider, and extends farther backward than it does in that species. It is also related to *O. Gilberti*, but differs in general proportions of the head, the details of the exterior and posterior borders, and in the proportional size of the different lobes of the glabella.

As the genus *Olenellus* is held by geologists to mark a distinct and characteristic horizon in American strata, its discovery in that distant locality is peculiarly valuable and interesting. It is also an interesting and significant fact that the two species here described respectively represent in their specific characters the two originally-described species of the genus found associated in the Primordial rocks of Vermont and Canada, as these are found associated in rocks of the same period in Nevada.

The specimens from which the descriptions of the two species of *Olenellus* herein recorded were made are the same that were used by Mr. Meek in his original descriptions and naming of the species.

Position and locality.—Strata of the Primordial period, and probably of the Potsdam epoch, Pioche, Nevada.

VESTIGIA.

Plate I, fig. 6 *a* and *b*.

From the same strata that contain *Cruziana Linnarrsoni* and *C. rustica*, the collections contain some thin pieces of siliceous shale marked by a number of series of minute tracks that were probably made by some small Crustacean or other Articulate. They consist of double rows of slight transverse depressions upon the smooth surface of the shale, with a plain space between each series of the double row, about half as wide as the width of a series, but in some cases the two series of tracks constituting the double row nearly meet in the center. Each separate minute track or depression arches slightly, and, although very narrow, they are each nearly or quite as wide as the spaces between them are. In some portions, each separate depression appears as if it had been twice or thrice impressed with minute organs of locomotion of similar size and shape. The width of the double row is about three millimeters, and the transverse length of each separate impression or track is hardly more than one millimeter. There are about twelve impressions, or separate tracks, in the length of a centimeter.

The tracks pursue a slightly tortuous course; the longest series shown by the specimens in the collection having a continuous length of about six centimeters, but all of them are broken at both ends. No remains have been found associated with them that might indicate the characteristics of the animal that made them; but the narrowness and uniformity of the series, together with the fact that each separate minute track appears to have been repeatedly impressed by a series of similar organs of locomotion, seems to suggest vermiform characteristics, but it does not necessarily follow that the animal was a true worm.

The collections contain no other traces of animal life from these shales, and the formation has been referred to the Primordial period mainly upon stratigraphical grounds.

Position and locality.—Tonto shale, Primordial period; Grand Cañon of the Colorado River, Mohave County, Arizona.

CHAPTER IV.

CANADIAN PERIOD.

PROTOZOA.

CLASS RHIZOPODA.

ORDER FORAMINIFERA.

GENUS RECEPTACULITES Defrance, 1827.

Receptaculites ——— (?).

The collections contain a single fragment only of one of these strange and interesting forms. It is too imperfect for specific characterization, but is noticed here to make the account as complete as possible of the faunal characteristics of the strata which I have referred to the Canadian period. It seems to be a fragment from near the base of one of those broad sac- or urn-shaped species such as have been described by Mr. Billings from strata of the same period in Canada. Both ectorhin and endorhin have been mostly removed by weathering, whereby the open ends of the numerous close-set cylindrical tubes that connected them are exposed.

Position and locality.—Strata of the age of the Quebec group of Canada; Fish Spring, House range, Utah.

RADIATA.

CLASS HYDROZOA.

ORDER HYDROIDA.

FAMILY GRAPTOLITIDÆ.

GENUS PHYLLOGRAPTUS Hall, 1858.

Phyllograptus Loringi White.

Plate III, fig. 1 *a* and *b*.

Phyllograptus Loringi White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 9.

Stipe apparently having the usual quadripartite form of the genus; the foliate expansion having a somewhat irregular elongate-oval outline and a moderately narrow axis. Cellules leaving the axis at different angles with it in different parts of the stipe, ascending along the middle portion so as to form an acute angle with the axis, then sweeping outward with an increasing curvature to the lateral margins, where they are at right angles with the axis, or in some parts of the length of the stipe slightly recurving. Toward the apex, the cellules are less curved and form more acute angles with the axis. Each cellule gradually but slightly increases in size as it extends outward to the margin, where there are thirteen or fourteen in the space of a centimeter. Each cellule is provided at its aperture with a strong, prominent, recurving lower lip, the edges of which in our example, it being compressed, have somewhat the appearance of spine-like appendages. The stipe being broken at the lower end, the shape of that part is known only by inference, and for the same reason the full length has not been accurately ascertained, but it was apparently about four centimeters long; width, at about midlength, one and a half centimeters.

This species has the general aspect of *P. typus* Hall, but it differs from that species in the size of its cells and the character of its cell-apertures. According to Professor Hall, *P. typus* has a maximum of twenty-six cells in the space of an inch, while our species has from thirty-four to thirty-six in the same space. That species is represented as having small mucronate appendages at the cell-apertures, which those of our species are destitute of, but are provided instead with a thickened projecting lower lip.

Dedicated to the memory of Mr. F. W. Loring, who was murdered by the Apache Indians in October, 1871, while a member of one of the exploring parties.

Position and locality.—Strata of the age of the Quebec group of Canada; Fish Spring, House range, Utah.

MOLLUSCA.

MOLLUSCOIDEA.

CLASS BRACHIOPODA.

ORDER LYOPOMATA.

FAMILY LINGULIDÆ.

GENUS LINGULA Brugnière, 1789.

Lingula? manticula White.

Plate III, fig. 2 *a* and *b*.

Lingula? manticula White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 9.

Shell small elongate-subovate or subelliptical in outline, broadest at or a little behind the middle; beaks pointed.

Dorsal valve proportionally wider than the ventral, moderately convex; postero-lateral margins nearly straight, meeting at the beak at an angle of nearly forty-five degrees; beak small, depressed; front margin regularly rounded.

Ventral valve proportionally longer than the dorsal in consequence of the considerable projection of its beak behind that of the dorsal valve; the whole valve, except its prominent beak, corresponding nearly with the whole of the opposite one, but its posterior portion is a little more convex transversely than any part of the other valve is; the beak is more prominent and sharper, and the postero-lateral slopes straighter than they are in the dorsal valve. Surface of both valves having a smooth appearance, but fine concentric lines and obscure radiating striæ are to be seen under a lens.

Length of the dorsal valve represented by figure 2 *a*, Plate III, six millimeters; width, four millimeters. This is the largest valve the collections contain, but it is not improbable that the species attains a larger size.

This species in general aspect resembles *Lingula acuminata* Conrad, from the Calciferous sandstone formation of New York, especially in the narrowness of the posterior portion of the ventral valve and its slender beak; but it is not proportionally so broad anteriorly as that shell is, and in other respects the outline is materially different. The dorsal valve of our shell resembles the figure of a specimen that Professor Hall refers doubtingly to *Lingula mosia*, from the Potsdam formation of Wisconsin (Sixteenth Ann. Regent's Report New York State Cabinet, plate 6, figure 1); but the ventral valve of ours is proportionally longer than that figure, which is understood to represent a ventral valve. If this supposition is correct, that species has proportions materially different from those of ours.

I refer this species with doubt to the genus *Lingula*, because the internal characters of the shell are unknown, and because it is now generally admitted that among the linguloid shells of the older Paleozoic rocks, which were formerly referred to the genus *Lingula* without question, there are really several different genera, all distinct from the recent *Lingula*.

Position and locality.—Strata of the age of the Quebec group of Canada; Schellbourne, Schell Creek range, Nevada.

FAMILY DISCINIDÆ.

GENUS ACROTRETA Kutorga, 1848.

Acrotreta pyxidicula White.

Plate III, fig. 3 *a* and *b*.

Acrotreta pyxidicula White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 9.

Shell minute; marginal outline subcircular or transversely suboval; without observable mesial sinus or fold. Dorsal valve most prominent near the umbo; beak small, depressed, but well defined, hardly projecting beyond the hinge-line; cardinal angles rounded; hinge-line short, nearly straight; lateral and front margins regularly rounded.

Ventral valve obliquely depressed-subconical; apex acute, prominent, and perforated by a minute foramen; margin in front of the hinge-line regularly rounded; area small, triangular, nearly flat, the angles which it forms with the sides of the shell rounded. Surface of both valves smooth, or marked by very fine concentric lines of growth.

Width, two millimeters; length a little less; height a little less than the length.

This species, although so minute, seems to be a well-marked one, and possesses all the usual external characteristics of *Acrotreta*, except that the ventral valve is not so capacious as it generally is in that genus. It differs from *A. gemma* Billings, from strata of the age of the Quebec group in Newfoundland, in the less proportionate height of the ventral valve, and in the absence of a mesial sinus in the dorsal valve.

Position and locality.—Strata of the age of the Quebec group of Canada; Schellbourne, Schell Creek range, Nevada.

ORDER ARTHROPOMATA.

FAMILY STROPHOMENIDÆ.

GENUS STROPHOMENA Rafinesque, 1827.

Strophomena fontinalis White.

Plate III, fig. 4 *a*, *b*, and *c*.

Strophomena fontinalis White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 10.

Shell moderately concavo-convex or nearly flat; outline semi-elliptical; width from one-quarter to one-third greater than the length; width at the hinge-line varying from a little more to a little less than it is just in front of the hinge. Ventral valve slightly convex or somewhat flattened; convexity greatest behind the middle. Dorsal valve slightly concave, and in other respects corresponding with the ventral. Hinge and interior of both valves unknown.

Surface of both valves marked by fine, uniform, rounded, radiating striæ, which increase by bifurcation, and give the surface an appearance similar to that of the well-known *Strophomena fragilis* Hall, from the Devonian strata of New York and other States. Fine concentric striæ are also visible under a lens.

Length, eighteen millimeters; breadth, twenty-four millimeters.

This species resembles *S. recta* Conrad in outline, but the surface-markings are quite different. It also bears a general resemblance to *S. aurora* Billings, but differs in having rounded striæ of uniform size instead of the angular striæ of variable size which that species possesses.

Position and locality.—Strata of the age of the Quebec group of Canada; Fish Spring, House range, Utah.

GENUS ORTHIS Dalman, 1828.

Orthis Electra Billings (?).

Among the collections made at Fish Spring, House range, Utah, from strata of the age of the Quebec group of Canada, are a few imperfect specimens of a species of *Orthis* that is very closely related to *O. Electra* Billings (Paleozoic Fossils of Canada, vol. I, page 79), if it is not identical with it. In outline, convexity, and the fine striation of the surface, our specimens agree closely with it, but the size is considerably greater than that given for *O. Electra*. The width at the hinge-line of the largest specimen is about sixteen millimeters.

MOLLUSCA VERA.

CLASS GASTEROPODA.

SUBCLASS DIŒCA.

ORDER RHIPHIDOGLOSSA.

SUBORDER DICRANOBRANCHIATA.

FAMILY BELLEROPHONTIDÆ.

GENUS BELLEROPHON Montfort, 1808.

Bellerophon allegoricus White.

Plate III, fig. 6 *a*, *b*, and *c*.

Bellerophon allegoricus White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 10.

Shell not above medium size, rather compact, umbilicated; umbilicus very small; aperture expanded, greatest expansion at the sides, giving it a reniform outline; outer volution abruptly convex transversely; lip having a moderately large deep notch in front, of uniform width, the sides being parallel, and rounded at the bottom; of equal width, and continuous with this notch, there is a slightly-elevated, rounded, dorsal band extending along the center of the volution until it enters the aperture. Surface-markings not preserved in any of the specimens of the collection.

Extreme width across the aperture, eighteen millimeters; postero-anterior diameter of the shell, seventeen millimeters.

Although the specimens are imperfect in some respects, they are sufficently well preserved to show that they represent a species quite unlike any other known to me from any of the older Paleozoic rocks.

Position and locality.—Strata of the age of the Quebec group of Canada; Fish Spring, House range, Utah.

CLASS CEPHALOPODA.

ORDER TETRABRANCHIATA.

FAMILY ORTHOCERATIDÆ.

GENUS ORTHOCERAS Breynius, 1732.

SUBGENUS CAMAROCERAS Conrad, 1842.

Orthoceras (Camaroceras) colon White.

Plate III, fig. 5 *a*, *b*, *c*, and *d*.

Orthoceras colon White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 10.

Shell annulated, very slightly tapering; transverse section oval; siphuncle large, peripheral, in contact with one of the broadly-rounded sides, its diameter equal to about one-third the short diameter of the shell; septa smooth; convexity nearly uniform, reaching farther forward at the narrower sides than at the broader ones; annulations broadly rounded, passing sinuously around the shell, the sinuosity being greater upon one of the broad sides than it is upon the other; interspaces nearly corresponding in width and curvature with the annulations. Surface-markings unknown.

Long diameter, eighteen millimeters; short diameter, fifteen millimeters; distance from center to center of the annulations, six millimeters.

The only specimen contained in the collections is the one figured on Plate III. It has the appearance of being slightly curved, as shown in figure 5 *c*, which, if natural, of course removes it from the genus *Orthoceras;* but, as the specimen has been a little compressed at one end, it is thought the curvature is due to that cause alone. If originally straight, as it is thought to have been, it properly belongs to the subgenus *Camaroceras* of Conrad, as is shown by the large peripheral siphuncle.

Numerous annulated species of *Orthoceras* have been published, but the one here described possesses characteristics that seem to clearly distinguish it from them all. Compared with *O. pulchrum* Barrande, it differs in having sinuated instead of direct annulations, an oval instead of a circular transverse section, and in having a larger siphuncle, which is also peripheral instead of central. From *O. annulatum* Sowerby, as figured and described by Barrande (not *Endoceras annulatum* Hall), it differs in its proportionally narrower annulations as compared with the interspaces, its oval instead of circular or nearly circular transverse section, and in its larger and peripheral instead of central siphuncle. From *O. dulce* Barrande, it differs in its oval nstead of circular transverse section, and in its larger siphuncle, which is also peripheral instead of central. From *O. undulostriatum* Hall, it differs in the course of its sinuous annulations, which both species possess, and in its much larger and peripheral instead of central siphuncle. With *O. furtivum* Billings from the Calciferous formation of Canada, it is closely related in the character, size, and position of the siphuncle, but differs in its oval instead of circular transverse section, and also in the direction and character of the annulations.

Position and locality.—Strata of the age of the Quebec group of Canada; Fish Spring, House range, Utah.

FAMILY CYRTOCERATIDÆ.

GENUS CYRTOCERAS Goldfuss, 1833.

Cyrtoceras ——— (?)

Among the collections from strata of the age of the Quebec group, at Fish Spring, House range, Utah, there is a specimen of *Cyrtoceras*, too imperfect for specific characterization, but which resembles in general aspect

C. metellus Billings, from the Quebec strata of Canada. The curvature and proportions are similar to those of that species, and the septa are equally numerous and close-set.

ARTICULATA.

CLASS CRUSTACEA.

ORDER OSTRACADA.

FAMILY CYPRIDINIDÆ.

GENUS LEPERDITIA Rouault, 1851.

Leperditia bivia White.

Plate III, fig. 7, *a*, *b*, *c*, and *d*.

Leperditia bivia White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 11.

Shell not quite equivalve, inflated, the greatest transverse diameter being about midlength and below the middle; obliquely subovate in outline, widest behind the middle; the straight hinge-line about equal in length to two-thirds the entire length of the shell, and ending both posteriorly and anteriorly in a small, distinctly projecting angle, which it forms with the anterior and posterior margins respectively; posterior margin obliquely rounded, and provided with a moderately broad, somewhat flattened border; anterior margin abruptly rounded, having also a similarly-flattened border; the flattening of the borders of both valves and at both ends becoming obsolete upon reaching the ventral margin, which is broadly rounded; ventral border of the left valve bent sharply inward, and even a little upward, producing a narrow, plain, area-like surface there, which tapers to a sharp point at each end, and is nearly equal in length to the hinge-line; ventral border of the right valve not bent inward like that of the left, but the general convexity of the valve extends to the ventral edge. Upon the ventral border of this valve, near its edge, there are two distinct, comparatively large pores, which open divergingly upon the surface; the distance between them being equal to a little more than half the length of the hinge-line. Eye-tubercle not detected. Surface apparently smooth.

This species agrees nearly in size with, and bears a close general resemblance to, *L. Canadensis* Jones, from the Calciferous sandstone formation of Canada; but it may be readily distinguished from that species by the prominent angles at the ends of the hinge-line, the laterally-flattened anterior and posterior borders, the greater convexity below the middle, and by the presence of the two large pores at the ventral border of the right valve.

Position and locality.—Strata of the age of the Quebec group of Canada; Queen Spring Hill, Schell Creek range, Nevada.

Collected by Mr. J. E. Clayton.

ORDER TRILOBITA.

FAMILY ASAPHIDÆ.

GENUS MEGALASPIS Angelin, 1854.

Megalaspis belemnurus White.

Plate III, fig. 9.

Megalaspis belemnurus White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 11.

Pygidium subtriangular in outline, moderately convex transversely, and only slightly convex along the median line; length compared with the width across its anterior end about as fifteen to twenty-two; each outer margin having a wide smooth border, the outline of which is only slightly convex except near the antero-lateral angles, where the convexity increases and the angles are abruptly rounded; anterior margin moderately convex; posterior extremity ending in a short spine-like process; segmentation somewhat indistinct, but is most apparent upon the anterior portion of the axis; trilobation also rather obscure; axis depressed, slightly higher than the adjacent portions of the lateral lobes, its width equal to about one-half the width of a lateral lobe, ending posteriorly in the elevated terminal portion of the pygidium; dorsal furrows moderately distinct upon the anterior half of the pygidium but become obsolete posteriorly; lateral lobes slightly convex, indistinctly defined externally by the broad, nearly flat margina border; their inner sides more clearly defined, especially their anterior portions, by the dorsal furrows. Surface apparently smooth; but this character, as well as the remainder of the body, is unknown.

Length of the pygidium from the front end to the base of the caudal spine, fifteen millimeters; width of the same between the antero-lateral angles, twenty-two millimeters.

This species is closely related to *Asaphus* (*Megalaspis*) *goniocercus* Meek; but it differs from that species in its less distinctly triangular outline, its greater proportionate width, its proportionally narrower axis, and rather more distinct dorsal furrows. In general aspect, the pygidium of our species resembles that of a *Dalmanites*, but the obscure trilobation and segmentation separate it from that genus. It has not so complete a consolidation of the component elements of the pygidium as *Asaphus* has; and no striation of the under surface of the marginal border has been observed, such as is common in the genus *Asaphus*.

Position and locality.—Strata of the age of the Quebec group of Canada; Queen Spring Hill, Schell Creek range, Nevada.

Collected by Mr. J. E. Clayton.

FAMILY ———— (?).

GENUS DICELLOCEPHALUS Owen, 1852.

Dicellocephalus ? flagricaudus White.

Plate III, fig. 8 *a* and *b*.

Dicellocephalus flagricaudus White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 12.

Pygidium contracted-fan-shaped; lateral lobes each consisting of three segments directed backward; the inner one of each side lying close to the dorsal furrow, nearly parallel with the axis of the body or converging a little posteriorly, and becoming obsolete upon each side of a small, but comparatively wide, sloping border that extends around the posterior end of the axial lobe.

The middle pair of segments commence at the dorsal furrow of each side respectively near the anterior end of the pygidium, bend abruptly, and extend backward parallel with the first, and project beyond the border as converging posterior spines. The third and outer pair of segments commence anteriorly at the dorsal furrows, where they are very narrow, extend outward a little, then curving abruptly backward they lie parallel with the others and form raised lateral margins of considerable but unequal width to the pygidium, and thence they extend posteriorly as an outer pair of converging spines. Axis prominent, especially at its apex, where it terminates in a moderately distinct angle, about one-quarter wider anteriorly than posteriorly, well defined by the nearly straight dorsal furrows, and marked by five or six distinctly defined segments, which cross it almost transversely, but with a slightly sinuous course.

Length of the pygidium along the median line, seven millimeters; greatest transverse diameter, nine millimeters.

The collections contain only the pygidium of this species, and I have therefore referred it doubtingly to *Dicellocephalus*, although it might perhaps, with equal propriety, be referred to *Amphion*. It has a general resemblance to the pygidium of *D. magnificus* Billings, and a still closer resemblance to *D.? cora* Billings, from the Quebec group of Canada.

Position and locality.—Strata of the age of the Quebec group of Canada; Schellbourne, Schell Creek range, Nevada.

CHAPTER V.

TRENTON PERIOD.

RADIATA.

CLASS HYDROZOA.

ORDER HYDROIDA.

FAMILY GRAPTOLITIDÆ.

GENUS GRAPTOLITHUS Linnæus, 1736.

SUBGENUS CLIMACOGRAPTUS Hall, 1865.

Graptolithus (Climacograptus*) ramulus White.

Plate IV, fig. 3 *a*, *b*, and *c*.

Graptolithus (*Climacograptus*) *ramulus* White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 13.

Stipe slender, bifurcating; bearing cells upon both edges below the bifurcation and upon one edge only (the outer) above that point, so that each series of cells is continuous from the common, proximal, extremity to the distal extremities of the branches respectively. The body of the stipe throughout is moderately thin and flat, but the cells are inflated so that their transverse diameter is considerably greater than the thickness of the stipe; cells moderately large, each bearing upon its outer wall about mid-

*I am inclined to think that the two groups into which Professor Geinitz has divided his genus *Cladograpsus* should be designated by separate generic or subgeneric names. In that case, it seems proper that his first group should retain the name *Cladograpsus*, which would replace *Climacograptus* of Professor Hall, while the second group seems to agree with *Didymograpsus* of Professor McCoy. Possibly, however, the peculiar character of the cells of the species above described may hereafter require a new generic designation.

height a slender outward-projecting spine. The cells are of peculiar shape, as shown in the enlarged figures on Plate IV, and their apertures appear to have been lateral, but of this I am not entirely satisfied. If they are so, it is rather remarkable that they are all upon one side, in view of the fact that bilateral symmetry of the stipe is so prevalent throughout the family.

This species has the general aspect of *G. ramosus* Hall from the dark shales at Norman's Kill near Albany, New York, and before its microscopic examination it was supposed to be identical with it. It is found, however, to differ very materially in the form of its cells and the character of the stipe, as may be seen by comparing our figures with those of *G. ramosus* on Plate A, Decade II, Geological Survey of Canada.

Among these differences, there is one at least that seems to modify its relation to the subgenus *Climacograptus*, and especially to that section of it to which *G. ramosus* is assigned by Professor Hall. This is the presence of inflated cells of irregular form, projecting from the general surface of the stipe, instead of having the cells short and square, and hollowed out of the body of the stipe,—characters which are understood to distinguish *Climacograptus*. Among the specific differences between our species and *G. ramosus* are the different proportions and shape of the cells, the presence of spines upon all of them in our species instead of upon a part only, and the position of the spines about midway instead above the cell-aperture as in that species.

Position and locality.—Shales, probably of the age of the graptolitic shales at Norman's Kill near Albany, New York; five miles north of Belmont, Nevada, where it is associated with the three following-described species.

Subgenus DIPLOGRAPTUS M'Coy, 1850.

Graptolithus (Diplograptus) hypniformis White.

Plate IV, fig. 4 *a* and *b*.

Graptolithus (*Diplograptus*) *hypniformis* White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 12.

Stipe simple, slender; sides flat; edges nearly straight and nearly parallel; the increase in width from the proximal or basal end toward the distal end being very slight, except near the base; serratures deep, narrow, sharply rounded or angular at the bottom; inner and outer sides both rising at acute angles with the axis of the stipe, those of adjacent cells joining together to form moderately long, slender, mucronate points, which are directed strongly upward between the cells. At the basal end of the stipe small, downward-diverging points are sometimes seen, such as those possessed by *G. Whitfieldi* Hall, and other allied species; like those species also, ours has a slender, thread-like axis, passing longitudinally through the center of the stipe and extending beyond the distal cells; serratures, or cells, about twelve in the length of a centimeter, but they have the aspect of being somewhat more numerous, because of the narrowness of the cells occasioned by the acuteness of the angle which the cell-axes form with the axis of the stipe. Exterior width of the stipe between the mucronate points of each side often less than two millimeters, and seldom more. Length of stipe, from one to three centimeters.

Upon the pieces of graptolitic shale in the collections are numerous stipes doubtless belonging to this species, but most of them have their details of structure so far obscured that it is difficult to distinguish them; the mucronate points between the cells, being delicate, are often removed, in which case the serratures have a blunted appearance. The more perfect stipes have somewhat the aspect of portions of those of *Hypnum*, or other related mosses, which circumstance has suggested the specific name.

This species is related to *G. Whitfieldi* Hall from the graptolitic shales at Norman's Kill near Albany, New York; but the prolongations of the cell-walls are mucronate, pointing upward, in ours, and not setæform, pointing outward, as in that species. Ours is also a smaller and more slender species, and has proportionally narrower cells.

Position and locality.—Shales, probably of the age of those at Norman's Kill, near Albany, New York; five miles north of Belmont, Nevada, where it is associated with the last described, and also with the two following species.

Graptolithus (Diplograptus) pristis Hall, (?).

Plate IV, fig. 2 *a* and *b*.

? *Prionotus pristis* Hisinger, 1837, Lethæa Suecica, 114.
Graptolithus pristis Hall, 1847, Paleontology of New York, i, 265.

Stipe flattened; outline of the broader sides sublinear or very elongate-oblanceolate; cells moderately large, their upper sides or apertures being transverse and the outer sides sloping directly downward and inward gives the edges of the stipe a distinctly dentate appearance as it is compressed in the shale. Like related species, this has a slender thread-like axis passing longitudinally through its middle and extending beyond the distant cells.

In my preliminary report on these collections, this species was confounded with *G. quadrimucronatus* Hall?; fragments of the two species being mingled in the same pieces of shale. This circumstance modified my description of that species, but the correction is made in this report from the study of more perfect specimens. Our examples show some differences from the typical forms of *G. pristis*, but they correspond so nearly with them that I do not at present feel warranted in proposing a separate specific name.

Position and locality.—Shales of the Trenton period, probably of the Utica epoch; five miles north of Belmont, Nevada, where it is associated with the two species last described, and also with the following one.

Graptolithus quadrimucronatus Hall (?).

Plate IV, fig. 1 *a* and *b*.

Graptolithus quadrimucronatus Hall, 1865, Geol. Surv. Canada, decade ii, 144.
Graptolithus quadrimucronatus? White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 13.

Stipe quadrilateral, transverse section oblong, gradually but slightly increasing in diameter from the proximal or basal end to about midlength, where the maximum size is reached; cells opening on the two narrower sides of the stipe; their apertures opening obliquely upward, being narrow, transverse, four-sided slits of uniform size, about half as wide as the interspaces, their length equaling the full diameter of the stipe; the outer corner of each cell-aperture provided with a minute projecting point.

The specimens of the collection are all compressed upon shale; but there are among them examples of stipes compressed in the various postures they happened to assume when prostrated. These enable us to make out the structure as above indicated with comparatively little difficulty. Without bearing in mind the quadrilateral form of the stipe, one may mistake the confusion of details which the laterally-compressed specimens exhibit for examples of two stipes of an ordinary *Diplograptus* lying parallel and compressed together; but the adjustment and uniformity of the parts show that they all belong to a single body.

This species, so far as can be determined from the specimens of the collection, is so closely like *G. quadrimucronatus* Hall, from the "Utica slate formation, Lake Saint John, east from Blue Point", that I prefer to assign it provisionally to that species rather than to a new one. Our specimens, however, are more delicate and slender, and the mucronate points much less conspicuous than they are in the typical forms. The cells are also a little more prominent and the cell-apertures proportionally wider vertically.

Position and locality.—Shales, probably of the age of those at Norman's Kill, near Albany, New York; five miles north of Belmont, Nevada, where it is associated with the three species last described.

CLASS ACTINOZOA.

ORDER ZOANTHARIA.

FAMILY FAVOSITIDÆ.

GENUS MONTICULIPORA d'Orbigny, 1850.

Monticulipora Dalii Edwards and Haime.

Plate IV, fig. 5.

Chætetes Dalii Edwards et Haime, 1851, Monographie des Polypiers Fossiles, 266.

Coral dendroid; the branches cylindrical, six or eight millimeters in diameter; surface marked by small, slightly-raised mammillations, distant two or three times their own diameter from each other; calyces subequal in size, about one-quarter of a millimeter in diameter.

Our specimen presents no material difference from the figures and description given by Edwards and Haime, and it evidently belongs to that species. Their type-specimens were obtained by de Verneuil from strata of the Trenton period in Ohio.

Position and locality.—Strata of the age of the Trenton period; Silver Cañon, Pahranagat range, Nevada.

GENUS FAVOSITES Lamarck, 1816.

Favosites ——— (?).

Among the collections are some specimens of *Favosites* that were obtained from strata of the Cincinnati epoch, both at Silver City and Upper Mimbres Mining Camp, New Mexico. They have been mostly silicified, by which change their wall-pores and other minute details of structure have been obliterated.

The specimens have the general aspect of *F. Gothlandica*, and, indeed, of several other admitted species also. But in view of the small number of characteristics possessed by even well-preserved specimens of this genus that may be relied upon for specific discrimination, and also of the imperfect condition of the specimens contained in the collections, no specific designation is given them.

FAMILY THECIDÆ.

GENUS FAVISTELLA Hall, 1847.

Favistella stellata Hall.

Plate IV, fig. 6 *a*, *b*, and *c*.

Favistella stellata Hall, 1847, Paleontology of New York, i, 275.
Columnaria alveolata Edwards et Haime, 1851, Monographie des Polypiers Fossiles, 309.
Favistella stellata Hall, 1862, Geol. Wisconsin, i, 430.
avist ella stellata Dana, 1862, Manual Geol., 220; ib., 2d ed., 1874, 204.

Coral forming an irregular compact or subhemispherical mass; cells varying in diameter from two to four millimeters, the average being about three millimeters; the number of sides of each cell also varying from four to seven; diaphragms numerous, flat, or nearly so, at their central portions, but are bent downward a little at their margins, where they join the vertical walls, which gives them the appearance of being slightly convex; some ten or twelve rays, or dissepiments, extend upon the surface of each diaphragm, from the walls to its center; walls well developed and vertically striated as if by undeveloped rays.

I am unable to perceive any specific difference between the specimens contained in the collections and those which I have collected from the localities that furnished Professor Hall with the type-specimens of the species.

Not having the means at hand for making a critical investigation of the grounds upon which Edwards and Haime referred this species to *Columnaria alveolata* Goldfuss, rejecting both the genus and species as established by Professor Hall, I make use of the names given by the last-named author. I do this with little hesitation, not only for the reason just stated, but also because the fossil under consideration is widely known and generally recognized by that designation among American geologists.

The specimens of the collection are all silicified, by which means they have lost some of their finer markings and details of structure; but a few of the cells are in a fine state of preservation.

Position and locality.—Strata of the Trenton period, Cincinnati epoch; Silver City, New Mexico.

FAMILY CYATHOPHYLLIDÆ.

GENUS ZAPHRENTIS Rafinesque et Clifford, 1820.

Zaphrentis ——— (?).

Some specimens of *Zaphrentis* were also obtained from the strata of the Cincinnati epoch, at Silver City, New Mexico. They are either too imperfect or possess too few characters to distinguish them specifically, and they are noticed only for their generic value in a faunal summary of the strata of that region that I have referred to the Trenton period.

MOLLUSCA.

MOLLUSCOIDEA.

CLASS BRACHIOPODA.

ORDER ARTHROPOMATA.

FAMILY STROPHOMENIDÆ.

GENUS STROPHOMENA Rafinesque, 1827.

Strophomena filitexta Hall.

Plate IV, fig. 8.

Leptæna filitexta Hall, 1847, Paleontology of New York, i, 112.
Strophomena filitexta Hall, 1859, 12th Reg. Rep. N. Y. State Cab., 70.
Strophomena filitexta Meek, 1873, Paleontology of Ohio, i, 83.

Shell a little above medium size compared with other species of the genus; concavo-convex, semi-oval or subsemicircular in outline; widest at the hinge-line, or, in rare cases, a trifle narrower there than it is a little farther forward; sides generally forming an angle of about forty or forty-five degrees with the hinge-line; lateral and front margins continuously rounded, with a nearly semicircular curve.

Dorsal valve depressed or flattened in the umbonal region, but somewhat regularly arching from that part to the front and lateral margins; beak hardly distinguishable as such; area very narrow, projecting directly backward.

Ventral valve broadly concave, except near the beak, where it rises into a slight convexity; beak small, not prominent; area moderately high, its posterior or outer border sloping a little laterally but not forming an acute angle at the hinge-extremity with its cardinal or inner margin; foramen triangular and closed by a prominent pseudo-deltidium; hinge-teeth well developed; dental laminæ continuous from the bases of the teeth with a prominent ridge, which almost or entirely encircles the concave depression occupied by the muscular scars; this depression sometimes having a narrow ridge extending longitudinally through its middle; cardinal margin of the area sharp; anterior and lateral margins of the valve thickened and roughened by the vascular markings, which are much less distinct within the thickened border than they are upon it.

Surface of both valves marked by fine, close-set, radiating striæ, often of somewhat unequal size, the smaller ones being those that are implanted at various distances from the beak between those that are continuous from it to the margins; under a lens, the radiating striæ are seen to be finely crenulated by the crossing of numerous delicate concentric striæ.

Compared with authentic specimens of *S. filitexta*, and also with those of associated species to which it is closely related, our specimens correspond most nearly with those of the species to which they are here referred, although they present some slight differences.

Length, twenty-two millimeters; breadth, thirty-four millimeters.

Position and locality.—Strata of the Trenton period, Cincinnati epoch; Silver City, New Mexico.

GENUS LEPTÆNA Dalman, 1828.

Leptæna sericea Sowerby (?).

Plate IV, fig. 7.

Among the fossils collected at Silver City, New Mexico, from strata that are unmistakably referable to the Cincinnati epoch, are a few imperfect specimens of *Leptæna* that I refer with some doubt to the species generally recognized in America as *L. sericea* Sowerby. The specimens are too imperfect to base a specific description upon, but enough is shown to indicate that if they are not specifically identical with *L. sericea*, they belong to a closely-related and representative species.

GENUS ORTHIS Dalman, 1828.

Orthis occidentalis Hall.

Plate IV, fig. 11 *a* and *b*.

Orthis occidentalis **Hall, 1847, Paleontology of New York, i, 127.**
Orthis sinuata **Hall, ib., 128.**
Orthis subjugata **Hall, ib., 129.**
Orthis occidentalis **Meek, 1873, Paleontology of Ohio, i, 96.**

Shell moderately large, suboval or subquadrate in outline, the transverse diameter being greater than the longitudinal; dorso-ventral diameter comparatively small in young shells, but it increases with age, so that some old shells are very ventricose; hinge-line sometimes a little less than the greatest width of the shell, but generally about equaling it; usually, the antero-lateral margins are regularly rounded and the front a little emarginate; postero-lateral margins generally almost straight from about the mid-length of the shell to the extremities of the hinge-line, with which they form more or less distinct angles.

Dorsal valve more convex than the ventral, even in the young, and it increases in convexity with age more than the ventral valve does; greatest convexity at or behind the middle, an indistinctly-defined longitudinal depression, or mesial sinus, is observable in many shells, but in some it is absent, even at the front margin, and is represented only by a slight flattening of the valve in the visceral region; umbo prominent; beak abruptly incurved; area moderately wide in the middle, narrowing to acute points at the extremities of the hinge-line, concave transversely; foramen broad at base, triangular.

Ventral valve broadly convex, convexity greatest near the beak; sides very slightly convex transversely; mesial sinus scarcely defined on the posterior half of the valve, but in front it consists of a broad, usually very shallow depression, which becomes obsolete about the middle of the valve; beak moderately prominent; area a little wider than that of the dorsal valve, and, like that area, it ends in acute angles at the extremities of the hinge-line; this area less arcuate than the other, sometimes arching a little backward, sometimes vertical with the plane of the valve, and sometimes inclining a little forward; foramen triangular, a little higher than wide, extending to the apex of the beak.

Surface of both valves marked by distinct, prominent, radiating striæ, which increase both by implantation and bifurcation, and are crossed by a few concentric lines of growth.

Mature specimens average about two and a half centimeters in length and three centimeters in breadth. The more gibbous specimens of that size sometimes reach nearly two and a half centimeters in dorso-ventral diameter.

Several varieties of *O. occidentalis* have been described as distinct species. Those of the collections agree well with the typical forms of the species, but it is not unlikely that future examinations of the strata from which they were collected will reveal associated varietal forms similar to those of the typical localities. This shell is one of the most common of those which characterize the rocks of the Cincinnati epoch, having been found in strata of that age in Ohio, Indiana, Illinois, Iowa, and Wisconsin, at which places it is understood to prevail in, if it is not confined to, the upper part of the group.

Position and locality.—Strata of the Trenton period, Cincinnati epoch; Silver City, Nevada.

Orthis testudinaria Dalman (?).

Associated with the foregoing at Silver City, New Mexico, some imperfect specimens of an *Orthis* were obtained that very closely resemble *O. testudinaria*, but they are not sufficiently perfect to allow of a satisfactory determination of their specific identity. Their association in the strata there with species that are undoubtedly identical with the common associates of *O. testudinaria* elsewhere adds force to the supposition that our specimens belong to that species.

Orthis plicatella Hall (?).

Plate IV, fig. 10 *a, b, c,* and *d.*

Orthis plicatella Hall, 1847, paleontology of New York, i, 122.
Orthis plicatella Meek, 1873, paleontology of Ohio, i, 108.

Shell rather small suboval or somewhat semi-elliptical in outline, wider than long; length of hinge-line generally a little less than the greatest breadth of the shell; sides regularly rounded to the front, which is broadly rounded with an elliptical curve.

Dorsal valve not quite so convex as the ventral, most prominent about the middle; beak depressed; area directed backward, narrow at the middle, and diminishing to a point at each hinge-extremity; foramen triangular, broad at its base, comparatively large; muscular scars not distinctly defined, but are separated by a comparatively broad, slightly-raised, medial ridge; cardinal process small, narrow, wedge-shaped, the larger end inward, not filling the foramen; cardinal sockets small; brachial processes moderately strong, supported by a thin lamina in young shells, and by a still greater thickening of shell-substance beneath them in older ones.

Ventral valve gently arching from beak to front, and also from side to side; greatest convexity near the beak, which is abruptly pointed and projects backward beyond the hinge-line; area wider than that of the dorsal valve, and like that area it diminishes to a point at each extremity of the hinge; foramen triangular, extending to the apex of the beak.

Surface of both valves marked by strong, elevated plications, which are slightly flattened, or have a narrow linear depression along the back, each interspace also having a corresponding slender, slightly-raised line along its middle. So far as observed, all the plications extend without interruption from the umbonal region of each valve to the margins. The plications are shown distinctly upon the inner surface of the valves, especially at the margins, where also slight linear depressions are seen that mark the places of the raised lines between the plications on the outer side. Very fine concentric striæ are visible under a lens upon the outer surface, which, in consequence of erosion probably, are usually more distinct between the plications than upon them.

This shell is referred with doubt to *O. plicatella* Hall. It agrees with that shell in general characters, and yet it presents differences that are at least as great as those which separate *O. fissicosta* Hall from *O. plicatella*. It is also much like *O. tricenaria* Conrad in some of its features, but seems to differ from that shell as much as from *O. plicatella*. The differences from the latter are the continuity of all (?) the plications from the umbonal region to the margin without bifurcation or implantation, the slight flattening or depression of the back of each plication, and the presence of the slightly-raised lines at the bottom of the interspaces. Since the species is known to be a variable one, I am disposed to regard these differences as only varietal until further comparisons can be made.

Length of one of the largest specimens in the collection, fifteen millimeters; breadth, eighteen millimeters; distance from center to center of the plications at the front margin, about one and a half millimeters.

Position and locality.—Strata of Lower Silurian age, probably of the Trenton period; Fossil Butte, near Hico, Nevada.

Orthis biforata Schlotheim, var. **lynx.**

Plate IV, fig. 9 *a* and *b*.

Shell nearly equivalve; width exceeding the length; hinge-line varying in length from a little greater to a little less than the greatest width of the shell, usually a little less; cardinal extremities generally more or less prominent in either case; cardinal area present and nearly alike in both valves; they are narrow, well defined, each having a triangular foramen; dorso-ventral diameter varying with age from equal to one-half the transverse diameter to the full extent of the same; in the latter case, the shells have a compact subglobose form.

Dorsal valve having a prominent, well-defined mesial fold, sometimes a little rounded but often quite angular, narrow, but distinct at the beak, and rapidly increasing in width toward the front; lateral portions convex transversely, and regularly arching from front to rear; beak not prominent, but arching over the area, and nearly meeting its fellow of the opposite valve.

Ventral valve about equally capacious with the dorsal; convexity of its sides similar to that of the sides of the dorsal valve, having a deep sinus corresponding with the elevated mesial fold of the other valve; its beak also similar in size, prominence, and incurvature to that of the dorsal valve.

The surface of each valve is marked by from eighteen to twenty-six strong, usually angular, plications, either three or four of which are at the bottom of the mesial sinus, and either four or five of them upon the mesial fold. The plications at each side of the mesial fold and sinus are similar in character to the others; all being usually simple, or continuous from the beak to the margin.

Length, about twenty-five millimeters; breadth, about thirty-three millimeters.

Several varieties of this exceedingly variable species, both in this country and Europe, have been described as distinct species. Its geographical distribution being very great, and notices and descriptions of it having been published at various times and places during more than one hundred and fifty years, its synonymy has attained unusual magnitude and diversity.

It is too voluminous for transscription here, and the reader is referred to the great works of Davidson on the Fossil Brachiopoda for the most complete exhibition of it yet published. The specimens contained in the collection are all referred to the variety generally known as *Orthis lynx* Eichwald.

Position and locality.—Lower Silurian strata of the Cincinnati epoch; Silver City, New Mexico, where it is associated with equally well-known forms of that epoch.

FAMILY RHYNCHONELLIDÆ.

GENUS RHYNCHONELLA Fischer, 1809.

Rhynchonella argenturbica White.

Plate IV, fig. 12 *a*, *b*, *c*, *d*, and *e*.

Rhynchonella argenturbica White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 14.

Shell somewhat less than medium size, compact, subtrihedral in outline; length and width nearly equal; maximum height in old shells nearly equal to the width; postero-lateral margins somewhat straightened or slightly convex; rostral angle from forty to forty-five degrees; antero-lateral margins rounded; front, viewed from the dorsal or ventral side, either sinuous or truncate.

Dorsal valve more convex than the ventral, abruptly arching behind the middle; break strongly incurved; mesial fold very prominent, distinctly defined even to the umbo, divided into either three or four prominent angular or sharply-rounded plications; sides regularly arching to the margins, both longitudinally and transversely, but become somewhat laterally flattened near the beak; each side marked by from four to seven plications, those nearest the mesial fold being of about the same size as those upon it, but they become smaller toward, and obsolete upon, the postero-lateral margins.

Ventral valve less capacious than the dorsal, and also less strongly arched; beak prominent; mesial sinus deep, occupying about one-half the width of the shell at the front margin, its sides abrupt and its bottom bearing either two or three plications like those of the dorsal fold; sides sloping away from the edges of the sinus with less convexity than the sides of the dorsal valve have, and become laterally compressed near the beak; plications about seven on each side of the sinus, becoming smaller toward, and finally obsolete at, the postero-lateral regions. Both valves have the plications distinctly defined to the beaks, and, being sharply angular at the front, they give the margin there a sharply zigzag appearance. Besides the plications, the surface of both valves is marked by regular and distinct lines of growth, which appear more prominent upon the plications than between them, giving them a delicately-knotted or crenulated appearance in some shells.

Length and breadth, each about ten millimeters; height, about eight millimeters.

Separated valves of this species somewhat resemble those of *R. subtrigonalis* Hall, and also, to a less extent, *R. Anticostiensis* Billings. From the first, it differs in its more compact form and its more elevated mesial fold; from the latter it differs, in similar particulars, and also in its greater approach to an angular outline.

Position and locality.—Lower Silurian strata of the Cincinnati epoch; Silver City and Upper Mimbres Mining Camp, New Mexico.

CLASS CONCHIFERA.

ORDER HETEROMYARIA.

FAMILY MYTILIDÆ.

GENUS MODIOLOPSIS Hall, 1847.

Modiolopsis ——(?).

Among the collections made at Upper Mimbres Mining Camp, New Mexico, are some specimens of a Conchifer that evidently belong to the genus *Modiolopsis* Hall. They are too imperfect for specific characterization, and are noticed only for their generic value in stratigraphical determinations, and for the purpose of giving a full account of the fossils collected at that interesting locality.

CLASS GASTEROPODA.

SUBCLASS DIŒCA.

ORDER RHIPHIDOGLOSSA.

SUBORDER PODOPHTHALMA.

FAMILY MACLURÆIDÆ.

GENUS MACLUREA Le Sueur, 1818.

Maclurea ——— (?).

On Amargosa range, at the head of Amargosa Desert, Nevada, a single specimen of *Maclurea* was found in a mass of rock not *in situ*. Like the species last noticed, it is too imperfect for specific determination, and is noticed here only because of the value the genus possesses in stratigraphical determinations. The mass of rock in which it was found had not probably been far removed from its original position, and therefore the presence of Silurian strata in that neighborhood is inferred.

FAMILY PLEUROTOMARIIDÆ.

GENUS RAPHISTOMA Hall, 1847.

Raphistoma trochiscus Meek.

Plate IV, fig. 13 *a*, *b*, and *c*.

Euomphalus (*Raphistoma?*) *trochiscus* Meek, 1870, Proceed. Phila. Acad. Sci., 61.

Shell small, sublenticular; spire very slightly convex; suture not distinct; volutions three or four, flattened-convex both above and below, thin and sharply rounded at the outer side; inner or umbilical side not so sharply rounded as the outer; the inner third of the upper side impressed to receive the outer portion of the broadly-rounded lower side of the next volution within. The inner edges of the volutions are separate from each other within the umbilicus, but the outer edge of each is so nicely joined upon the next outer one that the convexity of the outer part of the upper side of each volution forms a part of the continuous convexity of the spire.

Width of the umbilicus about equal to the transverse diameter of the aperture, which is a little greater than one-third of the full transverse diameter of the shell.

Transverse diameter of the shell, nine millimeters; height of same, two and a half millimeters.

This shell differs slightly from the species as described and figured by Mr. Meek (*loc. cit.*), but it is probable that it is not specifically different.

Position and locality.—Silurian strata, probably of the Trenton period; Ewell's Spring, Arizona (lower horizon).

CHAPTER VI.

CARBONIFEROUS AGE.

SUBCARBONIFEROUS PERIOD.

RADIATA.

CLASS ACTINOZOA.

ORDER ZOANTHARIA.

FAMILY FAVOSITIDÆ.

GENUS FAVOSITES Lamarck, 1816.

Favosites divergens White and Whitfield.

Plate V, fig. 4.

Favosites ——— White and Whitfield, 1862, Proc. Boston Soc. Nat. Hist.; viii, 306.
Favosites divergens White and Whitfield, 1862 (manuscript).
Favosites divergens Winchell, 1865, Proc. Acad. Nat. Sci. Phila., 112.
Favosites Whitfieldi White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 15.

Coral irregularly flattened-convex or subhemispherical; cells abruptly diverging from the base, increasing interstitially; apertures unequal in size, the smaller ones being those of beginning interstitial cells; vertical walls comparatively strong; diaphragms thin, about three within a space equal to the diameter of a cell. Diameter of cells from two to three millimeters.

The only specimen which the collection contains is silicified and partly imbedded in limestone, so that the finer details of structure have been obscured; but it is sufficiently perfect to indicate with little or no doubt its identity with *F. divergens*. So far as I am aware, no other species of this genus has been discovered in the Subcarboniferous rocks of North America, nor in any rocks of later than Devonian age. This statement is made upon the supposition that *Favosites? mancus* Winchell from the Goniatite limestone of Indiana is not a true *Favosites*. The type-specimens of this species were obtained from the Subcarboniferous strata at Burlington, Iowa, where it is rare. When the description of the species was first published, the specific name was inadvertently omitted, but was added in manuscript to the copies of the memoir that were separately distributed. When publishing the preliminary report upon these collections, it was my intention to compliment my friend by giving his name to the species; but, finding that the manuscript name had been used in the publications of Professor Winchell, I erased the personal name and restored the original one, but the the typographical correction was inadvertently omitted.

Position and locality.—Strata of the Subcarboniferous period; Ewell's Spring, Arizona (upper horizon), where it is associated with the two following species.

GENUS SYRINGOPORA Goldfuss, 1826.

Syringopora Harveyi White (?)

Among the fossils collected from the Subcarboniferous strata at Ewell's Spring, Arizona (upper horizon), there are a few examples of *Syringopora.* Their specific characters, indefinite enough in the most perfect specimens of the genus, are obscured by being imbedded in hard siliceous limestone. They closely resemble *S. Harveyi* White from the Kinderhook formation of the Subcarboniferous period at Burlington, Iowa, and, as no other species of the genus is known to me in that horizon, they are referred to the species named.

CLASS ECHINODERMATA.

ORDER BLASTOIDEA.

FAMILY PENTREMITIDÆ.

GENUS GRANATOCRINUS Troost, 1850.

Granatocrinus lotoblastus White.

Plate V, fig. 3 *a* and *b*.

Granatocrinus lotoblastus White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 15.

Body subelliptical in outline by side-view; greatest breadth about the middle; distinctly but not very deeply pentalobate at the base, truncate at top; base depressed; basal plates very small; radial plates apparently very short, and embracing only the lower extremities of the pseud-ambulacral areas; interradial plates long and narrow, apparently reaching the summit; a comparatively shallow vertical furrow extending along the middle of each; pseud-ambulacral areas prominent, narrow, reaching down to, or below the plane of, the basal plates.

Our only example is silicified and partly imbedded in siliceous limestone, whereby the finer details of structure and ornamentation, including the structure of the parts at the anal side of the summit, are obscured; but the more conspicuous features are sufficient to indicate its specific separation from any similar form known to me.

Height, nine millimeters; transverse diameter, seven millimeters.

In general aspect, this little *Granatocrinus* is much like *G. melo* (=*Pentremtes melo* Owen and Shumard) from the Subcarboniferous strata at Burlington, Iowa; but it differs from that species in its less robust form, and in not possessing the distinct longitudinal lobes that suggested to those authors its specific name.

In that species also, the pseud-ambulacral areas are more or less depressed below the general surface of the interradial plates, while in ours those parts are the most prominent portions in the outline of a transverse section of the body. If the generic identification of this fossil as distinct from *Nucleocrinus* is correct, as it is believed to be, there seems to be no reason for questioning the Subcarboniferous age of the strata containing it, since the genus as thus restricted is understood to be confined to strata of that period alone. The Subcarboniferous age of the strata is also indicated by other types of that period associated with this species.

Position and locality.—Strata of the Subcarboniferous period; Ewell's Spring (upper horizon), Arizona.

ORDER CRINOIDEA.

FAMILY PLATYCRINIDÆ.

GENUS PLATYCRINUS Miller, 1821.

Platycrinus ——— (?).

Plate V, fig. 2.

Upon the weathered surface of a piece of limestone in the collections, there are three or four more or less imperfect Crinoids. They are partly imbedded in the limestone, and partly defaced by weathering. One of these is a *Platycrinus*, as shown by characters other than the body-plates, the exact outlines of which are obscured by the injury the specimen has suffered. The outline of the calyx is shown, however, being broad cup-shaped, the base slightly depressed at the middle; arms bifurcating two or three times; branches of arms slender; the whole upper part of the body prolonged into a proboscidiform dome, which has a height equal to about three times that of the calyx, and stands erect between the arms; stem slender, composed of joints of unequal size.

Breadth of the calyx about eight millimeters; height, five millimeters; height from base of the calyx to the top of the proboscidiform dome, two centimeters; the arms were capable of being extended nearly a centimeter farther. The apparent breadth of the calyx has possibly been increased a little by pressure; but the general proportions have evidently not been much changed.

This species is a delicate one in all its parts. Except that it is not nearly so rubust, nor so large, it resembles *P. lævis* Miller, as figured by de Koninck and le Hon (Recher. Crinoides du Terr. Carb. de la Belgique). Judging from the general features of the fossil and such details as its condition allows of being observed, it seems to belong to an undescribed species, but of this I am not entirely satisfied. In case the discovery of more perfect specimens should show the species to be new, I propose for it the name of *P. vexabilis.*

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada.

FAMILY ACTINOCRINIDÆ.

GENUS ACTINOCRINUS Miller, 1821.

Actinocrinus viaticus White.

Plate V, fig. 1.

Actinocrinus viaticus White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 16.

Body below the arms broadly turbinate; arms slender, somewhat flattened laterally, apparently numbering thirty in all, the two full rays and one-half of another shown by the specimen bearing such proportionate numbers. The appearance of branching of the arms begins below the periphery of the body, where, starting as if for simple pairs, they almost immediately bifurcate, the two inner branches of the two pairs thus formed again bifurcating at or just beyond the periphery, the two outer branches of each original pair remaining simple. Surface of the body-plates marked by sharp, radiating ridges, which give the whole surface below the arms a confused, cancellated appearance.

Breadth of the body at its periphery, about eighteen millimeters.

The body of this species resembles in general aspect that of *A. proboscidialis* Hall, and also that of *A. asperimus* Meek and Worthen, both from the Subcarboniferous limestone at Burlington, Iowa; but it differs from both in shape, in its more delicate surface-ornamentation, and in the different character and branching of the arms.

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada.

MOLLUSCA.

MOLLUSCOIDEA.

CLASS BRACHIOPODA.

ORDER ARTHROPOMATA.

FAMILY PRODUCTIDÆ.

GENUS PRODUCTUS Sowerby, 1812.

Productus parvus Meek and Worthen.

Plate V, fig. 6 *a* and *b*.

Productus parvus Meek and Worthen, 1866, Geol. Surv. of Illinois, ii, 297.

Shell small, subhemispherical, length and breadth about equal; length of hinge-line nearly or quite equal to the greatest breadth of the shell; margin regularly rounded from ear to ear by the convexity of the shell.

Ventral valve regularly convex, without central flattening or mesial sinus; beak slightly incurved over the hinge-line; ears small; surface marked by fine, distinct, uniform striæ, about two within the space of a millimeter, increasing in number by occasional bifurcation, rarely by implantation; faint concentric wrinkles are observable upon the posterior half, especially near the beak, and fine concentric striæ are also to be seen under a lens. A few small erect spines are scattered over the surface of the ventral valve, but they become broken off in the imbedding rock, and their bases do not form a conspicuous surface-feature of the shell.

Length in a straight line from beak to front margin, twelve millimeters; breadth, fourteen millimeters; convexity, about nine millimeters.

Meek and Worthen's type-specimens of this species were obtained from the Chester limestone of the Subcarboniferous period at Chester, Illinois, and, so far as I am aware, the species has never been recognized elsewhere except at the locality that furnished examples to these collections. Compared with the figures and original description given by those authors, our shell is found to differ in no material characters from theirs; while compared with other known species of similar size and general aspect, they are found to possess characters that clearly separate them from our species. This species has a general resemblance to *P. elegans* Norwood and Pratten, also from the Chester limestone, *P. arcuatus* Hall, from the Burlington limestone, both of the Subcarboniferous group; and also to some varieties of *P. longispinus* Sowerby, from the Coal-Measure strata. It is most nearly related to a variety of the last-named species which is found in considerable numbers near Santa Fé, New Mexico. In those shells, there is, however, more or less of a mesial flattening of the ventral valve; the ears also are more flattened and the hinge-line more extended than in the species under consideration.

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada.

FAMILY STROPHOMENIDÆ.

GENUS STROPHOMENA Rafinesque, 1827.

Strophomena rhomboidalis Wilckins, * *sp.*

Plate V, fig. 5.

Conchita rhomboidalis Wilckins, 1767, Nachricht von selt. Verst., 77.
Anomites rhomboidalis Wahlenberg, 1821, Acta Societat. Scient. Upsal. viii, 65.
Productus depressa Sowerby, 1823, Mineral Conchology, v, 86.
Leptæna rugosa Dalman, 1826, Kongliga Vetens. Akad. Handl., 106.
Leptæna tenuistriata Sowerby, 1839, Silurian System, 623, 636.
Strophomena depressa Vanuxem, 1842, Geol. Third District New York, 79.
Orthis depressa Portlock, 1843, Geol. Lond., Tyrone, & Ferm., 450.
Leptæna tenuistriata Hall, 1847, Paleontology of New York, i, 108.
Strophomena rhomboidalis Lindstrom, 1860, Gothl. Brach., 371.
Strophomena rhomboidalis Hall, 1867, Paleontology of New York, iv, 76.
Strophomena rhomboidalis Davidson, 1868, Trans. Geol. Soc. Glasgow, Paleoz. Ser., i, 16.
Strophomena rhomboidalis Meek and Worthen, 1868, Geol. Surv. Illinois, iii, 426.
Strophomena rhomboidalis Meek, 1873, Paleontology of Ohio, i, 74.

Shell varying in outline, but generally subsemicircular, widest at the hinge-line; lateral and front margins bent strongly upward all around, the portion inclosed by the geniculated margin flattened in both valves; the surfaces of these flattened spaces marked by conspicuous concentric wrinkles that increase in size from the beak outward; area narrow in both valves, that of the ventral being a little wider than the other. Surface marked by fine radiating striæ, which are nearly uniform in size, close-set, increasing both by implantation and bifurcation, most frequently by the latter method on the ventral valve and by the former method on the dorsal. Under a lens, minute concentric striæ are usually to be seen, as is also the punctate structure of the test, upon exfoliated surfaces.

Breadth at the hinge-line, of the largest specimen contained in the collections, four and a half centimeters. They are often smaller than this, their proportions and outline being also very variable.

The geological range of this species is greater than that of any other

* This is one of the most widely known of all the species of fossil *Mollusca*, and by some of its varieties it is familiar to every geologist and collector. Mr. Davidson, in his well-known Monographs gives a large number of authorities who have written upon or noticed the species. The synonymy here given is selected for the purpose of indicating some of the principal points in its literary, history and to show the numerous generic assignments that have been made of it besides the various specific names it has borne.

known fossil, which circumstance has naturally thrown much doubt on the real specific identity of specimens collected from rocks of different geological ages.

It appears under slight varietal forms in different formations, which, although not strongly marked, have served to induce some naturalists to separate them as distinct species; but after the scientific scrutiny these shells have had for more than a hundred years, no person has succeeded in pointing out characteristics which entirely satisfy naturalists that they really constitute more than one species. As thus specifically recognized, its range is from the Trenton period of Lower Silurian age to the Subcarboniferous period, and it is also a common fossil in both hemisperes. Therefore, whenever this species is found associated with Upper Silurian or Devonian forms, and more especially if found unassociated with other fossils, it has of itself no valuable significance as to the geological age of the strata in which it is discovered; but when found associated with true Carboniferous types, it is understood to indicate the *Sub*carboniferous age of the strata containing it, because that period is regarded as the extreme recent limit of the range of the species in time.

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada, where it was found associated with the *Platycrinus* and *Actinocrinus* herein described as well as with other Subcarboniferous types.

FAMILY SPIRIFERIDÆ.

GENUS SPIRIFER Sowerby, 1815.

Spirifer centronatus Winchell.

Plate V, fig. 8 *a*, *b*, and *c*.

Spirifer centronata Winchell, 1865, Proc. Acad. Nat. Sci. Phila., 118.

Shell of medium size, usually subsemicircular in outline, broadest at the hinge-line; the cardinal extremities often cuspidate, but sometimes a little rounded; both valves moderately convex.

Dorsal valve broadly and regularly convex transversely, a little depressed at the lateral extremities; convexity abrupt along the median line from the beak to the middle of the valve, but from the middle to the front margin it is very slight or nearly straight; area very narrow; beak strongly incurved and projecting a little over the hinge-line; mesial fold distinctly defined from the front margin to the apex of the beak, where it is minute, but widens a little more rapidly near the front than elsewhere; it is not much elevated above the adjacent parts of the valve, but is distinctly separated from them by an interspace on each side of it, which is a little deeper and wider than those which separate the plications from each other.

Ventral valve regularly arching from rear to front; sides somewhat regularly convex, but like the other valve it is a little depressed at the lateral extremities; beak prominent, strongly incurved, abruptly narrowing to a point; mesial sinus distinctly defined from the front border to the apex of the beak, nowhere very deep, increasing uniformly in width toward the front; area moderately narrow, striated transversely; foramen triangular, nearly equilateral.

Surface marked by from thirty-four to forty-two small, rounded, distinct plications, nearly or quite all of which are simple; the two plications that form the lateral boundaries of the mesial sinus a little larger than any of the others, gradually but slightly diminishing in size from the sinus to the lateral extremities, where they become obsolete. From four to six plications are found upon the mesial sinus and fold respectively, all of which are similar to those upon the sides of the shell, except that the former diminish more rapidly in width toward the beaks. Concentric lines and undulations exist upon both valves.

Breadth at the hinge-line, about thirty-eight millimeters; length from beak to front, twenty-two millimeters; thickness, sixteen millimeters.

Professor Winchell's type-specimens were obtained from the Subcarboniferous strata at Cuyahoga Falls, Ohio, and seem, from the description, to have consisted of ventral valves only. His carefully-drawn description of that portion of the shell agrees so very closely with the corresponding part of ours that I should entertain little or no doubt of the specific identity of the two if it were not that he speaks of his shell as being very nearly like *S. cuspidatus* Hall (not Martin), which I understand to differ considerably from ours.

Position and locality.—Subcarboniferous strata; Mountain Spring, old Mormon road, Nevada.

Spirifer striatus Martin, *sp.*

Plate V, fig. 10 *a*.

Associated with characteristic Subcarboniferous forms at Mountain Spring, old Mormon road, Nevada, some specimens of the well and widely-known *Spirifer striatus* were obtained. They are all more or less imperfect, but their identity with that species seems unquestionable. The striæ which mark the surface are regular and nearly uniform in size, and show no inclination to become fasciculated as those of *S. cameratus* always do to a greater or less degree. The collections also contain specimens, apparently of this species, from a higher geological horizon, which are noticed upon another page, among the Coal-Measure species.

Varieties of *S. striatus* have been described under different specific names from the Subcarboniferous rocks of the United States; but when compared with authentic specimens from the Carboniferous rocks of Europe, I am not able to discover differences of specific value. In view of this fact, I have less hesitation in referring our specimens to *S. striatus* than I otherwise would have.

Spirifer extenuatus Hall.

Plate V, fig. 9 *a*, *b*, *c*, and *d*.

Spirifer extenuatus Hall, 1858, Geology of Iowa, i, pt. ii, 520.
Syringothyris Halli Winchell, 1863, Proc. Acad. Nat. Sci. Phila., 8.

Shell of medium size, much extended at the hinge-line; length from hinge to front usually a little less than the height from the ventral beak to the dorsal umbo.

Ventral valve capacious, subpyramidal, having a moderately deep sinus, which is well defined from front to beak, and rapidly widening toward the front; beak extended, pointed, its point a little incurved over the area; sides sloping from the beak to the hinge-extremities with little or no convexity of outline, and also little or no convexity to the front and lateral margins; area large, triangular transversely striated, flat or distorted a little by the twisting of the beak, and its inclination more or less toward the dextral side of the shell; fissure of the area triangular, nearly twice as high as it is wide at the base; each of its lateral border-angles truncated by a shallow groove; a little more than one quarter of the length of the fissure from its apex closed by a slightly convex pseudo-deltidium.

Dorsal valve moderately convex, differing in degree of convexity in different directions from its middle, but is somewhat regular in all; front margin broadly and regularly rounded, except that the lateral extremities are more or less extended, and the central portion is emarginate by the infolding of the mesial sinus of the ventral valve; mesial fold moderately elevated, well defined from front margin to the beak, and increasing rapidly in width from beak to front.

Surface of both valves marked by from fourteen to eighteen rounded plications on each side of the mesial field and sinus, which become less distinct toward, and disappear upon, the lateral extremities; surface of both mesial fold and sinus plain, except that, in common with the surface of all other parts of the shell, it is marked by fine concentric lines of growth. Shell-substance distinctly punctate.

Breadth along the hinge-line, nearly four centimeters; height from ventral beak to dorsal umbo, eighteen millimeters; length from hinge to front margin, sixteen millimeters.

The transverse plate connecting the dental laminæ, together with the tube, which it bears along the middle of its under surface (characters that distinguish the group of spiriferoid shells which Professor Winchell has separated under the generic name of *Syringothyris*), are concealed by the stony filling of our specimens; but as they possess the other characteristics of that group, those mentioned are doubtless present also. So far as external characters are concerned, no specific difference can be detected between our shell and *Syringothyris Halli* Winchell (*loc. cit.*). His type-specimens were obtained from strata of the Kinderhook formation at Burlington, Iowa, and Clarksville, Missouri. Those of Professor Hall were obtained from the same strata at the first-named locality. The want of material difference between the dorsal valve of Professor Hall's species (the only part of the shell described and figured by him) and the corresponding part of Professor Winchell's specimens, together with the fact that they are associated in the same strata at one of the typical localities, leaves little cause for doubting the specific identity of *Syringothyris Halli* and *Spirifer extenuatus*.

In the course of some extended remarks upon the genus *Spirifer*, Messrs. Meek and Worthen (Geological Survey of Illinois, vol. iii, 532) have shown that the original species of the genus possessed the same peculiarities of structure that formed the basis of Professor Winchell's genus *Syringothyris*. They also show that the numerous species which have been generally regarded as typical forms of the genus *Spirifer* really belong to a group for which Kœnig proposed the generic name of *Trigonotreta* long before the publication of *Syringothyris*. This being the case, a strict enforcement of the rule of priority in scientific nomenclature will require that *Syringothyris* be suppressed, and that all shells having the structure which characterizes that group retain the name of *Spirifer;* also that Kœnig's name *Trigonotreta* be applied exclusively to those ordinary forms which have so generally been referred to *Spirifer*, at least in a subgeneric sense. In view of the question thus raised, and being at present without the means of deciding it for myself by personal investigation, the generic assignments I have made of these forms in this report should be regarded as provisional only.

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada.

SUBGENUS MARTINIA McCoy, 1844.

Spirifer (Martinia) peculiaris Shumard.

Plate V, fig. 7 *a* and *b*.

Spirifer peculiaris Shumard, 1855, Geological Survey of Missouri, part 2, 202.

Ventral valve arching regularly from beak to front, the curvature being greatest near the beak; sides convex; beak narrow, extended, incurved; antero-lateral margins broadly rounded; postero-lateral margins abruptly rounded to the short hinge-line; postero-lateral surfaces rounded backward to the small, indistinctly-defined cardinal area; foramen triangular, its apical end closed by a pseudo-deltidium; mesial sinus shallow, traceable nearly to the beak, widening a little more rapidly near the front than elsewhere, nearly plain, but two faint, incipient plications are observable, one at each side, and also a slight flattening along its middle. Surface on each side of the sinus marked by six or seven small, convex-flattened plications, which are separated by very narrow interspaces, becoming smaller toward, and finally disappearing upon, the postero-lateral regions.

Only the ventral valve of this species is contained in the collections; but that agrees in all essential characters with *S. peculiaris* Shumard, the type-specimens of which species were obtained from the Kinderhook formation of the Subcarboniferous group in Missouri. The principal variations which it shows from the typical forms as described and figured by Dr. Shumard are the incipient plications of the mesial sinus and the somewhat greater rounding of the postero-lateral angles. Possibly more perfect examples may show other differences also, but the characters so far observed do not seem to warrant a specific separation from *S. peculiaris*.

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada.

GENUS SPIRIGERA D'Orbigny, 1847.

Spirigera monticola White.

Plate V, fig. 11, *a*, *b*, *c*, and *d*.

Spirigera monticola White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 16.

Shell subelliptical or subtetrahedral in outline, always wider than long, widest at, or a little forward of, the middle, moderately gibbous; valves almost equally capacious; postero-lateral margins in old shells thickened, but in younger ones the whole margin is more or less sharp; front margin only slightly sinuous in very young shells, but it is very deeply sinuous in some old ones.

Ventral valve broadly convex from side to side, regularly arching from beak to front; beak moderately prominent and slightly incurved; foramen, as usual, nearly round, rather small; mesial sinus moderately narrow, scarcely apparent in young shells, but in some old ones becoming very deep at the front, where the margin is much prolonged upward to follow the fold of the other valve.

Dorsal valve gibbous in the umbonal region, prominent along the middle, from which the sides slope away by gentle convexity to the lateral margins; mesial fold rather narrow, and in some examples not well defined, in which case the valve has a broad, nearly uniform, convexity; yet in others the mesial fold is well defined and prominent, especially at the front; but in all cases it is hardly discernible behind the middle of the shell, even in adult examples.

Surface of both valves marked by concentric lines, of fine lamellær of growth, and occasionally indications of fine radiating striæ are to be seen under a lens.

Length of an adult specimen of average size, twenty-three millimeters; extreme breadth, twenty-nine millimeters; height, sixteen millimeters.

This shell is quite different from any other described species of the genus known to occur in American Carboniferous strata. The most nearly allied form with which I am acquainted is an undescribed one in the Subcarboniferous stata of Franklin County, Iowa, with which our species is probably identical. It somewhat resembles *S. incrassatus* Hall from the Burlington limestone, but it differs from that species in outline, the less prominence of the ventral beak, the character of the mesial fold and sinus, and in the surface-markings.

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada.

Spirigera obmaxima McChesney.

Plate V, fig. 12.

Athyris obmaxima McChesney, 1860, Descr. New Paleozoic Fossils, 80
Spirigera pectinifera Swallow, 1863, Trans. St. Louis Acad. Sci., ii, 88.

Shell large, broader than long, greatest breadth about midlength; outline suboval; ear-like projections of fibrous shell-substance sometimes seen upon the postero-lateral margins. Ventral valve broadly convex, bearing a broad, shallow mesial sinus upon the front half of old shells, obsolete upon the posterior half; greatest convexity at the umbonal region; beak not very prominent, incurved.

Dorsal valve having its greatest convexity along the median line; mesial fold indistinctly defined except at the front; umbonal region not prominent; beak strongly incurved beneath that of the other valve.

Breadth, six centimeters or more; length above five centimeters.

This species is remarkable for its great size, and, although the specimens of the collection are imperfect, I have hardly a doubt of their specific identity with *S. obmaxima* McChesney.

Position and locality.—Subcarboniferous strata; Mountain Spring, old Mormon road, Nevada, and also at a locality below Ophir City, Utah.

FAMILY TEREBRATULIDÆ.

GENUS TEREBRATULA Lhwhyd, 1698.

SUBGENUS DIELASMA King, 1859.

Terebratula (Dielasma) Burlingtonensis White.

Terebratula Burlingtonensis White, 1860, Jour. Bost. Soc. Nat. Hist., 228.

Shell of moderate size, subovate in outline, more or less gibbous, broadest a little forward of the middle.

Ventral valve regularly convex; beak prominent, projecting considerably behind that of the dorsal valve, moderately incurved; a faintly-defined ridge at each side of the beak follows its curvature from the foramen forward, and disappears near the middle of the shell; dental plates moderately strong, their front edges sharp and perpendicular with the teeth, placed near the sides of the beak, and diverging a little as the beak increases in size; mesial sinus absent or obsolete.

Dorsal valve depressed-convex, greatest convexity near the beak, which is not prominent; mesial fold absent. Surface smooth or marked by indistinct lines of growth; shell-structnre finely punctate.

Average length, about twenty-two millimeters.

The type-specimens of this species were obtained from the Subcarboniferous rocks at Burlington, Iowa, and those of the collections agree with them in all essential respects. The reference to the subgenus *Dielasma* of this species is made in consequence of the presence of dental plates, the other characteristics of the subgenus not having been observed. It differs from *T. bovideus* especially in wanting the longitudinally arcuate form, so constant in that species.

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada.

MOLLUSCA VERA.

CLASS CONCHIFERA.

ORDER DIMYARIA.

FAMILY CARDIIDÆ (?).

GENUS CONOCARDIUM Brown, 1835.

Conocardium ——— (?).

From strata of the Subcarboniferous period below Ophir City, Utah, a single example of a species of *Conocardium* was obtained. It is too imperfect for full specific determination, but its observable characters indicate that it belongs to an undescribed species. It is similar in size and also in many of its details to *C. trigonale* Hall from the Corniferous limestone of New York and Ohio. The costæ and interspaces, as well as the very fine concentric striæ that mark the surface, are very similar to those of that species, but our shell differs in its smaller and more numerous costæ, in being less produced at the antero-ventral angle, and in the more distinct rounding of the antero-lateral ridges.

In case the discovery of more perfect specimens should confirm the opinion that this shell belongs to an undescribed species, I propose for it the name of *C. semiplenum.*

CLASS GASTEROPODA.

SUBCLASS DIŒCA.

ORDER RHIPHIDOGLOSSA.

SUBORDER PODOPHTHALMA.

FAMILY EUOMPHALIDÆ.

GENUS EUOMPHALUS Sowerby, 1815.

Euomphalus luxus, White.

Plate V, fig. 13 *a* and *b*.

Shell of medium size, subdiscoidal, the spire being only a little elevated; volutions four or five; outer side of volutions convex below but flattened a little above so as to form a more or less distinct angle with the flattened upper side; under side regularly and continuously rounded from the outer side into the umbilicus, where it meets the next volution within; suture distinct; umbilicus moderately deep and broad. Surface marked by distinct lines and occasional corrugations of growth. Diameter of coil of the largest specimen in the collections, thirty-eight millimeters.

This species resembles *E. latus* Hall, the type-specimens of which were obtained from the Burlington limestone division of the Subcarboniferous group at Burlington, Iowa, and Quincy, Illinois. The specimens of the collection present differences from the typical forms of the species which I at first regarded as only varietal, but upon further examination I consider them specific; the principal of which differences are their smaller size, less rapidly increasing volutions, and the absence of the elevation, or incipient fold, upon the upper side of the volutions adjacent to the suture which characterizes *E. latus.*

Position and locality.—Strata of the Subcarboniferous period; below Ophir City, Utah, and also "near the base of the anticlinal", at Ophir City.

CHAPTER VII.

CARBONIFEROUS PERIOD.

PROTOZOA.

CLASS RHIZOPODA.

ORDER FORAMINIFERA.

GENUS FUSULINA Fischer, 1837.

Fusulina cylindrica Fischer.

Plate VI, fig. 6 *a* and *b*.

Fusulina cylindrica Fischer, 1837, Oryct. du Gouv. de Moscou, 126.
Fusulina cylindrica D'Orbigny, 1845, Geol. Russ., ii, pt. iii, 16.
Fusulina cylindrica Owen, 1852, Geol. Surv. Wisconsin, Iowa, and Minnesota, 131
Fusulina cylindrica Meek and Hayden, 1859, Proc. Acad. Nat. Sci. Phila., 26.
Fusulina cylindrica Dana, 1862, Manual of Geology, 164.
Fusulina cylindrica Meek and Hayden, 1864, Paleontology Upper Missouri, 14.
Fusulina cylindrica Meek, 1864, Paleontology of California, pt. i, i, 4.
Fusulina cylindrica Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 71.
Fusulina cylindrica White, 1870, Geology of Iowa, i, 250.
Fusulina cylindrica Meek, 1872, United States Geol. Surv. of Nebraska, 140.

Shell varying from terete to subglobose, assuming all intermediate fusiform shapes, generally somewhat obtusely pointed, especially the terete ones, usually having the appearance of being slightly twisted at the ends; septal furrows moderately distinct, even upon unweathered specimens, extending in more or less direct lines longitudinally, but are a little deflected just at the ends; centrifugal apertures about twice as high as the thickness of the cell-wall covering them, more than twice as broad as high, and of nearly uniform size throughout the whole coil. The locular or external aperture, since it varied with the progress of construction of the cell, and must have been fragile until it was completed, is seldom clearly shown upon the fossils.

It was apparently linear, extending the full length of the shell until closed by a new longitudinal septum at each side, leaving only a new centrifugal aperture at the middle, in line with the others. Volutions from five to eight; septa from twenty to thirty in the outer volution; septa nearly straight at their outer or external edges, but laterally undulating at their inner edges, where they join the outer surface of the next volution within, as may be seen in specimens that have had a part of their outer volution removed by weathering; the same defacement also showing portions of the series of entrifugal apertures. The undulations of the inner edges of contiguous septa are not usually parallel; but the convexity of the folds of each septum generally comes opposite that of the folds of the next adjacent septum, which gives rise to a peculiar confused and complex appearance of the septa in those specimens that have suffered erosion or weathering of the outer volution.

Dimensions very variable; one of the more robust specimens in the collections being one centimeter long and half a centimeter in diameter; another measures nine millimeters long and two millimeters in diameter.

Fischer described another species, together with *F. cylindrica* (*loc. cit.*), under the name of *F. depressa*, which latter species Dr. Geinitz (*loc. cit.*) recognizes from Upper Coal-Measure strata at Nebraska City, Nebraska. Meek and Hayden have proposed the name *F. ventricosa* to include certain robust forms from the Coal-Measures of Missouri and Kansas (Proc. Acad. Nat. Sci. Phila., 1858, 261), and Mr. Meek has described two other species from a similar horizon in California under the names of *F. robusta* and *F. gracilis* (Geological Survey of California, paleontology, vol. i, 1864). With due deference to the views of those able and careful paleontologists, I feel bound to differ with them in relation to the propriety of a specific separation of these forms. Long familiarity with this protean species, distributed over an extensive region, has served to convince me that all the varieties referred to, including *F. depressa* Fischer, belong to one species only. In Southwestern Iowa, where *Fusulina* is abundant in strata of the Upper Coal-Measures, varieties prevail at certain localities respectively that will answer the description of every imputed specific form of the genus yet known to me. Intermediate forms may also be obtained in the same region that may be made to connect all the varieties referred to. Remembering also that these shells were formed by animals, each of which consisted of a mere particle of organless sarcode, not having even the least differentiation of tissue, the wonder seems rather that intra-specific variation should not be much greater than the difference is found to be between any individual shells hitherto referred to the genus *Fusulina*.

Position and locality.—Strata of the Carboniferous period at the following localities in Utah, besides others elsewhere: Wasatch range, south of Spanish Fork; U-i-ya-bi Pass, Gosute range; near Beckwith Spring, Cedar range; near the mouth of Spanish Fork Cañon; and southeast of Mount Nebo.

RADIATA.

CLASS ACTINOZOA.

ORDER ZOANTHARIA.

FAMILY FAVOSITIDÆ.

Genus CHÆTETES Fischer, 1837.

Chætetes milleporaceus Troost, *sp.*

Plate VI, fig. 2 *a*.

Calamapora milleporacea Troost, 1849? (manuscript).
Chætetes milleporaceus Edwards et Haime, 1851, Monographie Polyp. Fossiles, 272.

Polypary massive; cells slender, capilliform in aspect, of nearly equal size among themselves and of uniform diameter from their proximal to their distal ends; diameter of cells about one-third of a millimeter, and upon the split surfaces of some specimens they have been traced continuously nearly the length of a decimeter; masses varying in size from four or five centimeters to as many decimeters in diameter; shape of the masses irregularly globular to irregularly flattened-convex, the latter being the most usual form. Sometimes specimens, apparently of this species, are irregularly elongate in form, and show some indications of incipient branching; but the species is essentially a massive and not a branching coral.

This coral is not uncommon in the Upper Coal-Measures of Missouri, Iowa, and Nebraska. The type-specimens of the species which were used by Edwards and Haime in their original description were obtained from Carboniferous strata in the Cumberland Mountains of Tennessee, and also from the same geological horizon near Evansville, Indiana. The late Dr. Troost had catalogued the species before his death, with the intention of publishing a description of it. In its subsequent publication by Edwards and Haime (*loc. cit.*), they adopted his specific name.

Position and locality.—Strata of the Carboniferous period; Virgin range, southwest of Saint George, Utah.

GENUS RHOMBIPORA Meek, 1872.

Rhombipora lepidodendroides Meek.

Plate VI, fig. 5 *a*, *b*, *c*, and *d*.

Rhombipora lepidodendroides Meek, 1872, United States Geol. Surv. Nebraska, 141.

Coral slender, ramose; stem and branches terete; branches not numerous, generally attaining at once nearly or quite the size of the stems: branching taking place at somewhat regular intervals in some specimens, but irregularly in others, the divergence being some thirty or forty degrees; stem and branches usually nearly or quite straight between the points of bifurcation, but neither the stem nor the branch above the point of bifurcation retain the axial direction of the part below; cells small; starting from a non-substantial axis they arch upward and outward, increasing a little in size as they extend, and open upon the outer surface; interspaces between the cells about equal in width to the diameter of the cells, the intercellular substance being itself minutely cellular in structure; cell-apertures rhombic or rhombic-oval in outline, the vertical diameter generally greatest; cells arranged in both vertical and oblique rows, which are always quite regular; spaces between the apertures ornamented with minute nodes, the largest ones of which are placed opposite the angles of the apertures, at which points there are sometimes two such nodes. Stems varying in diameter from one to four millimeters; number of cell-apertures five or six in the space of two millimeters, measured parallel with the axis of the stem, and seven or eight in the same space measured along one of the oblique rows. The variation of the latter measurements in different specimens is not proportionally so great as the variation of the diameter of stems, because the angle of the oblique rows with the axis is greater in large stems than in small ones; this gives the cell-apertures a greater proportional width in large stems, while the actual width is nearly uniform in all.

Most of the examples in the collection are considerably larger than the type-specimens of Mr. Meek, but some of them agree perfectly with his types as to size, and the structure is identical in all, so far as can be determined. Specimens, apparently of this species, from the Upper Coal-Measures of Northern Missouri and Southern Iowa, are still larger than any contained in the collections. Some of the specimens of the collections are more or less completely silicified, and one or two of them have a hollow axis. This seems to have resulted from the failure of the central portion to become silicified like the outer portion, which, remaining calcareous, was subsequently removed by dissolving agencies that the outer silicified portion resisted. This is really shown to be the case by the breaking of others, and finding the central portion yet calcareous and retaining the structure of the coral, the parts of which structure being in direct continuity with those of the outer silicified portion. On the other hand, a fragment of a species of this genus obtained from the Subcarboniferous limestone of Washington County, Indiana, seems to have a hollow axis, the whole of the coral being calcareous. It is, however, not certain that the axis of even this example was originally hollow.

Position and locality.—Strata of the Carboniferous period; west face of Oquirrh range, near "E. T. City", Utah, and at the confluence of White Mountain and Black Rivers, Arizona.

GENUS SYRINGOPORA Goldfuss, 1826.

Syringopora multattenuata McChesney (?).

From strata of the Carboniferous period, at various localities in Nevada and Utah, specimens of a species of *Syringopora* were obtained. They are too imperfectly preserved for satisfactory specific identification, but they probably belong to *S. mulattenuata* McChesney, as they are not unlike that species and occupy a similar geological position. That species is a more or less common one in the Upper Coal-Measure strata of Iowa, Illinois, Missouri, and Nebraska.

FAMILY CYATHOPHYLLIDÆ.

GENUS ZAPHRENTIS Rafinesque et Clifford.

Zaphrentis excentrica Meek.

Plate VI, fig. 3 *a*.

Zaphrentis excentrica Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, and Utah, 495.

Corallum large, comparatively short, broadly turbinate, slight curved; principal septa sixty or seventy, not extending to the center of the calyx, but leaving a large plain surface at its bottom; tabulæ numerous, broad, thin, transverse, or a little concave; vesicular zone comparatively narrow. Height, about seven centimeters; breadth at top, about six centimeters.

Our specimens are silicified and somewhat imperfect, but they are doubtless specifically identical with *Z. excentrica* Meek, the type-specimens of which were obtained from strata of the same period at "Old Baldy", near Virginia City, Montana.

Position and locality.—Strata of the Carboniferous period; Fossil Hill, White Pine County, Nevada.

GENUS LOPHOPHYLLUM Edwards et Haime, 1850.

Lophophyllum proliferum McChesney, *sp.*, var. sauridens.

Plate VI, fig. 4 *a*, *b*, *c*, and *d*.

Cyathaxonia prolifera McChesney, 1860, Descriptions of New Paleozoic Fossils, 75.
Cyathaxonia, sp., Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 65–66.
Lophophyllum proliferum Meek, 1872, U. S. Geol. Surv. Nebraska, 144.

Corallum conical or elongate-conical, usually curved, rarely almost straight, tapering to a more or less slender point at its proximal end; transverse section circular; surface marked by longitudinal striæ of uniform size, some of which are continuous from the apex to the rim of the calyx, but the additional striæ required by the increasing diameter of the corallum are often so arranged as to form a kind of longitudinal suture by commencing successively along the side of an outer stria of a series that are continuous from apex to calyx; longitudinal striæ crossed by more or less distinct wrinkles, and very fine encircling lines of growth.

Calyx comparatively deep; its sides rather thin between the septa, and of nearly uniform thickness from rim to bottom; rays within the calyces of the largest specimens sometimes reaching fifty in number, not projecting far inward from the sides except toward and at the bottom, upon which they reach the columella; bottom of the calyx really sloping downward from the columella all around, and ending abruptly against the sides, but the numerous septa, by gradually approaching the columella from the sides, give the bottom a concave appearance when viewed from above; septal fossette not very conspicuous, usually occupying a little more than the space of one principal body-ray, or septum; septa below the calyx, less numerous than the rays within it, well developed, and reaching nearly or quite to the columella, but none of them apparently becoming consolidated with it except the one opposite the septal fossette; columella strong, transverse section broadly oval, projecting considerably from the calyx, bluntly crested, well consolidated by the almost complete fusion of the middle portions of the tabulæ that compose it, not firmly united to the surrounding portions of the corallum, but readily cleaving from them when the parts are broken; when thus separated, its surface shows somewhat twisted, longitudinal, raised, striæ which correspond more or less closely with the inner edges of the septa, but are not really separated parts of them, as they at first sight appear to be; tabulæ comparatively thin, between the columella and the sides, sloping or arching downward, and ending abruptly against the inner side of the outer wall.

Length of the largest specimen in the collection, along its convex side, upward of four centimeters; diameter of the calyx, twelve millimeters. The average size of full-grown specimens is not materially less.

Our examples present a different aspect from typical forms of *S. proliferum*, and they perhaps belong to a different species; yet it is difficult to point out distinct structural differences of specific value. They have, however, a larger average size, and are more robust, less wrinkled, and less contorted than typical forms of *S. proliferum*, which characters seem to indicate at least a distinct variety, for which the name *sauridens* is proposed. The prominent solid axis of that species, separating so readily from the surrounding parts in broken specimens, caused it for a time to be referred to the genus *Cyathaxonia*, but Mr. Meek has shown (*loc. cit.*) that it has the internal structure of *Lophophyllum*.

Position and locality.—Strata of the Carboniferous period; near Santa Fé, New Mexico, and at Rock Creek, Lake County, Colorado.

GENUS LITHOSTROTION Fleming, 1828

Lithostrotion Whitneyi Meek.

Plate VI, fig. 1 *a*, *b*, and *c*.

Lithostrotion Whitneyi Meek, 1875, Pal. of U. S. Geol. Expl. 40th Parallel, (manuscript).

Corallum fasciculated; corallites cylindrical, somewhat flexuous and irregular, generally separate but seldom distant, and sometimes in contact; epitheca thin but distinct, marked by wrinkles and encircling lines of growth; columella small and very narrow, being laterally compressed; principal rays from twenty to twenty-eight in number, according to the size of the polypite, alternating with smaller rays; tabulæ numerous, comparatively broad, transverse or arching downward from the columella; vesicular zone narrow, composed of from three to five layers of vesicles.

Diameter of polypites, from eight to fourteen millimeters.

In splitting and polishing a polypite, so as to obtain a view of the internal structure, it is often difficult to make the section in such a manner as to show the columella, because it is so small and narrow. If the section is made parallel with one of its flat sides, but not cutting through it, the tabulæ appear to be separate from each other in all parts, and to extend directly across the polypite, as in *Cyathophyllum*. Such a section is shown in figure 1 *c*, Plate VI. If the section passes obliquely through the columella, its character is indistinctly shown, as in figure 1 *b* of the same plate. The section given by Mr. Meek in his illustrations of the species is through the short diameter of the columella.

Position and locality.—Strata of the Carboniferous period; Fossil Hill and Ice Creek, Steptoe Valley, White Pine County, Nevada.

CLASS ECHINODERMATA.

ORDER ECHINOIDEA.

FAMILY ARCHÆOCIDARIDÆ.

GENUS ARCHÆOCIDARIS McCoy, 1844.

Archæocidaris ornatus Newberry.

Plate VI, fig. 7.

Archæocidaris ornatus Newberry, 1861, Geol. Rep. Lieut. Ives's Expl. Col. Riv., 116.

Principal spines fusiform, strong, about seven centimeters long; greatest diameter a little below the middle, where it is about five millimeters; surface for a short distance above the basal ring plain or not conspicuously marked; above this plain space to the distal end, it is thickly set with spinules from one to two millimeters in length, which are arranged around the spine in imperfectly spiral lines, in which lines the intervals between the spinules are generally less than the diameter of their bases, but the vertical intervals are somewhat greater; basal ring rather large, crenulated at the border. An imperfect interambulacral plate embedded in the rock near one of the spines contained in the collection, and probably belonging to this species, shows a plain areolar surface, a raised center, and an elevated rim around a rather small central tubercle. Remainder of the body unknown.

Dr. Newberry's type-specimens were obtained from strata of the Carboniferous period near the confluence of the two Colorados, and also from strata of the same period near the Great Cañon of the Colorado River.

Position and locality.—Strata of the Carboniferous period; ten miles west of Ojo del Oso, near Fort Wingate, New Mexico.

Archæocidaris trudifer White.

Plate VI, fig. 8 *a* and *b*.

Archæocidaris trudifer White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 17.

Interambulacral plates comparatively broad, rather thin, having an elevated border all around, which is apparently composed of a series of small tubercles; areolar surface apparently plain; central tubercle small, perforate at the center, surrounded at its base by a very slightly-raised ring, and immediately outside of that by another ring, which is so much elevated as to form a little cup, with its rim somewhat expanded. Diameter of the largest plate in the collection, about twenty millimeters.

Spines very long and slender, one of those in the collection having been, when perfect, about twelve centimeters in length, terete; diameter of the basal ring, which expands abruptly from the shaft, greater than that of any portion of the shaft; diameter of the shaft nearly uniform for more than half its length above the basal ring, the upper portion gradually tapering to a point. Greatest diameter of the shaft of the long spine referred to, scarcely five millimeters; diameter of the basal ring, seven millimeters. Surface of the spine for a short distance above the basal ring apparently smooth, but, from that portion to the distal end, it is ornamented with numerous small points or incipient spinules, which are often removed by weathering, but, in well-preserved specimens, they are seen to be arranged around the spine in imperfectly spiral lines.

The very long, slender, terete spine, having a basal ring often much greater in diameter than any part of the shaft, together with the other characters described, distinguish this species from all others.

Position and locality.—Strata of the Carboniferous period ("Red Wall limestone"); Camp Apache, Arizona.

MOLLUSCA.

MOLLUSOIDEA.

CLASS POLYZOA.

ORDER GYMNOLÆMATA.

FAMILY MYRIAPORIDÆ.

GENUS GLAUCONOME Goldfuss, 1826.

Glauconome nereidis White.

Plate VII, fig. 5 *a*, *b*, *c*, *d*, and *e*.

Glauconome nereidis White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 18.

Polyzoary branching, the main stem sending off branches at irregular intervals; these in like manner sending off secondary branches, but less frequently; the stem and all the branches bearing branchlets of the usual character, in regular series at each side, all of which are straight or slightly curved; branches leaving the stem, and branchlets the stem and branches, at nearly or quite uniform angles of between sixty and seventy degrees; branchlets opposite, or alternating in their arrangement, the intervals between them being a little greater than the diameter of the branchlets; non-poriferous side of the stem, branches, and branchlets all convex and marked by fine longitudinal striæ. Poriferous side of the stem and branches bearing a row of pores along each of their lateral borders, the number of pores being about twice as great as that of the branchlets, but they are not placed in perfectly regular order with them. The space between these two lateral rows of pores is convex, and marked by scattered dimorphous pores that are not more than half as large as the principal ones which form the lateral rows. Branchlets also bearing a row of pores at each lateral border of the poriferous side, which are of the same character as the principal pores of the stem and branches, but they average a trifle smaller than those; pore-apertures with a rather prominent border, which gives the branchlets a somewhat knotted appearance under a lens.

There is considerable difference in the size of the broken stems and branches which constitute the specimens of the collection; but none of them, not even the longest fragment, perceptibly diminishes in size toward the dastal end. The largest stem is about half a millimeter in diameter and the smallest not more than half that size. The branchlets vary from one to three millimeters in length. The whole extent of the branching of a polyzoary of this species is unknown; but, as the branches are only excessively developed branchlets, there seems to be no necessary restriction in this regard, but, in fact, the branching seems to have been somewhat limited. When one of the branchlets reached a little greater length than its fellows adjacent, it sent off branchlets from its own sides and became a branch. In a few cases, these first branchlets of the newly-formed branch have been seen to coalesce with adjacent branchlets of the stem, thus forming a few irregular fenestrules.

This species differs from *G. triliniata* Meek, from strata of the same period in Nebraska, in being much branched, and especially in the presence of minute, dimorphous pores upon the axial portion of the poriferous side of the stem and branches, and also in the absence of the three longitudinal raised lines that distinguish that species.

Position and locality.—Strata of the Carboniferous period; at the confluence of White Mountain and Black Rivers, Arizona.

GENUS SYNOCLADIA King, 1849.

Synocladia biserialis Swallow.

Plate VII, fig. 3 *a*, *b*, and *c*.

Synocladia biserialis Swallow and Hawn, 1858, Trans. Acad. Sci. St. Louis. i, 179.
Synocladia virgulacea Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 70.
Synocladia biserialis Meek, 1872, U. S. Geol. Surv. Nebraska, 156.

Polyzoary probably infundibuliform, but the specimens usually found consist only of spreading frond-like fragments; primary branches a little larger than the others, the latter increasing by divergence at various angles from the primary branches, also occasionally from each other, and rarely by starting upward from the middle of a dissepiment; dissepiments celluliferous, a little narrower than the branches, and arching upward a little as they extend from branch to branch; fenestrules irregularly four-sided; upper side usually convex, and lower side sometimes concave, about nine in the length of a centimeter, measuring upward, generally wider than the branches, but occasionally narrower, especially near the base of the polyzoary. Upon the poriferous side, the branches and dissepiments, especially the former, are each provided with an irregular mesial carina, consisting of small, elongate, confluent nodes, which are sometimes sharp and prominent. Cell-apertures moderately large, rounded, borders prominent; cells arranged in single, quite distinct lines, one on each side of the mesial carina of the branches, and generally each dissepiment bears a double row of similar cells. Upon some of the dissepiments the cells form only a single row at the middle, while upon others they are not only double but another cell is added near the junction with the branch, giving three cells abreast at those points.

Professor Geinitz and others have referred this species to *S. virgulacea* as only varietally different from the typical forms of that species. *S.*

biserialis is now known to extend over an area more than one thousand miles across in a direct line, throughout the whole extent of which it is surprisingly constant in its specific characters, and just as constantly different from those of *S. virgulacea* as that species is represented by the figures and descriptions of European authors. The European species is without the mesial carina of ours, but has in its place a median row of pores, which our species never has.

Position and locality.—Strata of the Carboniferous period (Red Wall limestone); Camp Apache, Maricopa County, Arizona.

GENUS POLYPORA McCoy, 1844.

Polypora stragula White.

Plate VII, fig. 4 *a* and *b*.

Polypora biarmica Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 68 (not *P. biarmica* Keyserling).
Polypora (species undetermined) Meek, 1872, U. S. Geol. Surv. Nebraska, 155.
Polypora stragula White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 19.

Polyzoary apparently flabelliform; longitudinal branches bifurcating with more or less irregularity in different parts of the polyzoary; dissepiments little if any more than half as wide as the branches; fenestrules oval or oblong, the porportions of length and width varying in different parts of the polyzoary from about one-quarter longer than wide to twice as long as wide; varying also in size in different parts of the polyzoary, but averaging about six in number within the length of a centimeter, measured longitudinally; poriferous side of branches furnished with from four to six indistinct rows of small thick-set pores of uniform size, the arrangement of them in rows being more distinct obliquely than vertically; dissepiments usually free from pores, except near their junction with the branches, and a slightly-raised median ridge is often seen upon them.

This species is known to occur in the Carboniferous rocks of Iowa, Missouri, and Nebraska. It was from the latter State that Dr. Geinitz obtained the specimens which he referred (*loc. cit.*) to *P. biarmica* Keyserling, the type-specimens of which species were obtained from Permian strata of Petschoraland. Mr. Meek (*loc. cit.*) has pointed out very clearly the difference between our species and *P. biarmica*, and has also given for comparison a copy of Count Keyserling's figure, together with a copy of the figure of the species given by Dr. Geinitz.

Position and locality.—Strata of the Carboniferous period at the confluence of White Mountain and Black Rivers, Arizona.

CLASS BRACHIOPODA.

ORDER ARTHROPOMATA.

FAMILY PRODUCTIDÆ.

GENUS PRODUCTUS Sowerby, 1812.

Productus costatus Sowerby (?).

Plate VIII, fig. 2 *a*, *b*, *c*, and *d*.

? *Producta costata* Sowerby, 1827, Min. Conch., vi, 115.
? *Producta costellata* McCoy, 1844, Synop. Carb. Foss. of Ireland, 108.
? *Productus costatus* de Verneuil, 1845, Geol. Russ. et. Ural Mts., ii, 268.
? *Productus costatus* de Koninck, 1847, Monog. Product., pl. viii, f. 3, and pl. x, f. 3.
Productus Portlockianas Norwood and Pratten, 1854, Jour. Acad. Nat. Sci. Phila., viii, 15.
Productus costatus Shumard, 1855, Geological Report Missouri, 216.
Productus costatus var. Hall, 1858, Geology of Iowa, i, pt. 2, 712.
? *Productus costatus* Davidson, 1860, Monog. British Carb. Brachiopoda, 152.
? *Productus viminalis* White, 1862, Proc. Soc. Nat. Hist. Boston, ix, 29.
Productus costatus ? ? Meek, 1872, U. S. Geol. Surv. Nebraska, 159.

Shell of medium size; width greater than the length, measured in a straight line from hinge to front border, strongly and deeply arcuate; hinge-line nearly or quite equal in length to the greatest width of the shell; ears thin, well defined, and bent slightly downward; free margin broadly rounded, front emarginate.

Ventral valve very gibbous and strongly curved, having a broad shallow sinus extending from the umbonal region to the front, producing there the before-mentioned emargination of the front border; beak prominent, incurved, but only very slightly projecting over the hinge-line.

Dorsal valve flattened or only slightly concave in the visceral region, abruptly curved upward at the lateral and front margins; front showing a very slight mesial fold, corresponding with the broad, shallow mesial sinus of the other valve.

Surface of both valves, except that of the ears, marked by distinct, more or less unequal, rounded, radiating costæ, with interspaces of somewhat less than their own width between them; costæ generally continuous through a greater part of the length of the shell, but sometimes bifurcating, and occasionally two or more of them may be seen to coalesce and form a single costa of more than ordinary size; crossing the costæ, especially on the posterior half of the shell, and forming indistinct reticulations with them, are concentric wrinkles, more or less numerous. Upon the ventral valve, especially toward the margins, and upon the ears, there are usually scattered strong, more or less perpendicular, spines; some shells are apparently nearly free from spines, or have only a few of them upon and near the ears.

This shell is the American representative of the European *P. costatus* Sowerby, and has been, by European and most American geologists, referred to that species, in the belief that the differences are at most only varietal. Mr. Meek has, however, shown, in his paleontological report for the United States Geological Survey of Nebraska, that there are good reasons for doubting the specific identity of the American with the European shell. If his conclusions are correct, as they are believed to be, the proper name of this shell is *P. Portlockianus* Norwood and Pratten, these authors having been the first to recognize and publish the American form as distinct from the European. This species as it occurs in American strata is not only a variable one, but some of the varieties show so much constancy that they seem almost worthy of specific separation from the typical forms. One of these varieties was found plentifully near Santa Fé, New Mexico; but the figures given upon Plate VIII are of such examples as are regarded as typical forms of the species as it occurs in American strata. In *P. viminalis* White, from the Burlington limestone (Subcarboniferous), the front is more than usually produced, the costæ prominent, and more or less fasciculated, but these differences are probably only varietal.

The geological range of this species is through the strata of the whole Carboniferous period in Illinois, Missouri, Iowa, and Nebraska; and if *P. viminalis* is only a variety, as it is now supposed to be, the range is far toward the base of the Subcarboniferous group also.

Position and locality.—This is one of the most abundant species in the collections, it having been found at almost every locality at which collections were made from strata of the Carboniferous period. It occurs at the following, among other localities:—Camp Cottonwood, old Mormon road, Lincoln County; top of Grass Mountain, Ely range, thirty-five miles north of Pioche; and at Silver Peak, Nevada: head of Partridge Creek, Yavapai County; Salt River; and head of Big Dry Fork, Arizona; Kanab Cañon, Arizona: Rock Cañon, Wahsatch range, near Provo; Lake range, Fairfield road, and first camp south of Saint George, Utah; near Bear Spring; Camp Wingate, and in the Zuñi Mountains, between Camp Wingate and Nutria Spring, New Mexico.

Productus semireticulatus Martin, *sp.*

Plate VIII, fig. 1 *a*, *b*, and *c*.

Anomites semireticulatus Martin, 1809, Petrificata Derb., 7.
Anomites productus Martin, 1809, Petrificata Derb., 9.
Productus scoticus Sowerby, 1814, Min. Conch., i, pl. lxix, f. 3.
Productus antiquatus Sowerby, 1814, Min. Conch., i, 15.
Producta Martini Phillips, 1836, Geology of Yorkshire, ii, 213.
Producta pugilis Phillips, 1836, Geology of Yorkshire, ii, 215.
Leptæna antiquata Fischer, 1837, Oryct. du Gouv. de Mosc., pl. xxvi, figs. 4–5.
Leptæna tubifer Fischer, 1837, ib., pl. xxvi, f. 1 (not Deshayes).
Productus Inca D'Orbigny, 1843, Paleont. Voyage dans l'Amér. Mérid., viii, 51.
Producta flexistria McCoy, 1844, Synop. Carb. Fossils of Ireland, 109.
Productus semireticulatus de Koninck, 1847, Monog. Gen. Product., pl. viii, f. 1.
Productus semireticulatus Shumard, 1855, Geological Report of Missouri, 216.
Productus semireticulatus Davidson, 1857, Monograph British Carb. Brach.
Productus semireticulatus Marcou, 1858, Geology of North America, 46.
Productus semireticulatus Hall, 1858, Geology of Iowa, i, pt. 2, 637.
Productus Calhounianus Swallow, 1858, Trans. Acad. Sci. St. Louis, i, 181.
? *Productus Ivesii* Newberry, 1861, Expl. Exp. Col. Riv., Paleont., 122.
Productus semireticulatus Meek, 1872, U. S. Geol. Surv. Nebraska, 160.

Shell large, very arcuate; width greater than the length, the latter being measured in a straight line from hinge to front; length of hinge-line sometimes less and sometimes greater than the greatest width of the shell in front of it; area of both valves distinct, but, as usual in this genus, very narrow; ears thin, more or less prominent; lateral and front borders rounded; front emarginate.

Ventral valve very strongly curved; beak depressed and projecting a little or not at all over the cardinal border; a broad, shallow, obscurely defined mesial sinus extends from near the umbonal region to the front, giving the shell an indistinctly-bilobed appearance. Dorsal valve flattened in the visceral region, bent abruptly upward at the sides and front; beak flattened or slightly concave.

Surface of both valves marked by numerous coarse, rounded striæ, or small costæ, which are crossed in the visceral region by somewhat regular concentric wrinkles of nearly uniform size, giving that part of the shell a semireticulated appearance, which is more distinct in some examples than in others; more or less numerous, strong, erect spines are scattered upon the ventral valve, generally arising from the costæ upon the body of the shell, and from the strong wrinkles upon the ears, upon which latter part they are usually most numerous.

Length of a full average-sized specimen, measured in a straight line from hinge to front, four and a half centimeters; width, six centimeters.

The foregoing synonymy, copied largely from the works of Davidson and Meek, shows that this shell presents such variations, both in America and Europe, that it has been described under a variety of specific names by paleontologists of both hemispheres. The differences between the varieties thus described under different specific names are, in some cases at least, really very great; but, so far as my own observation has extended, there is such a want of constancy in these varieties, and such a lack of definite specific characters by which they may be clearly separated, that I am disposed to refer them all to one species, with the possible exception of *P. Ivesi* Newberry.

Viewing the species in this light, it is one of the most remarkable of all known fossil shells, not only for its great variation, but for its wide geographical distribution and great geological range. It is now known as a common fossil in the Carboniferous strata of Europe, India, South America, and North America. It is found in the Keokuk limestone of the Subcarboniferous period, in Illinois, Iowa, and Missouri, and also ranges through the whole series of strata of the Carboniferous period of those States as well as in Kansas and Nebraska. The localities given below make a still further addition to its known geographical range; but most of the examples in the collections are of the variety *P. Ivesii.*

Position and locality.—Strata of the Carboniferous period:—near Bear Spring, Camp Wingate, and near Santa Fé, New Mexico: Camp Cottonwood, old Mormon road, Lincoln County, and top of Grass Mountain, Ely range, thirty-five miles north of Pioche, Nevada: head of Partridge Creek; near Bill Williams's Mountain; Tenney's Ranch; Kaibab Plateau; head of Dry Fork, and Kanab Cañon (Aubrey limestone), Arizona: crest of Hurricane Hill, near Toquerville, and Meadow Creek, south of Fillmore, Utah.

Productus Prattenianus Norwood.

Plate VII, fig. 1 *a*, *b*, and *c*.

Productus cora Owen, 1852, Geol. Report Iowa, Wisconsin, and Minnesota, pl. v, fig. 1 (not d'Orbigny).
Productus semireticulatus Hall, 1852, Stansbury's Report Great Salt Lake, 411 (not Martin, *sp.*).
Productus Prattenianus Norwood, 1854, Jour. Acad. Nat. Sci. Phila., n. s., iii, 17.
Productus æquicostatus Shumard, 1855, Geol. Report Missouri, 201.
Productus cora Marcou, 1858, Geology of North America, pl. vi, figs. 4 and 4^a (not d'Orbigny).
? Productus lævicostus White, 1860, Jour. Bost. Soc. Nat. Hist., vii, 230.
Productus Flemingii Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 52 (not Sowerby, 1814).
Productus Calhounianus Geinitz, 1866, ib., 81 (not Swallow, 1858).
Productus Koninckianus Geinitz, 1866, ib., 53 (not de Verneuil, 1845).
Productus Prattenianus Meek, 1872, U. S. Geol. Surv. Nebraska, 163.

Shell usually of medium size, but sometimes quite large; breadth generally greater than the length, if the latter be measured in a straight line from hinge to front; hinge in most cases longer than the greatest width of the body of the shell; lateral and front margins regularly and continuously rounded; ears prominent, thin, and generally broken off in the embedding rock; mesial fold and sinus wanting.

Ventral valve somewhat uniformly convex, but in some old shells there is a greater or less mesial flattening of the visceral region; umbonal region gibbous as a rule, but in rare cases depressed; beak hardly projecting over the cardinal border; ears marked by strong wrinkles, which are continuous with similar faint ones that pass up from each side toward the visceral region of the valve, and in rare cases meeting at the middle, the wrinkles ending posteriorly at the cardinal margin, upon which they produce an appearance similar to that of a curtain gathered upon a cord.

Surface of the valve marked by fine, regular, rounded striæ, some of which may be traced continuously from the umbonal region to the front, increasing by implantation, and occasionally coalescing; somewhat strong, erect spines are usually scattered over the surface, the cardinal border being furnished with numerous strong ones, pointing backward.

Dorsal valve somewhat uniformly concave; ears with folds or wrinkles corresponding with those of the other valve; surface marked like that of the ventral valve, except that it is without spines and concentric folds, and that the lines of growth are rather more distinct upon it.

Length of a very large specimen, six centimeters; breadth, six and a half centimeters; but the average size is about one-third less.

This species ranges through the whole Coal-Measure or Carboniferous series; and if, as now seems probable, *P. lævicostus* White, from the Kinderhook formation in Iowa, is not specifically different, its range is through all the strata of both the Subcarboniferous and Carboniferous periods.

Position and locality.—Strata of the Carboniferous period:—near Santa Fé and Zandia Mountains, New Mexico: Piloncillo range near Gavilan Peak, and at the confluence of White Mountain and Black Rivers, Arizona: Egan range, thirty-five miles south of Egan Pass; Fossil Hill, White Pine County; Roberts' Creek range, Lander County; and top of Grass Mountain, Ely range, thirty-five miles north of Pioche, Nevada: near Beckwith Spring, Cedar range; near the top of Mount Nebo; and upon the west face of Oquirrh range, Utah. Imperfect specimens, apparently belonging to this species, were also found at Mountain Spring, Lincoln County, Nevada, and at a locality below Ophir City, Utah, in rocks that I have referred to the Subcarboniferous period. As already shown, it is not improbable that the species ranges from strata of that period upward.

Productus punctatus Martin, *sp.*

Plate VII, fig. 2 *a*, *b*, and *c*.

Anomites punctatus Martin, 1809, Petrificata Derb., pl. xxxvii, fig. 6 (only).
Trigonia rugosa Parkinson, 1811, Organic Remains, iii, pl. xii, fig. 11.
Productus punctatus Sowerby, 1822, Min. Conch., 22.
Anomites thecarius Schlotheim, 1823, Nachtrag zum Petref., ii, 63.
Productus concentricus Potiez et Michaud, 1844, Gal. des Moll. du Mus. de Douai, ii, 25.
Producta punctata Phillips, 1836, Geology of Yorkshire, 215.

Leptæna sulcata Fischer, 1837, Oryct. du Gouv. de Moscou, pl. xxiii, fig. 2 (not Sowerby).
Productus semipunctatus Shephard, 1838, Amer. Jour Sci., xxxiv, fig. 9.
Productus punctatus de Koninck, 1843, Animaux Foss. Carb. Belg., 196.
Productus punctatus de Verneuil, 1845, Russia and the Ural Mountains, ii, 276.
Productus vittatus Hall, 1858, Geology of Iowa, i, pt. ii, 639.
Productus punctatus Davidson, 1860, Monog. British Carb. Brachiopoda, 172.
Productus tubulospinus McChesney, 1860, Descr. New Paleozoic Fossils, 37.
Productus punctatus Meek, 1872, U. S. Geol. Surv. Nebraska.

Shell large, thin; outline varying from imperfectly four-sided, the narrowest side being the posterior one, to subovate; sometimes wider than long, but oftener longer than wide; cardinal margin almost invariably shorter than the width of the shell at any part in front of it; anterior border broadly rounded, but usually a little emarginate at the middle; sides flattened, by which means the lateral margins are somewhat straightened; ears small.

Ventral valve broadly arcuate from front to rear, in which direction there is also a broad mesial flattening of the valve, with usually a shallow but distinct mesial sinus along its middle; umbo prominent, narrow, beak small, incurved, and projecting slightly over the cardinal margin. Dorsal valve moderately concave; beak concave; mesial fold slightly raised, extending along the visceral and anterior portions of the valve.

Surface of both valves marked by rather numerous and regular concentric folds, which are smaller at the beak and borders than elsewhere upon adult shells, and smaller and more indistinct upon the dorsal than upon the ventral valve; interspaces between the concentric folds plain; folds supporting numerous spines of various sizes, but all small, and all more or less appressed.

Length of the specimen figured, four and a half centimeters; breadth, at the broadest part, four centimeters; but this is rather smaller than the average size of adult shells.

This species is known throughout the whole Coal-Measure series of the United States, especially in the valleys of the Mississippi and Missouri, and is also a common Carboniferous species in Europe. Besides its range through all the strata of the Carboniferous period in this country, examples are frequently found in the Subcarboniferous strata of Missouri, Illinois, and Iowa that I am quite unable to separate specifically from *P. punctatus*, among which are the examples described by Hall (*loc. cit.*) under that name, from the Keokuk limestone at Keokuk, Iowa, and Nauvoo, Illinois. The collections contain comparatively few specimens of this species, a fact probably due less to its scarcity or absence at other localities than to the well-known fragility of the shell, which has doubtless prevented its perfect preservation, such as we find in the case of many other shells associated with it.

Position and locality.—Strata of the Carboniferous period; at and near the top of Grass Mountain, Ely range, thirty-five miles north of Pioche, Nevada.

Productus Nebrascensis Owen.

Plate VIII, fig. 3 *a*, *b*, *c*, and *d*.

Productus Nebrascensis Owen, 1852, Geol. Report Iowa, Wisconsin, and Minnesota, 584.
Productus Rogersi Norwood and Pratten, 1854, Jour. Acad. Nat. Sci. Phila., n. s., iii, 9.
Productus Rogersi Hall, 1856, Pacific Railroad Report, iii, 104.
Productus asper McChesney, 1860, Descr. New Paleozoic Fossils, 34.
Strophalosia horrescens Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 81 (not Murchison, de Verneuil, and Keyserling, 1845).
Productus Nebrascensis Meek, 1872, U. S. Geol. Surv. Nebraska, 165.

Shell of about average size for a species of this genus; outline, in front of the cardinal border, suboval or sub-hemispherical; length usually less than the breadth; hinge generally less in length than the greatest breadth of the shell, and seldom equaling it; antero-lateral margins strongly, and front margin broadly, rounded, the latter sometimes a little emarginate; postero-lateral margins somewhat straightened upon, and in front of, the ears, meeting the cardinal border at a somewhat obtuse angle; ears small, seldom prominent.

Ventral valve somewhat regularly convex from front to rear; greatest convexity behind the middle; umbo prominent, projecting behind the hinge-line; beak prominent, incurved a little over the cardinal margin; a mesial flattening, amounting sometimes, but rarely, to a distinct sinus, extending from the umbo to the front margin. Dorsal valve flattened in the visceral region, the antero-lateral and front portions curving abruptly upward; beak and auricular regions depressed so as to produce a slightly-raised, rounded, diverging fold between them, respectively, at each side; mesial fold seldom distinct, and perceptible only at the front.

Surface of both valves covered with numerous spines of different sizes, but all very small; those of the ventral valve are borne upon more or less distinctly defined concentric folds, and may be divided into two sets, or kinds, one consisting of the stronger and more erect spines, and the other of small, short ones, which latter are closely appressed against the surface; both kinds are more or less connected by means of numerous raised, radiating lines, which are apparent upon the concentric folds, but scarcely so upon the surface of the interspaces.

Length, thirty-three millimeters; breadth, thirty-five millimeters.

As usually obtained from a limestone matrix, the spines and more or less of the surface of the shell remain with the matrix. Such specimens present an appearance so different from that of those which have been perfectly preserved in a soft matrix that they have been referred to different species. Among references of this kind is that made by Professor Geinitz (*loc. cit.*) of this species to *Strophalosia horrescens.* Concerning this I can only say that I have collected and examined hundreds of examples of this species from his typical locality, and from numerous other localities in Nebraska, Iowa, Illinois, and Missouri, many of them having the interior and all other parts well preserved and shown, and not one of them was found to possess any of the generic characters peculiar to *Strophalosia.* That, as suggested by Dr. Geinitz, the genus *Strophalosia* may have been developed from *Productus,* and also that in some cases, while it was effecting such a generic transition, the specific characters may have remained comparatively unchanged, I am willing to believe; but that question need not be now discussed. That *Productus Nebrascensis,* however, affords any evidence of such a change, I am by no means prepared to admit.

Position and locality.—Strata of the Carboniferous period:—Camp Apache and Carrizo Creek, Maricopa County, Arizona: Rubyville, Schell Creek range; and top of Grass Mountain, Ely range, Nevada: Meadow Creek, south of Fillmore, Utah; and other localities.

Productus longispinus Sowerby.

Plate VIII, fig. 5 *a*, *b*, *c*, and *d*.

Productus longispinus Sowerby, 1814, Mineral Conchology, i, 154.
Productus Flemingii Sowerby, 1814, ib., 154.
Productus spinosus Sowerby, 1814, ib., 155.
Productus lobatus Sowerby, 1814, ib., iv, 16.
Producta setosa Phillips, 1836, Geol. of Yorkshire, ii, 214.
Productus longispinus de Koninck, 1843, Anim. Foss. Terr. Carb. Belg., 184.
Productus capacii d'Orbigny, 1843, Voyage dans l'Amérique Mérid., iii, 50.
Productus tubarius Keyserling, 1846, Reise in das Petschora Land, 208.
Productus longispinus Davidson, 1853, Int. Brit. Foss. Brach., pl. ix, 221.
Productus Wabashensis Norwood and Pratten, 1854, Jour. Acad. Nat. Sci. Phila., n. s., iii, 13.
Productus splendens Norwood and Pratten, 1854, ib., 11.
Productus Orbignyanus Geinitz, 1866, Carbonformat. und Dyas in Neb., 56 (not de Koninck, 1848).
Productus horridus Geinitz, 1866, ib., 55 (not Sowerby, 1822).
Productus longispinus Meek, 1872, U. S. Geol. Surv. Nebraska, 161.

Shell small, almost always broader than long, usually broadest at the hinge-line; ears distinct, a little reflexed, sometimes very prominent, each antero-lateral border regularly rounded from the base of the ear to the mesial sinus.

Ventral valve very gibbous, greatest convexity behind the middle, where the antero-posterior curvature is sometimes so abrupt as to make the hinder portion almost perpendicular with the plane of the margins, but the curvature is generally more regular, carrying the umbonal region to the rear of the hinge-line; beak small, slightly prominent, barely projecting over the cardinal margin; mesial sinus usually broad and distinct, but sometimes almost obsolete; postero-lateral slopes almost perpendicular with the ears. Surface of the valve marked by fine, radiating, rounded striæ, which are variable in their distinctness and size in different shells as they are also in different varieties, more distinct on the ventral than on the dorsal valve, generally obsolete on the umbonal region of both valves; striæ crossed by fine concentric wrinkles, which are distinct in some specimens but obsolete in others; fine concentric lines of growth are also to be seen under a lens; spines strong, erect, long, scattered over the surface somewhat uniformly, but from some specimens they have been removed so completely that they appear as if they had borne none.

Dorsal valve concave, having a faint mesial fold in front corresponding with the sinus of the other valve. No spines have been observed on the dorsal valve; but in other respects its surface is marked like that of the other.

Length of a large specimen from Meadow Creek, Utah, eighteen millimeters; length of a specimen of a variety obtained from near Santa Fé, New Mexico, twelve millimeters; breadth of the one last mentioned, thirteen millimeters.

The fact that Sowerby, who first described this species, divided it up into four, and that Phillips and Keyserling each added another one, is sufficient to indicate its variable character in Europe. The American forms are now almost universally regarded as identical with the European, and it is an interesting and significant fact that the species is as variable in this part of the world as its European representative is. Some of the American varieties are quite constant. The collections contain several fine examples, of one of these varieties from near Santa Fé, New Mexico, which variety is as worthy of a separate specific designation as any of those that have been mentioned. This variety is represented by figures 5 *c* and *d*, Plate VIII. It uniformly smaller than the average size of typical examples; the mesial sinus is obsolete, spines delicate, and the surface upon the visceral region more or less distinctly wrinkled.

Taking the view of the identity of this species that is indicated by the foregoing remarks, and the synonymy herewith presented, its geographical and geological range is found to be very great. It is a well-known fossil in the Carboniferous rocks of Europe, and also those of both North and South America. In this country, it is found to range through the whole series of strata of the Carboniferous period; but, so far as I am aware, it has not thus far been found in the Subcarboniferous rocks of North America.

Position and locality.—Strata of the Carboniferous period; east of Minersville, and at Meadow Creek, south of Fillmore, Utah; Camp Cottonwood, old Mormon road, Lincoln County, Nevada; near Santa Fé, New Mexico.

Productus muricatus Norwood and Pratten.

Plate VIII, fig. 4 *a*, *b*, and *c*.

Productus muricatus Norwood and Pratten, 1854, Jour. Acad. Nat. Sci. Phila., n. s., iii, 14.

Among the collections made by Prof. J. J. Stevenson from the "Middle Division, Carboniferous, Rock Creek, Lake County, Colorado", are some imperfect but unmistakable specimens of *P. muricatus* Norwood and Pratten. This is quite a well-known form; but Mr. Meek (U. S. Geological Survey of Nebraska, page 161) refers it with doubt to *P. longispinus*. Having found, in a long familiarity with all these shells, that, unlike most of the admitted varieties of *P. longispinus*, this species retains its specific characteristics with great constancy over wide areas, I am disposed to regard it as a distinct species.

So far as at present known, the geological range of the species is through the whole of the Carboniferous or Coal-Measure series. In Iowa, I found it almost characteristic of the Middle Coal-Measures, in the limestones and calcareous shales of which it was often found abundant.

Productus Mexicanus Shumard (?).

Plate VIII, fig. 6 *a*, *b*, and *c*.

Productus Mexicanus Shumard, 1858, Trans. Acad. Sci. St. Louis, i, 291.

Shell small, usually wider than long, emarginate in front, and flattened a little at the sides, giving it a somewhat four-sided outline when viewed vertically; cardinal border equal to, or greater than, the greatest breadth of the body of the shell; ears more or less prominent, distinctly defined and convex upon the ventral side. Ventral valve strongly and somewhat regularly arched, the curvature being greatest posteriorly; beak somewhat prominent, and slightly incurved over the cardinal border; mesial sinus obsolete or indistinctly defined, and disappearing at the visceral region.

Surface marked by from sixteen to twenty rounded, radiating costæ, with interspaces of similar width, all of which are most distinct upon the front part of the shell; the visceral region marked by concentric wrinkles, and the whole surface by fine concentric lines of growth; strong erect spines are scattered over the surface of the ventral valve, borne upon the costæ. Dorsal valve unknown.

Length, fourteen millimeters; breadth, in front of the ears, fifteen millimeters.

This shell differs considerably from any *Productus* known to me in the Carboniferous strata, and especially from any of its size, in the proportionally large size of its costæ. It answers the description given by Dr. Shumard (*loc. cit.*) in almost all particulars; but, as he gave no figure, I am a little in doubt as to its identity. Dr. Shumard described the species from what he then regarded as Permian strata of the Guadalupe Mountains, New Mexico, but they are perhaps equivalent with those now generally regarded as belonging to the Carboniferous period.

Position and locality.—Strata of the Carboniferous period; Camp Cottonwood, old Mormon road, Lincoln County, Nevada, and also near Salt lake, New Mexico.

GENUS CHONETES Fischer, 1837.

Chonetes platynota White.

Plate IX, fig. 6 *a*, *b*, *c*, *d*, and *e*.

Chonetes platynota White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 19.

Shell rather under average size, transversely suboval or indistinctly four-sided; length of hinge-line usually about equal to the greatest width of the shell, but it is sometimes a trifle greater and sometimes a trifle less.

Ventral valve moderately convex, flattened a little toward the hinge-extremities, without a defined mesial sinus, but in place of it there is a mesial flattening or a slight bending upward at the front, which straightens or emarginates the front border a little; beak not prominent; area of moderate width, wider than that of the other valve, bearing on its posterior margin five or six rather small oblique tube-spines each side of the beak. Dorsal valve almost flat, as often a little convex as concave, especially from side to side; mesial fold represented only in adult shells, and in these only by a very slight elevation of the front margin following the slight flexure of the margin of the ventral valve.

Surface of both valves marked by numerous fine, rather obscure, radiating striæ, and occasional imbricating lines of growth.

Length, nine millimeters; breadth, twelve millimeters.

There are only three species yet published from strata equivalent with those which contain this species that are likely in any degree to be confounded with it. From *C. glabra* Geinitz, which it resembles in size and outline, it differs in being radiately striated instead of smooth, in wanting a proper mesial fold and sinus, and in having a flat or slightly convex, instead of concave, dorsal valve. From *C. Verneuilianus* Norwood and Pratten, it differs in being much less extended at the hinge-line, in wanting a proper mesial fold and sinus, and in its flat or convex, instead of concave, dorsal valve. From *C. granulifera* Owen, it differs in its flat or slightly convex dorsal valve, its less extended hinge, and in its much smaller size and different outline.

Position and locality.—Strata of the Carboniferous period; near Santa Fé, and near Salt Lake, New Mexico.

Chonetes granulifera Owen.

Plate IX, fig, 8 *a*, *b*, and *c*.

Chonetes granulifera Owen, 1855, Geol. Report Min., Iowa, and Wisconsin, 583.
Chonetes mucronata Meek and Hayden, 1858, Proc. Acad. Nat. Sci. Phila., 262.
Chonetes mucronata Meek and Hayden, 1864, Paleont. Upper Missouri, 22.
Chonetes mucronata Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 60.
Chonetes granulifera Meek, 1872, U. S. Geol. Surv. Nebraska, 170.

Shell rather large, somewhat semicircular in outline, but the ears are often extended, and the front a little emarginate. Ventral valve having a broad general convexity, which is most prominent at the visceral region on each side of a broad, shallow mesial sinus; postero-lateral portions compressed; beak small, not prominent; cardinal margin having from six to ten oblique tube-spines on each side of the beak; area narrow; foramen broad, and partially closed by a convex pseudo-deltidium; dorsal valve more or less concave, greatest concavity at the beak and central portion; ears flattened; area well developed, narrow; the cardinal process occupying the unclosed portion of the foramen of the other valve.

Surface of both valves marked by very fine, somewhat indistinct, radiating striæ, which are crossed by a few concentric lines of growth. The hinge-line of the largest examples sometimes reaches a length of nearly three centimeters, and the shell a length of sixteen millimeters.

This species is quite a common one in the Upper Coal-Measures near the Missouri River in Missouri, Iowa, and Nebraska, and is represented lower in the Carboniferous series in the two first-named States and in Illinois by shells of somewhat smaller size, but otherwise apparently identical in species. It is probable also that this last-named variety is identical with *C. Smithii* Norwood and Pratten, and if so it becomes another synonym of *C. granulifera*.

Position and locality.—Strata of the Carboniferous period (Upper Aubrey limestone); Kanab Cañon, Arizona.

Chonetes mesoloba Norwood and Pratten.

Plate IX, fig. 7 *a*.

Chonetes mesoloba Norwood and Pratten? 1854, Jour. Acad. Nat. Sci. Phila., n. s., iii, 27.

Shell rather small, transverse, somewhat distinctly quadrilateral, seldom wider at the hinge than it is in front of it. Ventral valve having a greater or less general convexity; mesial sinus comparatively large, and bearing along its middle a small mesial fold or lobe; between the sinus and the postero-lateral portions of the valve there is at each side a comparatively large, more or less prominent, rounded fold, extending from near the beak to the antero-lateral margin. Dorsal valve concave, having at the front two folds, with a mesial depression between them, the depression corresponding with the mesial lobe within the sinus of the ventral valve. Surface marked by fine radiating striæ.

Length of the specimen figured, six millimeters; breadth, nine millimeters; but examples are often found that are one-third larger than this.

The constant presence of a lobe or fold in the mesial sinus of the ventral valve of this shell clearly distinguishes it from all other known species of the genus. Its range is through the whole series of strata of the Carboniferous period in Illinois, Missouri, and Iowa. In the latter State, it has been found almost wholly confined to the Middle Coal-Measures.

Position and locality.—The collections contain only a single specimen of this interesting species, which was obtained from strata of the Carboniferous period, at the confluence of White Mountain and Black Rivers, Arizona.

FAMILY STROPHOMENIDÆ.

GENUS HEMIPRONITES Pander, 1830.

Hemipronites crinistria Phillips, *sp.*

Plate X, fig. 9 *a*.

One of the most common fossils found in the rocks of the Carboniferous period in Illinois, Missouri, Iowa, Nebraska, and Kansas is a very variable shell that has during the past few years been generally referred to *Hemipronites crassus* Meek and Hayden. After the first publication of their description of this species in the Proceedings of the Academy of Natural Sciences of Philadelphia, for 1858, they expressed great doubt (Paleontology of the Upper Missouri, 1864), whether it is really different from *H. crinistria* Phillips (*sp.*) of Europe. The genus *Hemipronites* is also freely represented by different varieties in the Subcarboniferous strata of the States just named, so far as they exist there. After long study of these forms, from the strata of both periods, I have failed to discover entirely satisfactory grounds for the *specific* discrimination of more than one group.

While I am not prepared to deny that there may be more than one species of *Hemipronites* among those hitherto described from the various strata referred to, I have at present very little doubt that the species long known as *H. crassus* ranges through all the strata of both the Subcarboniferous and Carboniferous periods in the States before named, and that the species is identical with *H. crinistria* Phillips. The reader is referred to the following works for descriptions and illustrations of most of the varieties of *Hemipronites* that have been published from strata of the Carboniferous age in America:—Geology of Iowa, Hall, vol. i, part ii, 1858; Paleontology of the Upper Missouri, Meek and Hayden, 1864; Transactions of the Chicago Academy of Sciences, vol. i, part i, 1867; United States Geological Survey of Nebraska, 1872; and Carbonformation und Dyas in Nebraska, Geinitz, 1866.

Position and locality.—Strata of the Carboniferous period:—Meadow Creek, south of Fillmore; Star district, Picacho range; North Fork of Lewiston Cañon, Oquirrh range; below Ophir City; Kanab Cañon, Wasatch range; pass between Rush and Cedar Valleys; and east side of Mount Nebo, Utah; top of Grass Mountain, Ely range; Fossil Hill; Camp Apache; old Potosi mine; Tenney's Ranch; Kaibab Plateau; and at the confluence of White Mountain and Black Rivers, Nevada.

GENUS ORTHIS Dalman, 1828.

Orthis Pecosii Marcou.

Plate IX, fig. 5 *a*, *b*, *c*, *d*, and *e*.

Orthis Pecosii Marcou, 1858*, Geol. North America, 48.
Orthis carbonaria Swallow, 1858, Trans. St. Louis Acad. Sci., i, 218.
Orthis carbonaria Meek, 1872, U. S. Geol. Surv. Nebraska, 173.

Shell small, sublenticular; outline subcircular or subovate; length and breadth nearly equal, but sometimes the length is a little the greatest; front margin regularly rounded or slightly emarginate; hinge-line very short, less than half the breadth of the shell. Ventral valve having its greatest convexity at the umbo, often flattened a little at the front, but without a definite mesial sinus; beak small, pointed, somewhat prominent, and arched over the small, well-defined area, which arches with it.

Dorsal valve more convex than the ventral in old shells, its greatest convexity being behind the middle, generally having a mesial flattening extending from the umbo to the front, but no definite mesial sinus; area distinct, but smaller than that of the other valve; beak small, not prominent.

Surface of both valves marked by fine, close-set, radiating striæ, which increase mainly by implantation, but occasionally by bifurcation; the striæ crossed by fine concentric lines of growth, and, toward the front of old specimens, by imbricating lines.

The striæ often show small pores upon their backs, apparently marking the former places of minute tubular spines.

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* *Orthis Pecosii*, *Retzia Mormonii*, *Rhynchonella Uta*, *R. Rockymontana*, and *Spirifer Rockymontana* were published by Marcou in his Geology of North America. I have obtained satisfactory evidence that the work was published as early as March 1, 1858. Vol. xv of the Bulletin de la Société Géologique de France contains a statement that a copy of the book was sent to that society on April 20, 1858. In the same year, Shumard and Swallow published a paper containing descriptions of the three first-named species, under other names, in the Transactions of the St. Louis Academy of Sciences, but that publication was not made until about the first of June. In December of the same year, Hall published in the Geological Report of Iowa, *Spirifer Rockymontana* as *S. opimus*; and in 1860, McChesney published *R. Rockymontana* as *R. etoniæformis*. It thus appears clear that Marcou is entitled to priority of all five of the names above given, as stated in the synonymy heading the descriptions of those species in this report.

Width and length of a large specimen, each thirteen millimeters; but the average size is nearly one-third less.

This little shell belongs to a section of the genus *Orthis*, of which *O. Michilini* may be cited as the type, and of which *O. Pecosii* is the only representative known to me in American strata above the Subcarboniferous. It is very constant in its specific characters, and has a wide geographical range. Professor Marcou's type-specimens were obtained from New Mexico, but it is not an uncommon shell in the Middle and Upper Coal-Measures of Illinois, Iowa, Missouri, Kansas, and Nebraska. There is a small species of *Orthis* in the Keokuk limestone (Subcarboniferous) of Iowa and Illinois, which is very closely related to this one. If it is not identical with *O. Pecosii*, the range of the latter is probably confined to strata of the Carboniferous period alone.

Position and locality.—Strata of the Carboniferous period; near Santa Fé, New Mexico.

GENUS MEEKELLA White and St. John, 1867.

Meekella striatocostata Cox, *sp.*

Plate IX, fig. 4 *a*, *b*, *c*, *d*, and *e*.

Plicatula striatocostata Cox, 1857, Geol. Report Kentucky, iii, 568.
Orthisina Shumardiana Swallow, 1858, Trans. St. Louis Acad. Sci., i, 183.
Orthisina Missouriensis Swallow, 1858, ib., 219.
Streptorhynchus pyramidalis Newberry, 1861, Exp. Exped. Col. River, Paleont., 126.
Streptorhynchus occidentalis Newberry, 1861, ib., 126.
Orthis striatocostata Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 48.
Meekella striatocostata White and St. John, 1867, Trans. Chicago Acad. Sci., i, pt. i, 120.
Meekella striatocostata Meek, 1872, U. S. Geol. Surv. Nebraska, 175.

Shell variable in size and shape, indistinctly trihedral in outline; both valves becoming gibbous at full adult age; hinge-line generally much shorter than the greatest breadth of the shell.

Ventral valve usually more capacious than the other, but sometimes the difference in this respect is slight, deepest near the umbo; beak almost always more or less distorted by being flattened, depressed, bent backward or toward one side or the other, usually toward the dextral side; area triangular, more or less irregular in consequence of the distortion of the beak; height of area seldom so great as its width at the base, and is often much less, its lateral borders well defined, finely striated, both vertically and transversely; fissure varying in proportional width, but usually quite narrow, and completely closed by a pseudo-deltidium, which is more or less flattened along each side, prominent along the middle, along which prominence there is a slightly-raised mesial line.

Dorsal valve capacious, more regularly convex than the other; convexity so great behind the middle as to carry a portion of the valve a little behind the hinge-line, flattened a little toward the front, suggestive of a mesial sinus, but seldom or never possessing a true one; beak strongly incurved, not projecting over the cardinal border; area obsolete; postero-lateral portions laterally compressed, leaving small thin ears at the hinge-extremities.

Surface of each valve marked by from ten to fourteen, more or less angular, radiating plications, having deep, angular interspaces between them; plications not extending to the beak, increasing in size toward the front, mostly simple, but sometimes bifurcating; plications and interspaces both marked by numerous fine radiating striæ, which, toward the front margin of adult shells, usually converge to the crests of the plications, upon which they meet at acute angles; crossing these converging lines, there are also usually zig-zag lines of growth to be seen. The convergence of the radiating striæ does not take place until the shell has reached nearly mature size, and occasionally not then.

This shell is variable in size and shape, and to some extent in its surface-markings also; but its general characteristics are such as to separate it widely from any associated forms. Two principal varieties of the species have been recognized and published as separate species; but in the Upper Coal-Measure rocks of Iowa I have found these two varieties associated with such intermediate forms as to convince me that they are not specifically distinct. Some of these differences appear to be of such a character only as all species are subject to, and some of them are evidently due to difference in age alone.

I have not yet seen any American shell belonging to the genus *Meekella* that I regard as specifically distinct from *M. striatocostata.* Compared with a specimen of *Streptorhynchus pectiniformis* Davidson, sent me from

England by that gentleman, from collections made in Punjab, India, many specimens of our shell are found to be specifically undistinguishable from it by external features; and, unless its internal characters should prove to be different, it cannot be regarded as specifically distinct from *M. striatocostata*. In Iowa and Nebraska, it is confined to strata of the Upper Coal-Measures.

Length of one of the specimens figured, twenty-five millimeters; breadth, twenty-six millimeters; height, twenty millimeters; but examples are occasionally found having nearly or quite double these dimensions, but in such large ones the height is not often proportionally so great.

Position and locality.—Strata of the Carboniferous period:—Camp Cottonwood, Lincoln County, Nevada: Tenney's Ranch, Kaibab Plateau, Arizona: Kanab Cañon; Meadow Creek, south of Fillmore; Le Verkin's Creek; and at a cliff east of Belleview, Utah.

FAMILY RHYNCHONELLIDÆ.

GENUS RHYNCHONELLA Fischer, 1809.

Rhynchonella Uta Marcou, *sp.*

Plate IX, fig. 2 *a*, *b*, and *c*.

Terebratula Uta Marcou, 1858,* Geology of North America, 51.
Rhynchonella (Camarophora) Osagensis Swallow, 1858, Trans. St. Louis Acad. Sci., i, 219.
Camarophora globulina Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 38 (not *C. globulina* Phillips, *sp.*, 1834).
Rhynchonella Osagensis Meek, 1872, U. S. Geol. Surv. Nebraska, 179.

Shell rather small, varying considerably in form, usually somewhat trihedral, and a little wider than long; postero-lateral margins converging at an angle, varying in different shells from eighty to one hundred and ten degrees; front broadly rounded, emarginate at the middle.

Dorsal valve more capacious than the ventral, abruptly convex at the front; beak strongly incurved; mesial fold not prominent, and perceptible only at the front; plications somewhat angular, from nine to twelve in number, becoming obsolete at the middle and sides of the valve; three or four of these plications are borne upon the mesial fold, and there are also three or four upon each side of it.

* See foot-note concerning date of publication on page 125.

Ventral valve rather shallow, similar to the other valve in number, distribution, and character of the plications; mesial sinus broad, shallow, and short, generally having two plications at its bottom, but sometimes three; all the plications in both valves disappearing about the middle, so that the surface of the posterior portion of the shell is almost entirely unmarked except by faint concentric lines of growth.

Usual length of adult examples about ten millimeters; breadth, eleven millimeters; but many much smaller examples are found, and the collections contain a few specimens figured on Plate IX, the dimensions of which are one-third greater than those given, and yet they seem evidently referable to this species.

This shell has quite a wide geographical range, being found in the Carboniferous strata of Illinois, Iowa, Missouri, Kansas, and Nebraska, and Professor Marcou obtained his type-specimens from near Great Salt Lake, Utah So far as known, it is confined to the strata of the Carboniferous period. It is more nearly related to *R. Ottumwa* White than to any other shell known to me, the more gibbous examples of which it closely resembles.

Position and locality.—Strata of the Carboniferous period; North Fork of Lewiston Cañon, Oquirrh range, and at Meadow Creek, south of Fillmore, Utah.

Rhynchonella metallica White.

Plate X, fig. 10 *a*, *b*, *c*, and *d*.

Rhynchonella metallica White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 20.

Shell rather less than medium size, depressed, or moderately inflated when adult; transversely suboval in outline; antero-lateral borders abruptly rounded; front broadly rounded, but usually straightened or slightly emarginate at the middle; postero-lateral margins straightened, laterally compressed, and converging to the beaks at a very obtuse angle.

Dorsal valve more capacious than the ventral, broadly convex from side to side, a little flattened near the beak, abruptly bent downward at the margins; mesial fold broad, not much elevated, discernible only on the anterior part of the valve.

Ventral valve comparatively shallow, slightly convex from side to side;

convexity from the umbo to the antero-lateral margins about the same as it is from side to side; beak small, prominent, and incurved over that of the dorsal valve; mesial sinus broad, becoming obsolete near the middle of the shell, and is entirely wanting upon the posterior portion.

Surface marked by from fourteen to sixteen simple, angular, plications upon each valve, with angular interspaces of similar width between them, all of which are continuous from the front to the beaks; about four of these plications are borne in the mesial sinus, and five of them upon the mesial fold.

Length, ten millimeters; breadth twelve, millimeters; height, seven millimeters.

This shell is more nearly related to *R. Cooperensis* Shumard from the Subcarboniferous strata of Missouri than any other species with which I am acquainted; but it differs in having a less number of plications, and in wanting the numerous filiform striæ that mark the surface of that shell.

Position and locality.—Strata of the Carboniferous period; Old Potosi Mine, Lincoln County, Nevada.

Rhynchonella Wasatchensis White.

Plate IX, fig. 3 *a*, *b*, *c*, and *d*.

Rhynchonella Wasatchensis White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 19.

Shell under medium size, sublenticular or subglobose; valves nearly alike in their convexity; length equal to, or slightly greater than, the breadth; antero-lateral and front margins somewhat regularly rounded, the front being slightly straightened or a little emarginate; postero-lateral margins converging to the beaks at an obtuse angle.

Dorsal valve broadly convex from side to side; convexity from beak to front regular but a little greater than it is transversely; umbo prominent; beak strongly incurved; mesial fold obsolete or wanting.

Ventral valve strongly and somewhat regularly arching from beak to front; convexity from side to side a little less than it is longitudinally and about the same as the transverse convexity of the other valve; beak somewhat prominent and incurved over the beak of the dorsal valve; mesial sinus obsolete or wanting.

Surface marked by a few obscure radiating striæ, which are most conspicuous near the median line of each valve; fine concentric striæ are numerous, and in the adult shell there are also strong imbricating lines of growth near the front and lateral margins.

Length, fifteen millimeters; breadth, fourteen millimeters; height, twelve millimeters.

This shell is not only without the plications so common to the paleozoic species of *Rhynchonella*, but it has also a different general aspect. This has caused some doubts to arise as to the propriety of referring it to that genus, but the broken ventral beak shows no other characters than those of *Rhynchonella*, and the shell-structure is also distinctly fibrous and not punctate.

Position and locality.—Strata of the Carboniferous period; Rock Cañon, Wasatch Range, near Provo, Utah, where only a single example was obtained.

Rhynchonella Rockymontana Marcou.

Plate IX, fig. 1 *a*, *b*, *c*, and *d*.

Terebratula Rockymontana Marcou, 1858, Geology of North America, 50.
Rhynchonella catoniæformis McChesney, 1860, Description New Pal. Fossils, 49.

Shell rather large, inflated, subtrihedral in outline, broadest near the front; sides somewhat regularly rounded from the antero-lateral portions to the beaks. Ventral valve having its greatest convexity toward the beak; sides sloping away from the middle with slight convexity and becoming flattened or sometimes even a little concave near the lateral margins; beak rather small, prominent, and closely incurved over that of the other valve; mesial sinus very broad but not deep, prolonged far upward at the front, becoming obsolete about the middle of the valve and is entirely wanting upon its posterior portion; from two to four depressed angular plications occupy the mesial sinus and disappear with it, the sides and posterior portion being free from plications. Dorsal valve more capacious than the ventral; mesial fold distinct at the front, and, like the mesial sinus, becoming obsolete about the middle of the valve; from three to five plications like those of the other valve mark the fold, but the surface upon each side of it is plain like that of the posterior portions of both valves. The whole surface marked by fine striæ of growth, but no radiating striæ have been detected.

Length, twenty-five millimeters; breadth, twenty-six millimeters; height, seventeen millimeters.

The only American shell likely to be confounded with this species is *R. Missouriensis* Shumard, but it differs somewhat in outline and proportions as given in the description and figures of Dr. Shumard and also in the character of the plications. There is a shell in the Kinderhook formation at and in the vicinity of Burlington, Iowa, which is usually referred to *R. Missouriensis.* If that shell is correctly so referred, it differs materially from *R. Rockymontana* in being plainly marked by numerous distinct, radiating striæ upon both valves. This shell is also very closely like *R. reniformis* Sowerby from the Carboniferous strata of England, and may possibly be identical with it.

Position and locality.—Strata of the Carboniferous period; near Beckwith Spring, Cedar range, Utah. Professor Marcou obtained his type-specimens from Pecos Village, New Mexico, where he found them associated with *Productus semireticulatus* and *Spirigera subtilita.*

FAMILY SPIRIFERIDÆ.

GENUS SPIRIFER SOWERBY, 1815.

Spirifer cameratus Morton.

Plate X, fig. 1 *a*, *b*, *c*, and *d*.

Spirifer cameratus Morton, 1836, American Journal Science, xxix, 150.
Spirifer triplicatus Hall, 1852, Stansbury's Expedition Great Salt Lake, 410.
Spirifer Meusebachanus Roemer, 1852, Kreidebildung von Texas, 88.
Spirifer cameratus Hall, 1856, Pacific Railroad Surveys, iii, 102.
Spirifer cameratus Hall, 1858, Geology of Iowa, i, pt. ii, 709.
Spirifer cameratus Meek, 1872, U. S. Geol. Surv. Nebraska, 183.

Shell usually of medium size, but sometimes quite large, subsemicircular or subtrihedral in outline, almost always broadest at the hinge-line; the hinge-extremities often pointed and sometimes mucronate.

Dorsal valve not quite so capacious as the other; mesial fold distinct, broad at the front, sometimes sharply elevated, but more commonly rounded, clearly defined from front to beak, and rapidly increasing in width to the front by the greater or less curving-outward of the sides; sides of the valve sloping almost directly from the mesial fold to the lateral borders; antero-posterior convexity of the mesial fold very slight from front to middle, but increasing from the middle to the beak; beak small, projecting slightly over the cardinal border.

Ventral valve strongly arching from beak to front, the beak being prominent, pointed, and curved over the area; area concave, of moderate width, and not narrowing to a sharp angle at the hinge-extremities; foramen almost equilaterally triangular, partially closed by a pseudo-deltidium, which is often removed by weathering; mesial sinus well defined from front to beak, and in all respects answering to the mesial fold of the other valve.

Surface marked by numerous distinct, rounded striæ of unequal size, which increase gradually in size toward the front; striæ increasing in number by the division near the beak of the few that are continuous to its point; they are thus generally gathered into more or less distinct fascicles of three or more striæ in each, the middle striæ of the fascicle being the most prominent, and also the one that reaches the point of the beak; the mesial fold and sinus usually have striæ of the same character and arrangement as the sides of the shell have, but in some rare cases they are obsolete upon the sides of the fold and sinus respectively. Besides the radiating striæ the usual concentric lines and occasional coarser marks of growth exist.

Length of a good-sized example, thirty-two millimeters; breadth, at the hinge-line, forty-three millimeters; height, twenty-two millimeters.

This is one of the most common species in American strata of the Carboniferous period, and may generally be identified without hesitation, but there are some varieties of it that give more trouble in satisfactory identification. One variety has been described by Professor Swallow as var. *Kansasensis*, which is more than usually transverse, and the striæ nearly uniform in size, and not fasciculated, as they are in typical examples, approaching in these respects *S. striatus* Martin, *sp.*

Position and locality.—Strata of the Carboniferous period:—Fossil Hill, White Pine County; Ely range; Old Potosi Mine, Lincoln County, and Egan range, thirty-five miles south of Egan Pass, Nevada; Camp Apache, Maricopa County; Salt River; confluence of White Mountain and Black Rivers; and Cañon Butte, Arizona; Oquirrh range, near Camp Floyd; Lake range, on Fairfield road; west face of Oquirrh range; North Fork of Lewiston Cañon, Oquirrh range; cliff east of Belleview; Meadow Creek, south of Fillmore; North Star district, Picacho range; near Beckwith Spring, Cedar range; Rock Cañon, Wasatch range, near Provo, and Virgin range, southwest of Saint George, Utah.

Spirifer striatus Martin, *sp.*

The collections contain some examples of *Spirifer* that are more or less imperfect, but which are so closely like *S. striatus* that I am unwilling at present to make any other assignment of them. They are from strata of the Carboniferous period, near Fort Bayard, New Mexico, and the North Star district, Picacho range, Utah.

They seem to be different from Professor Swallow's variety of *S. cameratus* before mentioned, and are evidently identical with the shell referred by Professor Marcou to this species in his Geology of North America, examples of which he obtained in part from localities not far distant from those at which ours were obtained. Specimens of this species were also obtained from the Subcarboniferous strata at Mountain Spring, old Mormon road, Nevada, which are noticed on a previous page.

Spirifer rockymontanus Marcou.

Plate XI, fig. 9, *a*, *b*, *c*, and *d*.

Spirifer rockymontani Marcou, 1858,* Geol. North America, 50.
Spirifer opimus Hall, 1858, Geol. Iowa, i, pt. ii, 711.
Spirifer subventricosa McChesney, 1860, Descr. New Paleozoic Foss., 44.

Shell very variable in outline, some examples being scarcely broader than long, while the length and breadth of others have the relative proportions of seven to ten; regularly rounded in front of the hinge, the hinge-line being usually a trifle shorter than the breadth of the shell immediately in front of it; the valves are of almost equal capacity, and more or less gibbous. Ventral valve having a moderately well-defined mesial sinus,

*See foot-note on page 125 concerning date of publication of this species.

which is wide at the front, and distinctly defined from front to beak; area of moderate width, concave, the beak being strongly incurved over it.

Dorsal valve having a mesial fold corresponding in shape and distinctness with the sinus of the other valve; beak not prominent, projecting very little over the cardinal border.

Surface of each valve bearing from twenty-four to thirty radiating plications, distributed over the sides and also upon the fold and sinus; the middle plications somewhat larger than any of the others, the size diminishing gradually toward the postero-lateral regions.

The numerous specimens of this species in the collections present most perplexing variations, and I have repeatedly been almost persuaded to arrange some of them under a separate specific name, but the presence of intermediate forms has prevented such a decision. I have no doubt of the specific identity of our shell with *S. Rockymontanus* Marcou, and it will also be noticed that some of our examples were obtained from near the same localities that furnished the type-specimens used by Professor Marcou in writing his description. Many of the examples under examination agree in all essential particulars with *S. opimus* Hall, which thus becomes a synonym of *S. Rockymontanus*. Compared with figures and descriptions of *S. bisulcatus* Sowerby from the Subcarboniferous strata of Great Britain, some of our examples agree so closely that I suspect this American shell may, after all, prove to be identical with that European species.

Position and locality.—Strata of the Carboniferous period: North Fork of Lewiston Cañon, Oquirrh range, and upon the west face of Oquirrh range, Utah; also near Santa Fé, New Mexico.

SUBGENUS MARTINIA McCoy, 1844.

Spirifer (Martinia) planoconvexus Shumard.

Plate X, fig. 3 *a*, *b*, and *c*.

Spirifer planoconvexus Shumard, 1855, Geological Report of Missouri, 202.
Ambocœlia gemmula McChesney, 1860, Descr. New Paleozoic Fossils, 41.
Spirifer planoconvexus Meek and Hayden, 1864, Paleont. Upper Missouri, 20, 21.
Spirifer planoconvexus Geinitz, 1866, Carbonformation und Dyas in Nebraska, 42.
Compare with *Spirifer Urii* Fleming, 1828, British Animals, 376.

Shell very small; breadth varying from a little more to a little less than the length; hinge-line of considerable length, but always shorter than the full breadth of the shell in front of it; lateral and front borders regularly and continuously rounded.

The dorsal valve would be almost circular but for its truncation by the hinge-line, nearly flat, but slightly convex at the umbo, and sometimes slightly concave at the front; beak minute, not prominent; area very narrow.

Ventral valve capacious, especially its posterior portion, which extends much behind the hinge-line, and ends in a prominent, strongly incurving, pointed beak; area very narrow, high, concave; mesial sinus absent, but in its place there is usually a slight flattening at the front, and sometimes an indistinctly impressed line is to be seen extending from beak to front.

Surface apparently smooth, but under a lens it is seen to be finely granular, the apparent granules being the bases of minute setæ; a few concentric lines of growth are usually observable upon both valves.

This shell agrees so closely in many respects with *S. Urii* Fleming, from the British Carboniferous strata, that the propriety of placing it under any other specific name may well be questioned. In view, however, of the fact that the characteristics of this subgenus admit of the development of very few salient specific characters, I am at present disposed to regard these minor differences as affording sufficient reason for continuing the use of Shumard's name. It is one of the most common species in American rocks of the Carboniferous period, having been found in the Coal-Measure strata of Virginia, Pennsylvania, Illinois, Missouri, Iowa, Nebraska, and Kansas, besides the regions that have supplied it to our collections, being generally most abundant in the upper portion of the series. It is often gregarious; some portions of the strata in which it occurs being composed mainly of shells of this species alone. The collections, however, contain comparatively few examples.

Position and locality.—Strata of the Carboniferous period: near Santa Fé, New Mexico; and at Elko Mountain, Nevada.

Spirifer (Martinia) glaber var. contracta Meek and Worthen.

Plate X, fig. 2 *a*, *b*, and *c*.

Anomites glaber Martin, 1809, Petrificata Derbiensia, pl. xlviii, figs. 9, 10.
Spirifer glaber Sowerby, 1820, Mineral Conchology, iii, 123.

Trigonotreta oblata Bronn, 1836, Lethæa Geognostica, i, 81.
Spirifer glaber Phillips, 1836, Geology of Yorkshire, ii, 219.
Spirifer lævigatus von Buch, 1840, Mém. de la Soc. Géol. de France, iv, 198.
Spirifer glaber de Koninck, 1844, Animaux Fossiles de la Bélgique, 267.
Martinia glabra McCoy, 1844, Synopsis Carb. Fossils of Ireland, 139.
Spirifera glabra McCoy, 1855, British Palæozoic Fossils, 428.
Spirifera glabra Davidson, 1857, Monog. British Carb. Brachiopoda, 59.
Spirifer glaber var. *contracta* Meek and Worthen, 1866, Geol. Surv. of Illinois, ii, 298.

Shell reaching about medium size, rotund, gibbous, or becoming much inflated with age; length and breadth usually about equal; hinge-line short, not quite equal to half the transverse diameter of the shell. Dorsal valve less capacious than the other, subcircular, broadly rounded in front, most convex near the beak; the beak is small, slightly prominent, and projects trifle over the cardinal margin. Ventral valve capacious, arcuate; umbo extended much behind the hinge-line, especially in adult shells; mesial sinus absent or obsolete; beak prominent, pointed, and strongly incurved; area narrow laterally, moderately high, concave, lateral borders obscurely defined; foramen comparatively large, occupying the greater part of the area.

Surface apparently smooth, but under a lens fine concentric lines are seen, which appear to have been the seat of concentric rows of very minute setæ; concentric folds are also sometimes present, especially toward the margins of old shells.

Length and breadth of the largest specimen in the collection, each six millimeters; height, twenty millimeters; but this is considerably larger than the average size of the others, and the height is proportionally greater.

The type-specimens of this variety of *S. glaber* were obtained by Meek and Worthen from the Chester limestone (Subcarboniferous) at the town of Chester, Illinois. Our shell agrees so exactly with it that I feel compelled to refer it to that variety notwithstanding the fact that it was obtained from strata of another and later period. The principal observable difference between ours and Meek and Worthen's type-specimens seems to be a nearer approach in their shell to a defined mesial sinus than in ours, but this difference may be no more than an individual one. If it is not referable to this variety, I am not able at present to refer it to any other than the original European species. It especially resembles a variety from Yorkshire, England, which Mr. Davidson illustrates on Plate XII, figs. 8, 9, and 10, of his Monograph of British Carboniferous Brachiopoda, and refers with doubt to *S. glabra.*

Position and locality.—Strata of the Carboniferous period; Camp Cottonwood, Lincoln County, Nevada.

GENUS SPIRIFERINA d'Orbigny, 1847.

Spiriferina Kentuckensis Shumard.

Plate X, fig. 4 *a*, *b*, and *c*.

Spirifer octoplicatus Hall, 1852, Stansbury's Exped. Great Salt Lake, 409 (not *S. octoplicatus* Sowerby).
Spirifer Kentuckensis Shumard, 1855, Geol. Surv. Missouri, 203.
Spirifer laminosus Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 45 (not *S. laminosus* McCoy).
Spiriferina Kentuckensis Meek, 1872, U. S. Geol. Surv. Nebraska, 185.

Shell small, very variable in outline, usually subsemicircular, but sometimes the hinge-extremities are mucronate, and sometimes so shortened that the shell is subglobose in form, but it is always broader than long. Ventral valve more capacious than the other; beak prominent, arching backward; area moderately high, well defined, concave; foramen higher than wide; mesial sinus distinctly defined, rather narrow, often moderately deep, without plications, except occasionally a small obscure one at the bottom. Dorsal valve somewhat regularly convex; beak scarcely prominent, projecting very slightly over the cardinal margin; mesial fold narrow, distinctly defined, a faint linear depression sometimes observable along its middle corresponding with the small linear plication sometimes seen at the bottom of the sinus of the ventral valve.

Surface of each valve marked by from ten to eighteen simple prominent plications, rounded or almost angular at top, and having interspaces of similar width between them; the plications bounding the sinus are a little larger and a little more prominent than the others, which thus serve to more clearly define the sinus from the remainder of the shell. The entire surface is also marked by fine, distinct, prominent, and closely-crowded lines of growth.

Length of a specimen, of about average size and proportions, nine millimeters; breadth between the hinge-extremities, thirteen millimeters.

Mr. Meek, in his Paleontological Report for the United States Geological Survey of Nebraska, has pointed out the close relationship of the more compact forms of this species with *S. octoplicata* Sowerby from the Subcarboniferous strata of Europe, but expresses a doubt of its specific identity with the European shell. That it is really distinct from *S. octoplicata* is now apparently proven by the discovery in strata of the same period, and among the associates of *S. Kentuckensis*, of a species that seems to be unquestionably identical with the former species, and as certainly different from the latter.

Position and locality.---This species is quite a common one in the Carboniferous strata of Kentucky, Illinois, Missouri, Iowa, Nebraska, Kansas, and Texas; but I am not aware that it has ever been discovered in strata of the Subcarboniferous period. The collections contain it from strata of the Carboniferous period from near Santa Fé, New Mexico, at Meadow Creek, south of Fillmore, Utah, and Camp Apache, Arizona. The species is represented by an unexpectedly small number of specimens.

Spiriferina octoplicata Sowerby.

Plate X, fig. 8 *a*, *b*, and *c*.

Spirifer octoplicatus Sowerby, 1827, Mineral Conchology, 120.
Spirifer cristatus von Buch, 1837, Ueber Delthyris, 39.
Spirifer cristatus McCoy, 1855, Synopsis Carb. Foss. Ireland, 133.
Spiriferina cristata var. *octoplicata* Davidson, 1857, Monog. British Carb. Brachiopoda, 38.
Spiriferina spinosa var. *campestris* White, 1874, Expl. &. Surv. west 100th Merid., Prelim. Report Invert. Foss., 21.

Shell rather under medium size, suboval or somewhat tetrahedral in outline, broader than long, more or less gibbous; hinge-line extended, not mucronate, but usually a trifle shorter than the greatest breadth of the shell; valves of almost equal capacity.

Mesial fold of the dorsal valve narrow, plain, distinctly defined from front to beak, elevated at the front of the more gibbous examples; beak of the valve slightly projecting over the cardinal margin. Mesial sinus of the ventral valve plain, narrow or of moderate width, distinctly defined from front to beak, sometimes extended much upward at the front; beak of the valve prominent, incurved, its area moderately high and gently arching.

Surface marked by from four to six strong, prominent, simple plications on each side of the mesial fold and sinus respectively. The whole surface is also marked by fine granulations, and, near the front especially, by concentric lines of growth, but no spines have yet been detected. Exfoliated portions of the shell show its structure to be coarsely punctate.

Length of a robust example, sixteen millimeters; breadth, twenty-one millimeters; height, fourteen millimeters.

This species, as represented in the collections, has all the characteristics of the typical forms of *S. octoplicata*. *S. Kentuckensis* Shumard has been by some authors referred to that species, but our shell is distinguished from Shumard's species by its greater size, its more robust form, less numerous and larger plications, and in the absence of the fine, prominent, concentric striation which that species possesses. It is very closely related to *S. spinosa* Norwood and Pratten, from the Chester limestone of the Subcarboniferous period at Chester, Illinois. Indeed, almost the only difference I am able to detect between them is the apparently entire absence of spines from the surface of our examples, which characterize that species. Since we often find among other species of spine-bearing Brachiopods that there is a very great variation in the number of spines, even upon specimens associated together in the same strata, it may not be unreasonable to suppose that our shell has lineally descended from *S. spinosa*, suffering little or no change other than the loss of its spines during the transition from one geological period to the other. In my preliminary report, I regarded the examples contained in the collections as those of a variety of *S. spinosa*, but even that species is not unlikely a variety of *S. octoplicata*. In any case, further comparison has convinced me that our examples agree more nearly with the last-named species than with *S. spinosa*.

This supposition of lineal descent seems to be supported by the fact that more than one species found common in the Chester limestone formation is distinguishable from certain Coal-Measure forms only with great difficulty, if at all.

Position and locality.—Strata of the Carboniferous period; near Santa Fé, New Mexico, and at Camp Cottonwood, Lincoln County, Nevada.

GENUS RETZIA King, 1850.

Reztia Mormonii Marcou.

Plate X, fig. 7 *a*, *b*, and *c*.

Terebratula Mormonii Marcou, 1858,* Geology of North America, 51.
Retzia punctilifera Shumard, 1858, Trans. St. Louis Acad. Sci., i, 220.
Retzia Mormonii Meek and Hayden, 1859, Proc. Acad. Nat. Sci. Phila., 27.
Retzia subglobosa McChesney, 1860, Descr. New Pal. Fossils, 45.
Retzia Mormonii Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 39.
Retzia punctilifera Meek, 1872, U. S. Geol. Surv. Nebraska, 189.

Shell small, ovate in outline; both valves more or less gibbous; hinge-line short; ears very minute, and observable only in well-preserved examples. Ventral valve a little more capacious than the dorsal; posterior portion narrowed to the umbo, which is prominent and considerably arched; beak small, truncated by a foramen of moderate size; area small but well defined. Dorsal valve almost as prominently convex as the ventral; umbo prominent; beak incurved and extending a trifle over the cardinal border.

Surface of each valve marked by from fourteen to seventeen simple, narrow, radiating costæ, having interspaces of similar width; costæ sharply elevated, their backs, as well as the bottoms of the interspaces, somewhat flattened; mesial fold and sinus wanting or obsolete.

This shell is a characteristic and not uncommon one in the Carboniferous strata of Illinois, Missouri, Iowa, Nebraska, and Kansas, but it is represented by only a few examples in the collections.

Position and locality.—Strata of the Carboniferous period; near Santa Fé, New Mexico, and top of Grass Mountain, Ely range, thirty-five miles north of Pioche, Nevada. Professor Marcou obtained his type-specimens from Utah.

GENUS SPIRIGERA d'Orbigny, 1847.

Spirigera subtilita Hall.

Plate X, fig. 6 *a*, *b*, and *c*.

Terebratula subtilita Hall, 1852, Stansbury's Exped. Great Salt Lake, 409.
Terebratula? subtilita Davidson, 1857, Monog. British Carb. Brach., 18.
Spirigera subtilita Meek and Hayden, 1859, Proc. Acad. Nat. Sci. Phila., 20.

* See foot-note concerning date of publication on page 125.

Athyris subtilita Newberry, 1861, Exp. Exped. Colorado River, Paleontology, 126.
Athyris subtilita Davidson, 1863, Fossils of Southern India, pl. ix, fig. 7.
Athyris subtilita Meek, 1872, U. S. Geol. Surv. Nebraska, 180.
Compare *Athyris subquadrata* Hall, 1858, Geology of Iowa, i, part ii, 703.

Shell of moderate size, varying considerably in outline, but is generally subovate; seldom, if ever, as wide as it is long, moderately gibbous, but sometimes old shells are much inflated. Ventral valve generally a little more capacious than the dorsal; beak prominent, strongly incurved; mesial sinus not very deep, even at the front, and becoming obsolete about the middle; a more or less distinctly-impressed line usually exists along the bottom of the sinus, extending from front to beak.

Dorsal valve somewhat uniformly convex, but most prominently so near the umbo; beak small, slightly prominent; mesial fold not distinctly defined.

Surface marked by concentric striæ and by occasional imbricating lines of growth; faint traces of radiating striæ, such as are common on shells of this genus, are also occasionally seen.

Length of a specimen of ordinary size, twenty-four millimeters; breadth, twenty millimeters; height, nine millimeters.

In all the variations this shell is subject to, it is easily recognized after an acquaintance with the species has once been formed. One of the most noticeable of its constant characteristics is the impressed mesial line at the bottom of the sinus of the ventral valve, and extending from front to beak. This feature is rarely obscure, and usually distinct.

This species ranges through the whole series of strata of the Carboniferous period into the Permian, according to Mr. Meek; but it has not yet been recognized in the Subcarboniferous rocks of America, unless *S. sublamellosa* Hall, from the Chester limestone of Illinois, should prove to be a variety of this species. In England and India, however, it has been recognized in Subcarboniferous strata. Besides the localities at which it was collected by the exploring parties, it has been obtained from the Carboniferous strata of West Virginia, Ohio, Illinois, Missouri, Iowa, Nebraska, and Kansas, and also from the Permian rocks of the latter State.

Position and locality.—The following are the localities that have furnished the species to the collections:—Carizo Creek, Maricopa County;

Camp Apache; Tenney's Ranch, Kaibab Plateau; confluence of White Mountain and Black Rivers; Grass Mountain, thirty-five miles north of Pioche; and foot-hills of Dragoon Mountains, Arizona: Fossil Hill, White Pine County; and Camp Cottonwood, Nevada: fifteen miles south of Saint George; near Ophir City; Rock Cañon, Wasatch range, near Provo; and near Minersville, Utah.

Spirigera planosulcata Phillips, *sp.*

Plate X, fig. 5 *a*, *b*, *c*, and *d*.

Spirifer planosulcata Phillips, 1836, Geology of Yorkshire, ii, 220.
Terebratula planosulcata Marcou, 1858, Geology of North America, 52.
Compare *Athyris sublamellosa* Hall, 1858, Geology of Iowa, i, pt. ii, 702.
Compare *Athyris crassicardinalis* White, 1860, Jour. Bost. Soc. Nat. Hist., vii, 229.
Compare *Athyris planosulcata?* Meek and Worthen, 1866, Geol. Surv. Illinois, ii, 254.

Shell rather small, having a subtetrahedral, subpentahedral, or subcircular outline; both valves more or less gibbous; greatest breadth a little behind the middle, the valves almost equally capacious. Ventral valve without a proper mesial sinus, but in its place there is usually to be seen a slight mesial attenfling extending from the front to about the middle; beak small, prominent, curving upward so as to bring its small foramen about on a plane with the margin of the valve. Dorsal valve broadly convex, but it is in most cases mesially flattened a little at the front, like the ventral valve; this slight flattening of both valves produces a little straightening or truncation of the otherwise broadly-rounded front border.

Surface marked by numerous imbricating lines of growth and occasionally by faint traces of radiating striæ.

Length of an average-sized example in the collections, twelve millimeters; breadth, thirteen millimeters; height, eight millimeters.

The characteristics of this little shell as represented in the collections are quite constant, and it seems to agree in all essential respects with the species to which it is here referred; but, so far as I have been able to make comparisons, I am not without some doubt as to its specific identity with *S. planosulcata*, nor can I satisfactorily refer it to any other described species. In external characters, which are the only ones that have been observed in the shell under discussion, it agrees almost exactly with *S. crassicardinalis*

White from the Subcarboniferous strata at Burlington, Iowa. In general aspect, it is rather more nearly like that shell than the one which Meek and Worthen have referred (*loc. cit.*) to *S. planosulcata* from the Keokuk limestone of Illinois. If the species here described should be referred to any described American species, it ought, I think, to be referred to *S. crassicardinalis* White.

Position and locality.—Strata of the Carboniferous period: Santa Fé, New Mexico; and Rush Creek, Lake County, Colorado.

FAMILY TEREBRATULIDÆ.

GENUS TEREBRATULA Lhwhyd, 1698.

SUBGENUS DIELASMA King, 1859.

Terebratula (Dielasma) bovidens Morton.

Plate XI, fig. 10 *a*, *b*, and *c*.

Terebratula bovidens Morton, 1836, Am. Jour. Sci. & Arts, xxix, 150.
Terebratula millepunctata Hall, 1856, Pacific Railroad Surveys, iii, 101.
Terebratula geniculosa McChesney, 1860, Descr. New Pal. Fossils, 82.
Terebratula bovidens Meek, 1872, U. S. Geol. Surv. Nebraska, 187.
Dielasma? bovidens White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 21.

Shell ovate or elongate-ovate in outline; sides behind the middle laterally compressed, where also the shell is narrower, and its vertical diameter greater than in front of the middle. Ventral valve strongly arcuate from beak to front, the curvature being greatest behind the middle, rather more capacious than the other valve; beak prominent, incurved, but not coming quite in contact with that of the dorsal valve; foramen moderately large, not squarely truncating the beak, but opening obliquely backward; mesial sinus broad, and more or less distinct at the anterior part of the valve, but becoming obsolete at or behind the middle; dental plates extending but little, if any, in front of the teeth, placed so near the sides of the beak that the space between them and the sides of the shell is very narrow. Dorsal valve generally almost straight along the median line from the front margin to a little behind the middle, from which part it gently curves to the beak; gently and somewhat uniformly convex from side to side, without a mesial fold, except that sometimes the front margin is slightly raised to conform to the shallow sinus of the other valve; character of the loop not fully determined, but it is known to reach farther forward than the middle of the shell.

Surface nearly smooth; shell-structure finely punctate.

This shell varies considerably in size and shape; one specimen in my private collection from Nebraska measuring three centimeters in length, and is proportionally broad. Some in the collections from near Santa Fé are unusually elongate, in which respect they seem to possess somewhat definite varietal characters; one of them measuring about twenty-five millimeters in length, thirteen millimeters in breadth, and ten millimeters in height. The average size is about seventeen millimeters long and twelve or thirteen millimeters broad.

The presence of an elongated brachial loop in this shell, together with the dental plates in the beak of the ventral valve, plainly shows that its reference hitherto to the genus *Terebratula* proper is incorrect. Fragments of the loop have been seen by breaking some of the solidly-filled shells of the collections, but the best observations of that kind were made upon some examples from Iowa. These were filled with calcite in the process of their mineralization, the transparency of which allowed the loop to be seen by transmitted light after the shell had been ground off, and polished above and below. Only the general form and extent of the loop were ascertained, as the details were obscured by the confused character of the crystalline filling; but it is apparently much like that of *Waldheimia*. Besides the dental plates, a broken example among the collections shows what is apparently the bird-sternum-like process of the dorsal valve that characterizes *Dielasma*, as described by Professor King; but this is not shown clearly. The subgenus *Dielasma* is evidently closely allied to *Cryptonella* Hall; and if it is not really identical, the differences are apparently confined to internal characters alone. *Cryptonella* is known to exist in the Subcarboniferous strata of Michigan; but its presence in strata of the Carboniferous period is not certainly known. So far as indicated by the species I at present refer to, *Dielasma*, the subgenus, seems to be confined to strata of the Carboniferous age, and to range through all three of its periods. Besides the species here described, one is known to exist in the Subcarboniferous limestone of Washington County, Indiana; *D. Burlingtonensis* occurs in the Subcarboniferous strata at Burlington, Iowa, and in Nevada; and Professor Swallow has described one from the Subcarboniferous strata at Chester, Illinois, under the name of *Terebratula arcuata*, which is so nearly like *D. bovidens* that it is difficult to say wherein they differ. It has not thus far been discovered in the Permian strata of America, but it is understood to occur in strata of that period in Europe. The geographical range of *D. bovidens* is from Ohio to Nevada, and it has been discovered from base to top of the Coal-Measure series of strata.

Position and locality.—Strata of the Carboniferous period: near Santa Fé, N. Mex.; a few miles south of Saint George, Utah; and at the top of Grass Mountain, Ely range, thirty-five miles north of Pioche, Nevada.

MOLLUSCA VERA.

CLASS CONCHIFERA.

ORDER MONOMYARIA.

FAMILY PECTINIDÆ.

GENUS AVICULOPECTEN McCoy, 1852.

Aviculopecten occidentalis Shumard.

Plate XII, fig. 8 *a* and *b*.

Pecten occidentalis Shumard, 1855, Geol. Surv. Missouri, 207 (not Winchell, 1863).
Pecten Cleavelandicus Swallow, 1858, Trans. St. Louis Acad. Sci., i, 184.
Aviculopecten ———?, Meek and Hayden, 1864, Palæont. Upper Missouri, 50.
Pecten Missouriensis Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 35 (not Shumard, 1855).
Aviculopecten occidentalis 1872, U. S. Geol. Surv. Nebraska, 191.

Shell inequivalve, both ears well defined; the cardinal border at nearly right angles with the axis of the shell, and almost as long as its full antero-posterior diameter; outline, exclusive of the ears, subovate. Left valve more convex than the right; anterior ear about as long as the posterior, more convex, and a little more sharply defined from the body of the valve than the other ear by the auricular furrow; obtuse at the extremity, inferior border concave; its surface marked by distinct radiating costæ, which are a little coarser than those upon the body of the valve, at the same distance from the beak; posterior ear clearly defined from the body of the valve by a shallow auricular furrow, sharply angular at the outer extremity; outer margin concave; surface marked by concentric lines, all radiate markings being absent or obsolete. Surface of the body of the valve marked by depressed flattened or very slightly convex, radiating costæ, which very gradually increase in size toward the free margins, and increase in number by implantation at different distances from the beak, only about a dozen of them reaching it. The implanted costæ, beginning as mere striæ between the others, are of unequal size on all parts of the valve; costæ crossed by numerous rather distinct concentric striæ.

Right valve flat or very slightly convex; beak flattened and not distinct at the cardinal border; costæ similar in character to those of the other valve, but they are not nearly so distinct; outline corresponding with that of the left valve, except that the anterior ear is narrower and defined by a deeper and sharply angular sinus.

Length from base to cardinal border, of an example somewhat above average size, forty-two millimeters; breadth, thirty-seven millimeters.

This shell is one of the most common Conchifers found in the Carboniferous rocks of Kentucky, Illinois, Missouri, Iowa, Nebraska, and Kansas. It is most abundant in the Upper Coal-Measures; but, according to Mr. Meek, it is found in the Lower Coal-Measures of Illinois, and also in the true Permian strata of Kansas.

Position and locality.—Strata of the Carboniferous period; Camp Apache, Arizona.

Aviculopecten Coreyanus White.

Plate XI, fig. 1 *a* and *b*.

Aviculopecten Coreyanus White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 21.

Shell moderately large; breadth not exceeding the height, and is usually a little less; margin of the basal half forming almost a true semicircle in some examples, but is less regular in others; posterior margin continued thence in almost a direct line about half way to the cardinal margin; thence curving outward, it forms with the last-named margin a somewhat acute angle.

Hinge-line a little longer than the full breadth of the body of the shell and forming right angles with its vertical axis, extending farther backward than the posterior border below it does, but not reaching quite so far forward as the greatest convexity of the anterior border.

Left valve moderately convex, the greatest convexity being in the umbonal region; beak prominent and projecting a little beyond the cardinal border; posterior ear moderately large, acutely angular at the outer extremity, not distinctly defined from the body of the valve by an auricular furrow; anterior ear defined by a moderately deep byssal sinus and a distinct auricular furrow, not so prominent as the other ear; its outer border rounding downward and inward from the cardinal border into the byssal sinus, where it is met by the incurving anterior border of the body of the valve. Surface marked by numerous fine, radiating costæ of unequal size, which are in turn marked by very fine, radiating striæ, all of which are crossed by fine concentric lines of growth and occasional coarser lines of increment; upon the posterior ear, the radiating costæ are obsolete, but upon the anterior ear they are coarser than those of the body of the valve, and are also somewhat corrugated. Right valve unknown.

So far as the rather numerous, but more or less broken, examples of this shell will permit determination, the height, breadth, and length of the hinge-line are all nearly equal, being about six centimeters for the largest example.

This species somewhat resembles *A. occidentalis* Shumard, which is found in rocks of the same period, and perhaps associated with it; but it differs from that species in its greater proportionate breadth, in being less contracted below the ears, its less distinctly-defined posterior ear, its finer and rather more unequal costæ, and greater size.

Position and locality.—Strata of the Carboniferous period; Bear Spring, near Camp Wingate, New Mexico.

Aviculopecten McCoyi Meek and Hayden.

Plate XI, fig. 2 *a*.

Aviculopecten McCoyi Meek and Hayden, 1864, Palæont. Upper Missouri, 50.

Left valve moderately convex; height and breadth apparently about equal; posterior ear prominent, angular, its outer margin concave, and its surface marked by small, obscure, radiating costæ and numerous distinct lines of growth; anterior ear unknown. Surface of the body of the valve marked by six or eight strong elevated costæ, which have sudden enlargements, at irregular intervals, that are covered by vaulted, scale-like projections, giving the costæ a knotted appearance; the spaces between the large knotted costæ marked by numerous fine, distinct, slightly flexuous, raised striæ, which increase in number by implantation as the shell increases in size; the whole surface is also marked by fine concentric striæ and occasional coarser imbricating lines of growth. Full breadth of the shell about three centimeters. Right valve unknown.

The collections contain only a single imperfect left valve, but its surface-features are sufficiently characteristic to indicate its specific identity. In general aspect of the surface, this shell resembles that of *Pseudomonotis* or *Eumicrotis* rather more than an *Aviculopecten;* but the length of the hinge-line and the character of the posterior ear leave no doubt of its proper reference to the last-named genus, and its surface-markings and form, in addition, leave as little doubt as to its specific identity with *A. McCoyi* Meek and Hayden. These gentlemen obtained their type-specimens, from strata regarded by them as Permian, at South Cottonwood Creek, Kansas; while ours is evidently from a lower horizon.

Position and locality.—Strata of the Carboniferous period; near Bear Spring, Camp Wingate, New Mexico.

Aviculopecten ? interlineatus Meek and Worthen.

Plate XI, fig. 3 *a*.

Aviculopecten interlineatus Meek and Worthen, 1860, Proc. Acad. Nat. Sci. Phila., 454.
Aviculopecten interlineatus Meek and Worthen, 1866, Geol. Surv. Illinois, ii, 329.

Shell rather small, broadly subovate in outline exclusive of the ears; breadth nearly equal to the height, slightly oblique, or the axis almost at right angles with the cardinal border; hinge about equal in length to the full breadth of the shell; ears prominent, posterior one most so; anterior, basal, and posterior margins regularly and continuously rounded; beak depressed; umbonal slopes moderately distinct. Left valve slightly convex or nearly straight; posterior ear about the same size as the other, forming a nearly sharp angle with the cardinal extremity, its outer border being nearly straight; anterior ear triangular, well defined, its outer border slightly convex or nearly straight, and its extremity blunt. Surface marked by ten or twelve sharply-raised, slender, concentric ridges, each of nearly uniform width throughout, but each successively a trifle larger than the preceding one, separated, along the axis of the valve, by interspaces each four or five times as wide as the adjacent ridges, but the interspaces diminish in width toward the umbonal slopes, upon which the ridges are very near together; the latter then diverge in crossing the ears, and all end abruptly upon the cardinal border; surface between the ridges marked by numerous fine, uniform, concentric striæ, and also by very faint indications of radiating costæ.

Breadth, sixteen millimeters; height, from base to cardinal border, seventeen millimeters.

This interesting shell is rare; only the left valve having been discovered. The only other locality at which it has been found, so far as I am aware, is La Salle, Illinois, where the type-specimens of the species were obtained, and where it occupies a geological position similar to that from which our specimen was obtained.

It is so unlike any other known species of *Aviculopecten* that no comparison is necessary. Only the exterior of the left valve of this species is yet known, and Meek and Worthen have suggested that the undiscovered parts will, if dicovered, be found to possess generic characters correlated with its peculiar surface-features that will separate the shell generically from *Aviculopecten.*

Position and locality.—Strata of the Carboniferous period; confluence of White Mountain and Black Rivers, Arizona.

FAMILY PINNIDÆ.

GENUS PINNA Linnæus, 1758.

Pinna peracuta Shumard (?).

Plate XI, fig. 5 *a*.

From the Mesa edge, near Relief Spring, Arizona, a single specimen of *Pinna* was obtained, which is too imperfect for full specific determination. It has the aspect and general features of a young example of *P. peracuta* Shumard, to which species it probably belongs. Certain traces of lines of growth, however, indicate that our specimen was much more slender than the typical forms of that species, and also that the border below the middle sloped much farther forward than it is known to do in *P. peracuta*. The species associated with it are the associates of *P. peracuta* elsewhere, which adds force to the supposition that our specimen belongs to that species.

Examples of *P. peracuta* are not uncommon in the Carboniferous strata of the States bordering the Mississippi; but, although the collections contain a greater number of species from the strata of the Carboniferous period than any other, this is the only example of *Pinna* found among all the Paleozoic fossils.

FAMILY PTERIIDÆ.

GENUS MONOPTERIA Meek and Worthen, 1866.

Monopteria Marian White.

Plate XI, fig. 4 *a*, *b*, and *c*.

Monopteria Marian White, 1874, Expl. Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 22.

Shell of moderate size, slender, nearly or quite equivalve, narrow and much extended posteriorly, the curvature being much the greater in the anterior half of the shell, the posterior half being nearly straight; body of the shell gradually tapering to near the posterior end, which is abruptly rounded; a more or less prominent ridge which is sometimes in part raised as a distinct carina, extends along the middle of the body of each valve from the beak to the posterior end; from this carina, or angle, the sides slope abruptly to both the inferior and upper borders, so that a cross-section of the shell behind the ear would have a rhomboidal outline; beaks moderately prominent, separate; hinge equal in length to about one-half the full length of the shell, and its direction is nearly parallel with the posterior half of the body; posterior wing well developed, not sharply defined from the body by an auricular furrow; its cardinal portion narrow and moderately extended; anterior ear obsolete; lunule moderately large and deep, the borders of which are slightly prominent laterally, but its margins sharply rounded inward.

Surface smooth in aspect, but it is marked by very numerous fine lines of growth.

Length, from front to posterior extremity, about four centimeters; height, from base to hinge-margin, eighteen millimeters; average width of the body of the shell, about one centimeter.

This shell somewhat resembles *M. longispina* (= *Gervillia longispina* Cox) from the Coal-Measure rocks of Kentucky; but it differs conspicuously from that species in its more slender and less deeply-curved body, and in having a shorter ear-spine than that species is represented to have by Professor Cox's figure.

Position and locality.—Strata of the Carboniferous period; Camp Apache, Maricopa County, Arizona.

GENUS MYALINA de Koninck, 1844.

Myalina ——— (?).

Associated with the foregoing at Camp Apache, some imperfect specimens of *Myalina* were obtained, which appear to belong to *M. recurvirostris* Meek and Worthen.

Myalina? Swallovi McChesney.

Plate XI, fig. 8 *a*.

Associated with the two foregoing species at Camp Apache, Arizona, a few examples of *Myalina? Swallovi* were obtained, the best one of which is represented by fig. 8 *a*, Plate XI.

GENUS BAKEVELLIA King, 1848.

Bakevellia parva Meek and Hayden.

Plate XI, fig. 7 *a* and *b*.

Bakevellia parva Meek and Hayden, 1858, Trans. Albany Institute, iv.
Bakevellia parva Meek and Hayden, 1864, Palæont. Upper Missouri, 57.

Shell very small, obliquely subovate in outline; valves gibbous, especially the anterior half of each; cardinal margin straight, its length not quite equal to the full length of the shell, forming an angle with its axis of about 30°; postero-dorsal region compressed, subalate; antero-dorsal region bluntly prominent; ventral margin broadly rounded downward and backward; posterior margin abruptly rounded below, and straight or slightly concave above, inclining a little forward, and forming an obtuse angle with the cardinal margin.

Surface marked by fine concentric striæ.

Length of the largest specimen, six millimeters; height, about four millimeters.

The collections contain examples from two widely-separated localities. Those from New Mexico are from true Carboniferous strata, and differ slightly from the types and description of Meek and Hayden. Those from Arizona are from strata probably of the Permian period. A figure of each is given on Plate XI, which exhibit considerable difference in outline. This may perhaps be due to specific difference; but it is thought it is not necessarily so, as other examples seem to show intermediate forms. The type-specimens of Meek and Hayden were obtained from strata, regarded by them as Permian, near the mouth of the Smoky Hill Fork of Kansas River, Kansas.

Position and locality.—Strata at the summit of the Carboniferous series; Bear Spring, Camp Wingate, New Mexico; and also near Jacob's Pool, Arizona.

ORDER DYMYARIA.

FAMILY TRIGONIDÆ.

GENUS SCHIZODUS King, 1844.

Schizodus Wheeleri Swallow.

Plate XI, fig. 6 *a* and *b*.

Cypricardia? Wheeleri Swallow, 1862, Trans. St. Louis Acad. Sci., ii, 96.
Schizodus obscurus Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 20 (not Sowerby, 1821).
Schizodus Wheeleri Meek, 1872, U. S. Geol. Surv. Nebraska, 209.

Shell of moderate size, irregularly subtrihedral or subovate in outline; posterior portion laterally compressed; anterior portion inflated; umbones elevated; beaks incurved, placed about one-quarter of the length of the shell from the anterior extremity; margins of the front and of the anterior part of the base forming a continuous and regular curve; basal margin sloping upward, and meeting the downward and backward slope of the posterior margin at a prominent angle, which is abruptly rounded; dorsal margin straight, sloping a little downward from the beaks to the obliquely-truncated posterior margin; posterior umbonal slope prominent, sometimes forming a rather distinct ridge, which ends at the prominent angle of the posterior margin and considerably increases its projection. Surface apparently unmarked except by concentric lines of growth.

Length, from front to posterior angle, thirty-one millimeters; height, from base to top of umbo, twenty-one millimeters.

Our examples are all natural casts, the shell-substance having in all cases been removed; but the characteristics of the species are so distinctive that it is recognized with little or no difficulty in that condition. It is a common species in the Upper Coal-Measures of Missouri, Illinois, Iowa, and Nebraska; Professor Swallow's type-specimens of the species having been obtained in the first-named State.

Position and locality.—Strata of the Carboniferous period; near Bear Spring, Camp Wingate, New Mexico.

GENUS ALLORISMA King, 1850.

Allorisma subcuneata (var.) Meek and Hayden.

Plate XII, fig. 7 *a* and *b*.

Allorisma subcuneata Meek and Hayden, 1858, Proc. Acad. Nat. Sci. Phila., 263.
Allorisma subcuneata Meek and Hayden, 1864, Paleont. of the Upper Missouri, 37.

Shell of moderate size; outline clavate-cuneate as seen by either dorsal or ventral view, oblong-suboval as seen by side-view; posterior portion laterally compressed; anterior portion moderately gibbous; beaks depressed and placed about one-eighth of the length of the shell from the anterior extremity; posterior end abruptly rounded; anterior end narrowly rounded, somewhat prominent below and obliquely sloping above; basal margin straightened along the middle, but gently rounding before and behind to meet the anterior and posterior borders respectively; dorsal margin straight. Surface marked by distinct concentric undulations.

Length, about six centimeters; height, from base to cardinal border, twenty-eight millimeters.

Our specimens are in moderately good condition, but not entirely perfect, and, so far as they exhibit essential specific characters, they agree with those of *A. subcuneata.* They are, however, considerably smaller and rather less gibbous anteriorly than the type-specimens of Meek and Hayden are, and may possibly belong to a different species, yet I do not at present feel warranted in separating them from that species except as a variety. Typical examples of the species are somewhat common in the Upper Coal-Measure limestones of Missouri, Iowa, and Nebraska.

Position and locality.—Strata of the Carboniferous period; near Agua Azul, New Mexico.

CLASS GASTEROPODA.

SUBCLASS PROSOPOCEPHALA.

ORDER SOLENOCONCHA.

FAMILY DENTALIIDÆ.

GENUS DENTALIUM Linnæus, 1740.

Dentalium canna White.

Plate XII, fig. 6 *a* and *b*.

Dentalium canna White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 23.

Shell large, straight, or very slightly curved; transverse section circular or nearly so; test thin; surface marked by numerous, somewhat distinct, encircling lines of growth, crossed by fine, obscure, longitudinal striæ, the latter seen only upon well-preserved examples. Our specimens indicate that some individuals of the species reached a length of ten or twelve centimeters. The largest fragment measures a little more than nine millimeters in diameter at the base, and, at a distance of five and a half centimeters toward the apex, the diameter is six millimeters.

This species is distinguished for its large size in connection with the presence of encircling and longitudinal striæ. It resembles *D. priscum* Muenster from the Carboniferous rocks of Belgium, as described and figured by de Koninck in *Animaux fossiles du terraine de la Belgique*, but its apical angle is smaller, and the aperture is little if any oblique, while in that species the obliquity of the aperture is a distinguishing character.

Position and locality.—Strata of the Carboniferous period: near Salt Lake, New Mexico; and near Relief Spring, Arizona.

SUBCLASS DIŒCA.

ORDER RHIPHIDOGLOSSA.

SUBORDER DICRANOBRANCHIA.

FAMILY BELLEROPHONTIDÆ.

GENUS BELLEROPHON Montfort, 1808.

Bellerophon crassus Meek and Worthen.

Plate XII, fig. 1 *a*.

Bellerophon crassus Meek and Worthen, 1860, Proc. Acad. Nat. Sci. Phila., 458.
Bellerophon crassus Meek and Worthen, 1866, Geol. Surv. Illinois, ii, 335.

Shell large, massive, subglobose; volutions gradually expanding laterally, broadly rounded upon the back, more abruptly rounded at the sides and into the umbilici, which are rather small; outline of aperture reniform, its transverse diameter greatest; postero-lateral portions of the lip thickened and spread outward and backward over the inner volutions and also partly over the umbilici; antero-lateral portions of the lip thinner, their margins slightly convex on each side of the mesial notch; mesial band narrow, more or less distinct; mesial notch not deep.

Surface marked by distinct lines of growth, a part of which assume the character of somewhat irregular transverse wrinkles.

The collections contain only a single specimen of this well-marked species, which, although it measures thirty-eight millimeters across the aperture, is one-quarter smaller than one of the type-specimens used by Meek and Worthen in their description of the species.

The types were obtained from the Lower Coal-Measures of Illinois, and the species is also known to occur in the Upper Coal-Measures of Iowa and Missouri. So far as I am aware, it has not been found in the Lower Coal-Measures of the two last-named States.

Position and locality.—Strata of the Carboniferous period; Camp Cottonwood, near Spring Mountain, Nevada.

SUBORDER PODOPHTHALMA.

FAMILY EUOMPHALIDÆ.

GENUS EUOMPHALUS Sowerby, 1815.

Euomphalus pernodosus Meek and Worthen.

Plate XII, fig. 2 *a* and *b*.

Straparollus (*Euomphalus*) *pernodosus* Meek and Worthen, 1870, Proc. Acad. Nat. Sci. Phila., 45.

Straparollus (*Euomphalus*) *pernodosus* Meek and Worthen, 1873, Geol. Surv. Illinois, v, 604.

Shell rather above medium size when full grown, nearly discoidal, the spire being only very slightly elevated, and the inner portion of it being quite flat, or even slightly depressed; test thick; volutions five or six, the upper side flattened and sloping gently inward to the distinct suture, outer side flattened convex, under side rounding and sloping into the umbilicus; the angle formed by the upper and outer sides constituting a distinct carina, which is rugose or corrugated upon the outer volution; upon the under side of the volutions there is a row of moderately large, rounded nodes, separated by spaces of about their own width, those of the last half of the outer volution, and apparently those also of the two or three inner volutions, being obsolete; umbilicus moderately broad and deep, showing all the inner volutions.

Surface marked by striæ, distinct lines, and even ridges, of growth. None of the specimens in the collections are quite perfect, but their identity with *E. pernodosus* is unmistakable. The largest example measures about four and a half centimeters in diameter of coil. The types of the species measured one centimeter more. This well-marked species is comparatively rare, and, so far as I know, it has been found only at the locality which furnished the type-specimens and that from which those in the collections were obtained. The former were from the Lower Coal-Measures of Illinois.

It is quite distinct from every other species known to me, and may be easily recognized by its carina upon the outer side of the volutions above and its strong nodes below.

Position and locality.—Strata of the Carboniferous period; at the Mesa, Carrizo River, Arizona.

ORDER PECTINIBRANCHIATA.

SUBORDER TÆNIOGLOSSA.

FAMILY NATICIDÆ.

GENUS NATICOPSIS McCoy, 1844.

Naticopsis nana Meek and Worthen.

Plate XII, fig. 4 *a* and *b*.

Naticopsis nana Meek and Worthen, 1866, Geol. Surv. Illinois, ii, 365.

Shell small, subglobose, wider than high; spire much depressed; volutions about three, increasing very rapidly in size, last one large and ventricose; suture well defined; aperture large, broad-subovate, somewhat straightened at the inner side, its diameter nearly equal to seven-eighths of the entire axial length of the shell; outer lip thin; inner lip not much thickened; columella slightly flattened. Surface marked by fine lines of growth, which are a little stronger and more uniform on the upper side of the whorls, near the suture, than elsewhere.

Length, four millimeters; breadth, five millimeters.

Our examples of this little shell agree so exactly with the description and figures given by Meek and Worthen (*loc. cit.*) that I have given the foregoing description almost in the words of those authors.

Position and locality.—Strata of the Carboniferous period; Camp Cottonwood, near Spring Mountain, Lincoln County, Nevada, where it was found associated with *Macrocheilus anguliferus* White.

FAMILY CAPULIDÆ.

GENUS PLATYCERAS Conrad, 1840.

Platyceras Nebrascense Meek.

Plate XII, fig. 5 *a*, *b*, *c*, and *d*.

Platyceras Nebrascensis Meek, 1872, U. S. Geol. Surv. Nebraska, 227.

Shell small, elongate-conical, strongly curved or subspiral; apex free, bluntly pointed, more or less curved toward the body, and turned to the dextral side of the shell; aperture irregularly oval; lip thin, broadly sinuous behind to the left of the apex, remainder of the border having several other more or less indistinct sinuosities, with all of which the lines of growth upon the surface of the shell correspond.

All the specimens in the collections, and also those in my private collection, obtained from the same Upper Coal-Measure strata in Nebraska that supplied Mr. Meek with the types of the species, have the apex a little more curved than his type-specimen had, as may be seen by comparing the figures on Plate XII with his illustrations (*loc. cit.*). In other respects, our examples correspond with his figures and description, and I have little or no doubt of their specific identity with *P. Nebrascensis.*

Length, nineteen millimeters; breadth, nine millimeters.

Position and locality.—Strata of the Carboniferous period; near Santa Fé, New Mexico.

FAMILY MACROCHEILIDÆ.

GENUS MACROCHEILUS Phillips, 1841.

Macrocheilus anguliferus White.

Plate XII, fig. 3 *a*, *b*, *c*, *d*, *e*, and *f*.

Macrocheilus anguliferus White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 22.

Shell of medium size, irregularly rhombic in outline by side-view; spire about equal in length to two-fifths the full axial length of the shell, acutely pointed; volutions six or seven, increasing somewhat rapidly in size; outer side of the volutions more or less convex, but the portion toward the apex is usually a little flattened; posterior side narrow, usually squarely truncated, so as to form a distinct angle with the outer side. This angle is usually more or less prominent, but in some cases it is nearly obsolete, in which latter case the slight flattening of the posterior side merely produces the appearance of a deeply-impressed suture; in the former case, there is a distinct, gradually-diminishing spiral shelf extending from the hinder part of the aperture to the apex; aperture irregularly ovate, more or less truncated behind by the shelf referred to, effuse below; outer lip sharp; columella a little tortuous or nearly on a line with the axis of the shell. Surface apparently unmarked, except by the usual lines of growth.

Length of the largest specimen in the collection, thirty-six millimeters; width of the body-volution, twenty-three millimeters.

This shell varies considerably, especially in the distinctness of the angle and the convexity of the volutions; but it differs conspicuously from all other known species of *Macrocheilus* in the possession of such an angle at the posterior part of the whorls as has been described, or, in the absence of it, the somewhat deeply-impressed suture.

Position and locality.—Strata of the Carboniferous period; Camp Cottonwood, near Spring Mountain, Nevada.

CLASS CEPHALOPODA.

ORDER TETRABRANCHIATA.

FAMILY GONIATITIDÆ.

GENUS GONIATITES de Haan, 1825.

From Carboniferous strata upon the east side of Mount Nebo, Utah, a single, very imperfect specimen of *Goniatites* was obtained. It is too imperfect for specific characterization; but yet its form and traces of the septa seem to indicate a difference from any known species. The shell is discoid; sides of the volutions slightly convex, the last one measuring at the aperture half as much as the full diameter across the whorls.

FAMILY NAUTILIDÆ.

GENUS NAUTILUS Breynius, 1732.

From strata of the Carboniferous period at the Mesa near Carrizo River, Arizona, some fragments of two species of *Nautilus* were obtained. One is probably identical with *N. latus* Meek and Worthen; the type-specimens of which were obtained from the Coal-Measures of Illinois. The other is either identical with, or closely allied to, *N. Springeri* White and St. John, the type of which species was obtained from the Upper Coal-Measures of Iowa.

CHAPTER VIII.

MESOZOIC AGE.

JURASSIC PERIOD.

RADIATA.

CLASS ECHINODERMATA.

ORDER CRINOIDEA.

FAMILY PENTACRINIDÆ.

GENUS PENTACRINUS Miller, 1821.

Pentacrinus asteriscus Meek and Hayden.

Plate XIII, fig. 6 *a* and *b*.

Pentacrinus asteriscus Meek and Hayden 1864, Paleont. Upper Missouri, 67.

This species was described by Meek and Hayden from fragments of the column and branches alone, which were collected from Jurassic strata at the southwest base of the Black Hills, North Platte River. They characterize the joints of the column thus:—" Rather small, thin, very symmetrical, pentagonal, star-shaped bodies, the rays of which are usually a little longer than wide, and somewhat acutely angular at their extremities. Through the center of each of these joints, there is a minute circular perforation, from which five lance-oval petaloid areas radiate, one to the extremity of each of the angles; the areas being bounded on each side by rather narrow, slightly-elevated, crenulate margins. This description applies more particularly to the largest-sized specimens, measuring about 0.18 inch from point to point of the opposite angles. Associated with these, there are smaller joints, varying from 0.05 to 0.10 inch in diameter, having proportionally shorter and broader rays, which are usually less angular at the points than the broader ones are."

All the specimens of this species contained in the collections consist of portions of the column, and, up to the present time, nothing more has been learned concerning the characteristics of the species. Generally, these portions of the *Crinoidea* are of very little value in specific discriminations; but the characters of those parts of this species are so constant, even in examples collected at widely-separated localities, that it has been relied upon with considerable confidence in the identification of Jurassic strata. This is the only species of the genus *Pentacrinus* yet recognized in the Jurassic rocks of America, but it is not improbable that others may hereafter be discovered in them. The largest examples in the collections have a diameter one-third greater than that of the largest of those mentioned by Meek and Hayden, and they also present some slight variations from the latter. The principal difference is the alternation, at irregular intervals, of joints that are almost pentahedral with those that are deeply pentalobate. This character is shown in one of the figures on Plate XIII, but it is probably not a specific one.

Position and locality.—Strata of the Jurassic period: Salt Creek, near Nephi; and Diamond Valley, near Saint George, Utah. It has quite an extended geographical range, having been also discovered in Idaho.

MOLLUSCA.

CLASS CONCHIFERA.

ORDER MONOMYARIA.

FAMILY OSTREIDÆ.

GENUS OSTREA Linnæus, 1758.

Ostrea strigilecula White.

Plate XIII, fig. 3 *a*, *b*, *c*, and *d*.

Shell small, irregularly suboval in outline; axis much curved, making the ventral border broadly arcuate and the dorsal border more or less irregularly concave; posterior margin rounded; hinge-line of moderate length. Right valve nearly flat or only very slightly convex; beak short; area narrow; ligamental groove small, shallow; muscular scar comparatively large, subcircular, situated nearly midlength of the valve, and nearer to the dorsal than to the ventral margin; internal face of the margins apparently not crenulated in any part. Left valve more capacious than the right; area small; ligamental groove small; an incipient alate expansion of the postero-dorsal portion is observable upon this valve, but not upon the other. Surface marked by the ordinary lines of growth, and also by a few very faint indications of radiating plications.

Length, twenty millimeters; breadth, fourteen millimeters.

The collections contain a few examples, of both right and left valves, in a good state of preservation, and they seem to represent a tolerably well-defined species of true *Ostrea*. The moderately large scar of attachment upon the beak of the left valve of our shell has somewhat distorted it; but there is no appearance of a curvature of the beak, such as is characteristic of the genus *Gryphea*.

The presence also of incipient plications upon the left valve, and of a ligamental groove, like that of *Ostrea*, upon its area, is also against the supposition that the shell belongs to the genus *Gryphea* rather than to *Ostrea*.

This species differs from the young of *O. Engelmanni* Meek and Hayden in being proportionally much longer and otherwise of different outline; the young of that species being broader than long, while ours is longer than broad, and has also the aspect of maturity.

Position and locality.—Strata of the Jurassic period; two miles south of Dirty Devil River, Utah.

FAMILY PECTINIDÆ.

GENUS CAMPTONECTES Meek (Agassiz), 1864.

Camptonectes stygius White.

Plate XIII, fig. 2 *a*, *b*, and *c*.

Camptonectes stygius White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 23.

Shell of moderate size, thin, lenticular; length of the hinge-line a little more than half the height of the shell from basal margin to beak; hinge-line very slightly oblique with the axis of the shell, the latter inclining backward; but yet more than half the bulk of the shell is in front of it; the margin of the lower two-thirds of the shell is regularly rounded, the basal portion having rather a shorter curve than either the anterior or posterior portions.

Right valve apparently smooth, depressed-convex; posterior ear rather small, plain, its outer border forming a somewhat obtuse angle with the cardinal border; anterior ear moderately large, prominent, proportionally narrow; byssal notch deep, narrow, the upper and lower sides approaching each other at an acute angle; anterior border extending farther forward than the extremity of the anterior ear does; the border at the front is abruptly rounded and then continued backward and upward in an almost direct line to the bottom of the byssal notch. Surface apparently marked only by concentric striæ of growth, but, in a favorable light, indications of radiating striæ may be observed upon the best-preserved examples.

Height from base to beak, forty-one millimeters; breadth, forty millimeters; length of hinge, twenty-three millimeters.

This shell resembles *C. bellistriatus* Meek and Hayden from Jurassic strata of Dakota; but it differs in the outlines of the borders, the shape of the ears and of the byssal notch, and also in the surface-markings.

Position and locality.—Strata of the Jurassic period; east of Aquarius Plateau, fifteen to twenty miles south of Dirty Devil River, and also at the North Fork of Virgin River, Utah.

Camptonectes bellistriatus Meek and Hayden.

Among the collections made at a locality of Jurassic strata, five miles east of Gunnison, Utah, some imperfect examples of *Camptonectes* were collected. They have the outlines and other characteristics, so far as they can be observed, of *C. bellistriatus* Meek and Hayden, and probably belong to that species.

Family PTEREIDÆ.

Genus INOCERAMUS Sowerby, 1814.

Inoceramus crassalatus White.

Plate XIII, fig. 4 *a*, *b*, and *c*.

Shell rather small, thin; valves subequal, moderately convex, subovate or obscurely tetrahedral in marginal outline; hinge-line rather short, forming an angle with the axis of the shell of about seventy degrees; beaks small, not very prominent. Left valve more capacious than the right, having an indistinct auricular furrow extending from just behind the beak to the postero-basal border, obscurely defining a thick posterior wing; but the right valve has little or no trace of a similar furrow.

Surface of both valves marked by the usual lines of growth, and also by more or less numerous, slightly-raised, concentric folds.

Greatest length of an average example in the collection, about thirty millimeters; thickness, both valves together, about fifteen millimeters.

Position and locality.—Strata of the Jurassic period; North Fork of Virgin River, Utah.

Order DIMYARIA.

Family TRIGONIIDÆ.

Genus MYOPHORIA Bronn, 1830.

Myophoria ambilineata White.

Plate XIII, fig. 5 *a* and *b*.

Shell subcircular or obscurely four-sided in outline, being very slightly longer than high, moderately gibbous; base broadly rounded; front regularly, but more shortly, rounded than the base; hinge-line of moderate length, straight or nearly so; posterior border, from the extremity of the hinge-line to the infero-posterior angle, nearly straight or slightly convex; infero-posterior angle sharply rounded; umbonal ridge passing to it from the beak with a slight curve, the convexity of which is toward the front; that ridge sometimes forming a slightly-raised but distinct carina.

Surface, both in front of, and behind, the umbonal ridge marked by numerous, distinct, slightly-raised, concentric lines or narrow folds, which meet at nearly right angles at the umbonal ridge.

Height, about eight millimeters; length, eight and a half millimeters.

Position and locality.—Strata probably of the Jurassic period; Camp Cottonwood, old Mormon road, Nevada.

GENUS TRIGONIA Bruguière, 1789.

Trigonia ——— (?).

Associated with *Camptonectes bellistriatus* Meek and Hayden at a locality five miles east of Gunnison, Utah, some imperfect examples of a species of *Trigonia* of Jurassic type were found. They are too imperfect for specific recognition, but are noticed here in consequence of the value of the type in stratigraphic geology.

CLASS GASTEROPODA.

SUBCLASS DIŒCA.

ORDER RHIPHIDOGLOSSA.

SUBORDER PODOPHTHALMA.

FAMILY NERITIDÆ.

GENUS NERITINA Lamarck, 1809.

Neritina? phaseolaris White.

Plate XIII, fig. 1 *a*, *b*, *c*, *d*, and *e*.

Neritina phaseolaris White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 24.

Shell small, obliquely suboval; volutions apparently from two and a half to three, the last one composing all but a very small part of that portion of the shell which is exposed to view; aperture obliquely ovate; character of the inner lip not clearly made out, but the shell has the external aspect of *Neritina*; a small elevated fold is usually seen at the suture upon the outer volution appressed against the next volution within. In some examples, the convexity of the outer volution, from the base of the small elevated fold above to the margin of the aperture below, is quite regular; but, in other examples, this volution has a revolving rounded prominence, situated a little nearer the suture than the base, which causes a more or less conspicuous flattening of the outer side of the volution, as well as a slighter flattening of the space between that prominence and the suture. All the examples of this species in the collection having been preserved in a hard arenaceous limestone, all the characters of the inner lip could not be ascertained.

Surface marked by moderately distinct lines of growth, and sometimes faint indications of revolving striæ are also seen.

Greatest diameter of the largest example in the collection, thirteen millimeters; shorter diameter, ten millimeters; greatest height, lying with its aperture downward upon the table, eight millimeters.

While preparing the preliminary report (*loc. cit.*), I thought I had ascertained to a good degree the character of the inner lip, but subsequent examination still leaves the true character of it in doubt.

Position and locality.—Strata of the Jurassic period; Salt Creek, near Nephi, Utah, where it is associated with *Pentacrinus asteriscus* Meek and Hayden.

CHAPTER IX.

CRETACEOUS PERIOD.

MOLLUSCA.

MOLLUSCOIDEA.

CLASS BRACHIOPODA.

ORDER LYOPOMATA.

FAMILY LINGULIDÆ.

GENUS LINGULA Bruguière, 1792.

Lingula subspatula Hall and Meek.

Plate XV, fig. 4 *a*.

Lingula subspatula Hall and Meek, 1856, Mem. Amer. Acad. Arts & Sci., new series, v, 380.

Shell of ordinary size, somewhat oblong or semi-elliptical; postero-lateral margins gently convex to the posterior margin; lateral and antero-lateral margins nearly straight or only slightly curved, so that the shell is narrowed a little toward the front; front margin subtruncate. Surface marked by fine concentric striæ and occasional gentle undulations.

Position and locality.—The type-specimens of the species were obtained by Hall and Meek from Cretaceous strata at "Red Cedar Island, thirty-five miles below Fort Pierre." Those contained in the collections from which the foregoing description was drawn were obtained from strata of the same period, ten miles southeast of old Fort Wingate, New Mexico.

MOLLUSCA VERA.

CLASS CONCHIFERA.

ORDER MONOMYARIA.

FAMILY OSTREIDÆ.

GENUS OSTREA Linnæus, 1858.

Ostrea cortex Conrad.

Plate XV, fig. 2 *a*, *b*, and *c*.

Ostrea cortex Conrad, 1857, U. S. & Mex. Bound. Surv., i, 157.

Shell elongate, moderately capacious; test of mature examples thick; inferior valve much more capacious than the other, narrowing toward the apex, which is pointed and rather small; ligamental furrow long, moderately broad and deep, somewhat curved, its raised borders broadly rounded; upper valve corresponding with the lower, except that it is usually nearly flat transversely.

Surface of both valves marked by numerous strong, prominent, imbricating concentric laminæ, which are sometimes laciniate, giving the shell a very rough appearance.

Length of the largest example in the collection, about one decimeter; breadth, nearly five centimeters.

Conrad's type-specimens of this species were obtained at "Dry Creek, Mexico," from strata the age of which was then unknown to him, because the collectors brought no associated species. Our collections, however, contain associated species that indicate unmistakably their Cretaceous age. Our examples show that the species is a very variable one; but they all present a certain facies that is quite characteristic, and which is expressed in the figures, both of Conrad's and this report. It is an interesting fact that the test in nearly all the examples of this species has been made completely porous by a species of *Cliona* or other burrowing sponge, while those of the following species are almost entirely unaffected by it. Possibly, however, the case of the last-named species is only a local exception.

Position and locality.—Strata of Cretaceous age; Colob Plateau, southwest of Kanara, and also at the North Fork of Virgin River, Utah.

Ostrea prudentia White.

Plate XIV, fig. 2 *a*, *b*, *c*, and *d*.

Shell neat and symmetrical for a species of this genus, suboval or subcircular in outline when adult, subcircular when young, moderately capacious; beaks small, usually distinct, and approaching so near to each other when the valves are together as to leave only a narrow space between the areas. Lower valve moderately deep; area short and broad; ligamental groove short, broad, and distinct, bounded at each side by a rounded ridge; beak extending very slightly beyond that of the other valve; scar of attachment sometimes occupying one-quarter of the outer surface, sometimes extremely small, and sometimes apparently absent. Upper valve usually flat or a little concave transversely, but a little convex longitudinally in adult shells; area a very little shorter than that of the other valve, moderately convex or nearly flat.

Surface of both valves marked by distinct lines and laminæ of growth, but this species is rather less laminated and roughened than is usual in the genus *Ostrea*. Somewhat numerous, corrugated, but rather indistinct radiating costæ are usually to be seen on the ventral valve of young examples, yet these corrugations seldom or never extend to the front half of old shells.

Length, six centimeters; breadth, five centimeters.

This species is somewhat remarkable for its neatness of form and freedom from the crude extravagancies which species of this genus often exhibit.

Position and locality.—Strata of the Cretaceous period; east of Impracticable Ridge, Utah.

GENUS GRYPHEA Lamarck, 1801.

Gryphea Pitcheri var. Morton.

Plate XVII, fig. 1 *a*, *b*, *c*, *d*, *e*, and *f*.

Gryphea Pitcheri Morton, 1834, Synop. Org. Remains, Cret. Group, 55.
Gryphea Pitcheri Rœmer, 1852, Kreidebildung von Texas, 73.
Gryphea Pitcheri Conrad, 1857, U. S. & Mex. Bound. Surv., i, 155.
Gryphea dilatata Marcou, 1858, Geol. North America, pl. iv, f. 2.

Shell reaching a moderately large size, very variable in shape, generally having an irregularly subovate marginal outline, often much longer than broad, but sometimes shorter than broad. Larger valve capacious, scaphoid, arcuate, more or less distinctly lobed, the posterior lobe occasionally somewhat wing-like; test rather thick; umbo large, prominent, and incurved, or flattened and short; scar of attachment small or wanting; surface sometimes distinctly lamellose, but generally somewhat smooth, although marked by concentric lines of growth.

Upper valve nearly flat, moderately thick in the umbonal region; hinge-line well defined, straight; area distinct; ligamental groove small; inner surface smooth, more or less distinctly crenulated at the lateral edges; outer surface marked by numerous concentric, imbricating lines of growth, and sometimes also by faint, impressed, radiating striæ.

The collections contain numerous examples of this widely-known species, none of which, however, are of so large a size as are some of those figured by Rœmer, Conrad, and others. In selecting examples for illustration, I have chosen representatives of two extremes of form from among others of all intermediate gradations. Mr. Conrad states (*loc. cit.*) that there are two distinct varietal types of this species, one of which resembles *G. vesicularis* Lamarck, and which was the typical form described and figured by Dr. Morton; and the other he designates as var. *navia*. The collections under examination, however, although they contain representatives of the two forms referred to by Mr. Conrad, seem to indicate no constancy of separate varietal characters, either of those forms or any others.

The largest specimens in the collections have a length of only about thirty-seven millimeters from the umbo to the basal margin, which is considerably less than that of some examples reported by other authors.

Position and locality.—Strata of the Cretaceous period:—twenty-five miles southeast of, and also near, Paria; East Fork of Paria Creek; east of Impracticable Ridge; Dirty Devil River, east of ridge, Utah: Cañon five miles west of Puerco; east of Mount Taylor; and Acoma Plateau, New Mexico, &c.

GENUS EXOGYRA Say, 1819.

Exogyra ponderosa Rœmer.

Plate XIV, fig. 1 *a*, *b*, and *c*.

Exogyra ponderosa Roemer, 1852, Kreidebildung von Texas, 71.
Exogyra costata Conrad, 1857, U. S. & Mex. Bound. Surv., i, 154.

Shell large, capacious; marginal outline irregularly subovate; larger valve very gibbous; umbo distinctly spiral, but the coil is usually obscured by a large scar of attachment; umbonal half obtusely carinate, the sides sloping abruptly from the carina to the margins; basal half not so deeply, but more regularly convex than the other. Test very massive, sometimes having a solid thickness of five or six centimeters, lamellose, so much so that the valve often splits into numerous pieces along the surfaces of the layers of growth; inner surface smooth; muscular scar of moderate size, somewhat deep, placed about midlength of the valve, and, as usual, a little nearer to the posterior than to the anterior side; surface marked by strong, irregular, imbricating lamellæ of growth, which become laciniate at and near the margins; surface also marked by fine concentric striæ, and by irregular, indistinct, radiating costæ, the latter being usually removed by exfoliation from old shells. The collections do not contain any example of the upper valve, but both Rœmer and Conrad describe it as thick, concentrically laminated; smooth within; umbo horizontal, distinctly spiral.

Length of an example rather under the average size, from umbo to basal margin, about one decimeter; breadth, eight centimeters; convexity of the larger valve, nearly six centimeters.

Among the numerous examples of this species in the collections, none, except the one figured, show the radiating costæ, and these costæ seem to be quite different from those, at least of the typical forms, of *E. costata* Say. Mr. Conrad states, however, that in New Jersey, Alabama, and Texas every intermediate gradation of form and character is found, from typical forms of *E. costata* to *E. ponderosa.* Judging from our examples alone, no person would suspect such specific relationship; and, in want of any intermediate forms for personal examination, I prefer at present to place our examples under the designation given by Dr. Rœmer.

Position and locality.—Strata of the Cretaceous period; east of Impracticable Ridge, Utah.

Exogyra læviuscula Rœmer.

Plate XVII, fig. 2 *a*, *b*, *c*, and *d*.

Exogyra læviuscula Rœmer, 1852, Kreidebildung von Texas, 70.
Exogyra læviuscula Conrad, 1857, U. S. & Mex. Bound. Surv., i, 154.
Gryphea læviuscula Conrad, 1857, ib., p. 170 and pl. vii.

Shell of moderate size, capacious, somewhat semi-ovate in form, suborbicular in marginal outline; test not massive; larger valve much inflated and subhemispherical; a very indistinctly-defined umbonal ridge is to be seen upon some examples, especially near the beak, but in others this feature is wanting.

Umbo small, distinctly spiral, making about two volutions, sometimes nearly free, but often very closely curved, giving the posterior side an umbilicated character, sometimes having a very small scar of attachment, but often without such a scar, and always quite symmetrical, or at least not distorted, as the beak often is in other species of this genus; periphery of its curve usually extending beyond the hinge-line, but sometimes not. The smaller valve is nearly flat, or slightly and somewhat irregularly concave, suborbicular in outline. Surface of both valves having a smooth aspect, but it is marked with such lines of growth as are common to other genera of shells, and free from the lamination of surface so common in the *Ostreidæ*.

Diameter of the largest example in the collection, from umbo to basal margin, forty-seven millimeters; transverse diameter, forty-two millimeters; depth of the larger valve, twenty-eight millimeters.

The collections contain numerous examples of this species, the type-specimens of which were obtained by Dr. Rœmer from near San Antonio, Texas. The figure given by Dr. Rœmer (*loc. cit.*) represents the umbo of the larger valve more nearly free than that of any of our examples is; the umbo in all our examples being closely incurved. In this respect, ours are more nearly like those figured and described by Conrad.

Position and locality.—Strata of the Cretaceous period; Linear Plateau, Southeastern Utah.

Exogyra costata Say, var. fluminis.

Plate XVII, fig. 3 *a*, *b*, *c*, and *d*.

Shell rather small, irregularly ovate in outline, somewhat expanded. The larger valve moderately capacious; greatest convexity near the middle, from which part the sides slope with less convexity to the basal and lateral margins; an obtuse, indistinct carina generally appears upon the umbo, becomes obsolete as it extends, and finally disappears about the middle of the valve; umbo small, depressed, distinctly spiral; volutions two or less; a scar of attachment usually obscures the inner volution, but seldom or never distorts the beak or impairs its symmetry. Smaller valve nearly flat or slightly concave, suborbicular in outline. Surface of the smaller valve marked by numerous thin imbricating striæ of growth; that of the larger valve marked by numerous small radiating costæ, which are quite distinct upon the umbonal region, but become obsolete or absent upon the basal portion of the valve. These costæ are slightly crenulate or irregular, increase a little in size from the umbo toward the base, increase in number both by intercalation and bifurcation, and occupy only the external layers of the test, exfoliated surfaces being free from them.

Diameter, from umbo to basal margin, of the largest example in the collection, forty-two millimeters; transverse diameter, thirty-four millimeters; convexity of the larger valve, nineteen millimeters.

This shell reaches a size nearly equal to that of *E. læviuscula* Rœmer; but it is distinguished from that species by the costate surface, less convexity, and smaller umbo of the larger valve.

From the typical forms of *E. costata* Say, as they are identified from the Cretaceous strata of New Jersey, Alabama, and Texas, it differs in its much smaller size, its thinner and more delicate test, and proportionally smaller costæ. The collections contain numerous examples of this variety, but none of the typical forms of *E. costata*. Some of the examples are very young, but the usual uniformity of size prevails among the larger ones that indicates adult age, and they have also the aspect of maturity. If it were not for the well-known tendency to extreme variation among the *Ostreidæ*, I should not hesitate to separate this as a distinct species rather than as a variety. It is not improbable that, when full and careful comparisons shall have been made, our shell will be found specifically distinct from *E. costata*. In such a case, I propose the varietal name given above for a specific one.

Position and locality.—Strata of the Cretaceous period; east bank of the Rio Puerco, six miles below Casa Salazan, New Mexico.

FAMILY PECTINIDÆ.

GENUS CAMPTONECTES Meek (Agassiz), 1864.

Camptonectes platessa White.

Plate XVII, fig. 5 *a*.

Camptonectes platessa White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 25.

Shell thin, suborbicular in outline; length of hinge-line about equal to one-half the transverse diameter; ears well defined by auricular furrows; posterior ear short, flat, its outer margin slightly concave; anterior ear moderately large, marked by distinct lines of growth and obscure radiating striæ. The anterior ear of the right valve separated from the body-portion by a deep, rather narrow, and somewhat angular sinus, the depth of which is equal to about one-half the length of the ear from its outer extremity to the beak. Radiating striæ of the surface moderately fine, increasing in number so rapidly that the direction of the outer ends of those above the middle of the valve is transverse, and farther toward the hinge they are distinctly recurving; the radiating lines crossed by fine concentric striæ, and occasionally by more distinct lines of growth.

Height and transverse diameter each about forty-five millimeters.

This species somewhat resembles *C. bellistriata* Meek and Hayden from the Jurassic strata of Dakota; but it is proportionally not so broad from front to rear, the ears are proportionally a little longer, and the radiating striæ a little coarser.

Position and locality.—Strata of the Cretaceous period; fifty miles north of Camp Apache, and five miles west of Mineral Spring, Arizona.

FAMILY LIMIDÆ.

GENUS LIMA Bruguière, 1791.

Lima Wacoensis Rœmer.

Plate XVII, fig. 4 *a*, *b*, and *c*.

Lima Wacoensis Rœmer, 1852, Kreidebildung von Texas, 63.
Lima Wacoensis Conrad, 1857, U. S. & Mex. Bound. Surv., i, 151.

Shell rather small, moderately convex, oblique, irregularly oval in marginal outline; antero-basal margin broadly rounded; posterior margin regularly but more shortly rounded than the base; front margin subtruncate; postero-dorsal margin nearly straight or slightly convex, and nearly parallel with the antero-basal margin; hinge short; ears of about equal size, small, but distinct, each forming an obtuse angle by the cardinal border, and the anterior and posterior borders respectively; beaks small, distinctly defined, projecting a very little over the cardinal border. Surface marked by numerous radiating costæ, which have interspaces of similar or slightly greater width between them; costæ becoming smaller upon each side of the umbonal region, and absent from the ears.

The long diameter of the largest example contained in the collections is about seventeen millimeters; short diameter, fourteen millimeters.

This beautiful and well-marked species has quite a wide geographical range. It was originally discovered by Rœmer in the Cretaceous strata of the valley of the Guadalupe, near New Braunfels, Texas.

Position and locality.—Strata of the Cretaceous period; southeast of Paria, Utah.

Family PTERIIDÆ.

Genus INOCERAMUS Sowerby, 1814.

Inoceramus problematicus Schlotheim, *sp.*

Plate XVI, fig. 3 *a*.

Mytilus problematicus Schlotheim, 1820, Petrefact., 312.
Mytilus labiatus Brongniart, 1822, Geol. des Envir. Paris, 215.
Inoceramus mytiloides Goldfuss, 1836, Petrefact. Germ., 118.
Inoceramus problematicus d'Orbigny, 1843, Pal. Française, iii, 510.
Inoceramus mytiloides Rœmer, 1852, Kreidebildung von Texas, 60.

Shell oblique, elongate-ovate in marginal outline, moderately inflated in its anterior and umbonal portions, but somewhat compressed posteriorly; valves subequal; left valve more capacious than the right; umbones oblique; beaks small, pointing forward and incurved, reaching a little farther forward than the anterior border; front side broadly rounded, and nearly parallel with the posterior side; each valve, for a short distance below the beaks, bent abruptly inward to the margin; postero-basal margin abruptly rounded; posterior or anal side broadly rounded to the cardinal border; hinge comparatively short.

Surface marked by moderately strong concentric plications, and also by fine concentric lines of growth.

The dimensions of this shell differ much with age in their relative proportions; the older ones being proportionally much more elongate than the young ones. This is due to the more rapid growth of the shell in and near the postero-lateral region than elsewhere. The long diameter of one of our examples is a little more than six centimeters; the short diameter about three and a half centimeters.

This is perhaps one of the most widely-distributed species of the genus in the Cretaceous strata of the United States, and also perhaps one of the most variable. This, together with the fact that no species of *Inoceramus* possesses very salient specific characters, often renders its identification a matter of some difficulty, especially if the specimens are imperfect. There seems, however, to be very little reason for doubting that the forms under examination belong to the species *I. problematicus*, as originally described by Schlotheim.

Position and locality.—Strata of the Cretaceous period: southeast of Paria, Utah; and also upon the West Fork of Paria Creek, Utah.

Inoceramus fragilis Hall and Meek.

Plate XV, fig. 3 *a*.

Inoceramus fragilis Hall and Meek, 1856, Mem. Am. Acad. Arts & Sci., n. s., v, 388.

Shell of medium size, obliquely ovate in marginal outline, somewhat inflated; beaks small, pointed, turned forward; hinge-line rather long; surface marked by concentric undulations and fine lines of growth, but the shell has a somewhat smooth aspect.

The collections contain only a single example of this species, which has been recognized by Mr. Meek as identical with *I. fragilis*.

Position and locality.—Strata of the Cretaceous period; southeast of Paria, Utah.

Inoceramus flaccidus White.

Plate XVI, fig. 1 *a* and *b*.

Shell large, irregularly subovate in marginal outline, exclusive of the ears; valves subequal, not much inflated; wing moderately large, well defined at its inner side by an auricular furrow; hinge-line not very long, nearly at right angles with the front of the shell, and only a little oblique with the axis; a more or less distinct, but somewhat irregular, furrow extending the whole length of the shell from the posterior side of the umbo to the postero-basal margin, giving each valve an obscurely-bilobed appearance; crenulated face of the hinge narrow, crenulations small; umbonal region narrow; beaks prominent, curved forward and inward; test comparatively thin throughout the whole shell; surface having the ordinary concentric lines of growth, and the test is also thrown into numerous rude and irregular concentric undulations.

Length of the largest example in the collection, about twenty-two centimeters; greatest breadth, about fifteen centimeters.

This species is remarkable for the rudeness and extravagant irregularity of the undulations of the surface, of which irregularity the outline also partakes, giving the shell a flaccid aspect. The specimens of the collections are almost wholly in the form of natural casts, being preserved in a fine-grained calcareous sandstone, some of which is crowded with fragments of this species.

Position and locality.—Strata of the Cretaceous period; five miles above Pueblo, Colorado.

Inoceramus deformis Meek.

Plate XV, fig. 1 *a* and *b*.

Inoceramus deformis Meek, 1872, Geol. Surv. Wyoming & Contiguous Territories, 296.
Inoceramus deformis Meek, 1874, (Manuscript) U. S. Geol. Expl. 40th Parallel.

Shell moderately large, irregularly subovate or subcircular in marginal outline; entire form subglobose when adult; valves subequal, very much inflated; beaks broad, not very prominent; hinge-line short; cardinal border of test somewhat massive; crenulated face of the hinge moderately broad; test thin in the middle region of the valves, but it becomes greatly thickened at the margin of old shells, in some cases forming a massive rim around the whole border of each valve, including the cardinal border.

Surface marked by the ordinary fine concentric lines of growth, and the test is also thrown into more or less regular, coarse, concentric folds or undulations.

Diameter of the largest example in the collections, measured along the axis of the shell, nearly sixteen centimeters; breadth of the same at right angles with the former measurement, about fourteen centimeters; thickness, both valves together, not far from fourteen centimeters.

This species is remarkable for its extreme gibbosity, and the great thickening of the test at the borders of the valves. Disconnected fragments of these thickened valves are often met with, which has led to the supposition that they indicated a species, perfect examples of which were not yet discovered, and which was provided with a test equally thick throughout. The relative thickness of the test, however, in different parts of the valve, is shown at least approximately in figure 1 *b*, Plate XV.

The test of all the known examples of this species, as is usually found to be the case with the test of *Inoceramus*, has wholly a prismatic structure, and is much thinner in the middle and umbonal regions than toward the free borders, while the reverse is usually the case with conchifers. This seems to indicate that a portion of the thickness of the valve at the middle and umbonal region was absorbed while the animal was alive, or that a thin pearly layer was originally formed upon the inside of the valves, as in *Pinna*, and that it became dissolved or decomposed after its entombment, by agencies which the prismatic layer resisted. The latter suggestion is strengthened by the fact that many of the Cretaceous *Pinnas* show no trace of a pearly layer, such as living Pinnas have, while the prismatic layer is well preserved. It is difficult, however, to reconcile this with the fact that the pearly layer in *I. Barabini* is often as well or better preserved than the prismatic layer.

Position and locality.—Strata of the Cretaceous period; five miles above Pueblo, Colorado.

Inoceramus Barabini Morton.

Plate XVI, fig. 4 *a*.

Inoceramus Barabini Morton, 1834, Synop. Org. Remains Cret. Group, 62.
? *Inoceramus Crispii* Conrad, 1857, U. S. & Mex. Bound. Surv., i, 152 (not Mantell).

Shell of medium size, elongate-ovate in marginal outline, moderately inflated, especially in front and in the umbonal regions; valves equal, or nearly so; umbones more or less inflated; beaks small, not reaching quite so far forward as the front side of the shell; front truncated and short; basal margin broadly rounded; posterior margin curving somewhat abruptly upward from the base and rounded to the cardinal margin; hinge-line long, sometimes nearly parallel with the basal border, and never much divergent from it.

Surface marked by moderately strong folds or undulations, and also by fine lines of growth.

Long diameter, of an average-sized example, about seven centimeters; shorter diameter, at right angles with the former measurement, four and a half centimeters.

The conspicuous features of this species are its long, slightly divergent hinge-line, and its inflated truncated front.

It is a fact worthy of note that the greater part of the examples of this species in the collections have the pearly layer of the test in a better state of preservation than the prismatic layer, while in the numerous other species of the genus that have come under my observation, the pearly layer is usually, if not always, wanting.

Position and locality.—Strata of the Cretaceous period; one and a quarter miles south of Bowlder, Colorado, and at Gallinas Creek, New Mexico.

Inoceramus dimidius White.

Plate XVI, fig. 2 *a*, *b*, *c*, and *d*.

Inoceramus dimidius White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 25.

Shell very small for one of this genus, inflated, sometimes much so, obliquely subovate in outline; valves subequal, the left one being a very little more capacious than the other; test thin; beaks small, prominent, acute, incurving, and pointing a very little forward; hinge-line straight or nearly so, rather short.

Surface marked by more or less regular and more or less strong concentric folds or undulations. In some cases, these undulations continued to be formed only until the shell had attained about half its full size, when they ceased, the remainder of the surface being marked only by ordinary concentric lines of growth. This irregularity in the formation of concentric folds is sometimes connected with considerable distortion of the usual symmetry of the shell.

The long diameter of an average example from the umbo to the postero-ventral margin, twenty-six millimeters; greatest breadth, eighteen millimeters; thickness, sixteen millimeters.

This species is especially distinguished by its small size. Its other more conspicuous specific characters are the small but prominent and pointed beaks and subequal valves. From the young of *I. problematicus*, the valves of which are also subequal, it differs in the character of the beaks just mentioned, the much greater convexity of the valves, and other evidences of mature growth.

The collections contain quite a large number of examples of this neat little species, both valves of which, in a majority of cases, are together in their natural position.

Position and locality.—Strata of the Cretaceous period; Ojo del Piscado, New Mexico.

FAMILY PINNIDÆ.

GENUS PINNA Linnæus, 1758.

Pinna petrina White.

Plate XIII, fig. 7 *a* and *b*.

Pinna petrina White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 24.

Shell moderately large, broad, rather thick, rapidly expanding in height as it increases in length; dorsal margin concave; ventral margin convex; a more or less strongly-raised carina extending from the beak to the posterior margin, defining a prominent longitudinal angle along the median portion of each valve, which is placed a little nearer the ventral than the dorsal border; transverse section rhomboidal, the sides of the rhomb being slightly convex; posterior margin oblique with the axis of the shell, forming a distinct but obtuse angle with the dorsal margin. The acute angle which it would form with the ventral margin if continued all the way to it in a direct course is abruptly rounded.

Surface marked by strong, distinct lines of growth, which run obliquely downward and backward in a nearly direct course from the dorsal margin, across the mesial angle, to near the ventral margin, where they are abruptly flexed forward, and blend with the ventral border. Crossing the lines of growth upon the surface above the mesial angle, there are coarse but indistinct radiating striæ, and occasionally still more indistinct traces of similar ones below that angle, all of which are more discernible upon the anterior than upon the posterior part of the shell. More or less of the test is preserved upon all the specimens; but no trace of the pearly layer has been detected, all the test having the usual prismatic structure.

Some of the largest examples measure seven and a half centimeters in width along the posterior margin, and they must have been not less than seventeen centimeters in length when entire. The large size, proportionally great width, and angular aspect of this shell distinguish it from any other likely to be confounded with it. It resembles *P. Renauxiana* d'Orbigny, as figured by him in Paléontologie Française, but it expands much more rapidly in width than that species does, is not proportionally so thick, and has a very different posterior marginal outline. In that shell it is the middle of the posterior margin that is most extended, while in ours the greatest extension is much below the middle.

Position and locality.—Strata of the Cretaceous period; east of Mount Taylor, one mile south of Pajuate, New Mexico.

ORDER DYMYARIA.

FAMILY ARCIDÆ.

GENUS IDONEARCA Conrad, 1862.

Idonearca depressa White.

Plate XVIII, fig. 13 *a* and *b*.

Shell of moderate size, gibbous, irregularly trapezoidal or subovate in marginal outline; posterior half of the basal margin nearly straight, broadly rounding upward anteriorly, and sharply rounding the end of the umbonal ridge to meet the posterior margin; anterior margin regularly rounded up to the hinge-line; posterior margin long, about equal in length to the full height of the shell, nearly straight or slightly convex, extending obliquely downward and backward; hinge-line equal to a little more than half the length of the shell; areas small, narrow, well defined, slightly concave; beaks very small, depressed, a little incurved; umbonal ridges very prominent, each bounding anteriorly a flattened, three-sided space, along the middle of which there is a radiating, raised line.

Surface marked by the usual lines of growth and also by numerous small, flat, radiating costæ of unequal width, with narrow, sharply-impressed interspaces between them; costæ largest upon and near the umbonal ridge, becoming obsolete near the cardinal border, both anteriorly and posteriorly.

Length, measuring across at about midheight of the shell, twenty-eight millimeters; height, from base to umbo, twenty-three millimeters; thickness, both valves together, about twenty millimeters.

This species is not fully represented in the collections, but its specific characters are very satisfactorily shown. A full collection of examples would probably show variations of outline, due to sex, in some cases, whereby the aspect of the shell may be a little different from that of the figure. It is perhaps as nearly related to *I. Shumardi* Meek and Hayden as to any other described species, but it is clearly distinguished from that by its depressed beaks and prominent umbonal ridges.

Position and locality.—Strata of the Cretaceous period; east bank of Rio Puerco, six miles below Casa Salazan, New Mexico.

FAMILY LUCINIDÆ.

GENUS LUCINA Brugnière, 1792.

Lucina subundata Hall and Meek.

Plate XVIII, fig. 12 *a*.

Lucina subundata Hall and Meek, 1856, Mem. Am. Acad. Arts & Sci., n. s., v, 382.

Shell suborbicular in marginal outline, lenticular, moderately convex, length a little greater than the height; basal margin broadly rounded; anterior and posterior margins a little more narrowly rounded than the base; postero-dorsal margin gently sloping; beak small, slightly elevated, a trifle nearer to the posterior than to the anterior side. Surface marked by the ordinary concentric lines of growth, which are crossed by very faint radiating striæ.

Length, fifteen millimeters; height, thirteen millimeters.

Position and locality.—Strata of the Cretaceous period; southeast of Paria, Utah.

Family GLOSSIDÆ.

Genus VENIELLA Stoliczska, 1870.

Veniella goniophora Meek.

Veniella goniophora Meek, 1875, Paleont. Upper Missouri River, 152.

Some imperfect examples of this species were obtained from Cretaceous strata southeast of Paria, Utah. Mr. Meek's types of the species were obtained from the valley of the Missouri River, near Fort Benton. The above-named work, which is now issuing from the press, contains full descriptions and illustrations, for which the examples in hand are too imperfect to furnish a satisfactory basis.

Family MACTRIDÆ.

Genus MACTRA Linnæus.

Mactra? incompta White.

Plate XVII, fig. 6 *a* and *b*.

Shell small, transversely subovate in marginal outline; valves moderately convex; beaks somewhat prominent, placed a little more than one-third the length of the shell from the front; dorsal border strongly arching; base broadly rounded; front regularly but strongly rounded; posterior border broadly rounded down to the basal margin, which it meets at an obtuse angle, and which is there met by an obscure, broadly-curving umbonal ridge. Surface marked by somewhat regular, small but distinct, raised, concentric striæ. The general aspect of the shell, the absence of an external ligament, and the presence of a well-developed lateral tooth in the left valve (all of the hinge yet seen) suggest its reference to the genus *Mactra*, but it may probably be found to differ from the typical forms of that genus by the discovery of the whole hinge.

Length, eighteen millimeters; height, from beaks to base, fourteen millimeters; thickness, nine millimeters.

Position and locality.—Strata of the Cretaceous period; five miles above Pueblo, Colorado.

FAMILY ANATINIDÆ.

GENUS LEIOPISTHA Meek, 1864.

SUBGENUS PSILOMYA Meek (manuscript, 1874).

Leiopistha (Psilomya) Meekii White.

Plate XVIII, fig. 14 *a*, *b*, *c*, and *d*.

Leiopistha (*Psilomya*) *Meekii* White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 26.

Shell short, much inflated; umbones large, elevated; beaks small, strongly curved inward and downward, and very slightly turned forward; posterior portion moderately produced, somewhat compressed laterally; free margins forming a regular but unequally convex curve, the greatest convexity of which is in front and the least along the base; upper portion of the posterior border obliquely truncated, so that the greatest posterior extension of the shell is a little below the hinge-extremity.

Surface having a smooth aspect, but it is marked by fine concentric lines of growth. Under a lens, very fine, obscure, radiating striæ are seen upon the surface of a little more than the anterior half of the shell; and upon the remainder of the surface, except a small space adjoining the posterior cardinal border, there are small, somewhat distant, radiating striæ, easily seen by the unassisted eye. Upon these striæ, both the distinct and obscure, the lens shows numerous minute punctures, placed at irregular intervals, which are the bases of minute, short, blunt spines, or which mark the places from which the spines have been removed.

Length twenty-five millimeters; height, from base to umbo, twenty millimeters; greatest thickness, both valves together, sixteen millimeters.

This shell seems to be more nearly related to *L. globosa* (= *Poromya globosa* Forbes) than to any other described species. Compared with that species, as figured and described by Stoliczska (Cretaceous Faüna of Southern India, vol. iii, p. 47, pl. iii, fig. 8, and pl. xvi, fig. 16), ours differs in being less globular, in having the umbones more elevated, and in the more distinct radiating striæ upon the posterior half of each valve.

This species belongs to an interesting group of shells, which form a part of the family *Anatinidæ*, and which Mr. F. B. Meek has defined under the generic name of *Leiopistha*, of which genus he regards the *Cardium elegantulum* of Rœmer as the type. He has also divided the genus into three sections or subgenera, under the names of *Leiopistha* proper, *Cymella* and *Psilomya* (the latter yet in manuscript and awaiting publication). The species here described is regarded as a typical one of the last-named subgenus. The completeness and precision with which that distinguished paleontologist has done the work upon this group of shells reflect great credit upon the science, and it affords me pleasure to name this species in his honor.

Position and locality.—Strata of Cretaceous age; southeast of Paria, Utah.

SUBGENUS CYMELLA Meek, 1864.

Leiopistha (Cymella) undata Meek and Hayden, *sp.*

Plate XVIII, fig. 15 *a*.

Pholadomya undata Meek and Hayden, 1856, Proc. Acad. Nat. Sci. Phila., 81.
Cymella undata Meek, 1864, Smithsonian Check-List Cret. and Jurassic Fossils, 34.

Shell small, subovate in marginal outline; valves moderately convex; beaks somewhat prominent, incurving, and very slightly turned forward, placed about two-fifths the length of the shell from the front; front margin regularly, and basal margin more broadly, rounded; dorsal margin sloping a little downward to the front and behind, sloping gently to the posterior margin; the latter margin regularly, but a little more abruptly, rounded than the front; concentric undulations comparatively strong and distinct, all around, parallel with the free margins; radiating impressed lines of the middle of the valves also distinct, but rapidly diminishing in distinctness toward both ends; a narrow fold extends from beneath the beak, along the postero-dorsal region, producing a narrow furrow along the lower side of the fold, and a similar but less distinct one between it and the dorsal border, both furrows being of about the same width as the fold.

Length, thirteen millimeters; height, from beak to base, nearly ten millimeters.

This species is the type of the subgenus *Cymella*.

Position and locality.—Strata of the Cretaceous period; Gallinas Creek, New Mexico.

Family CORBULIDÆ.

Genus CORBULA Bruguière, 1792.

Corbula nematophora Meek.

Plate XVII, fig. 7 *a*, *b*, and *c*.

Corbula nematophora Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, and Utah, 496.

Shell small, subovate or subtetrahedral in marginal outline, nearly equivalve, moderately gibbous, height in relation to the length about as seven to ten, posterior extremity somewhat produced; basal margin broadly rounded, abruptly rounded up at each end to meet the anterior and posterior slopes respectively; anterior slope more abrupt than the posterior, almost straight or slightly concave; posterior slope longer and more oblique than the anterior, nearly straight; umbones rather prominent; beaks small, slightly incurved; umbonal ridge somewhat distinct; postero-dorsal region flattened and sometimes marked by an inconspicuous radiating raised line.

Surface marked by fine, raised, concentric lines of growth, and also by strong, concentric folds placed at irregular intervals, having apparently been produced by the temporarily arrested marginal growth of the shell at irregular intervals of time. Sometimes the surface, especially that of the left valve, is nearly free from these folds, but in other cases they are so distinct as to produce considerable distortion of the valve.

Length, six millimeters; height, four millimeters.

The average size of the specimens contained in the collections is considerably less than that given by Mr. Meek (*loc. cit.*) for his largest typical example; but there seems to be very little reason to doubt that the shells under examination are specifically identical with *C. nematophora*.

The average size of the specimens obtained at the second locality named below is greater than that of those obtained from the first-named locality. This is probably due to the difference in the conditions of the habitat of the mollusks at the two localities respectively, while they lived, as indicated by the composition of the rock in which they are now embedded; that of the first-named locality being comparatively pure limestone, while the rock of the other locality is soft, clayey shale, with thin intercalated layers of impure limestone.

Position and locality.—Strata of the Cretaceous period; plateau near the west crossing of the North Fork of Virgin River, and elsewhere near the North Fork of that river, Utah.

CLASS GASTEROPODA.

SUBCLASS DIŒCA.

ORDER RHIPHIDOGLOSSA.

SUBORDER PODOPHTHALMA.

FAMILY NERITIDÆ.

GENUS NERITINA Lamarck, 1809.

SUBGENUS VELATELLA Meek, 1872.

Neritina (Velatella) carditoides Meek.

Plate XVIII, fig. 7 *a*, *b*, and *c*.

Neritina (*Dostia?*) *carditoides* Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, and Utah, 499.

Shell of medium size, broadly oval in marginal outline, depressed-convex; apex subspiral, slightly oblique, reaching nearly to the posterior margin, and depressed nearly upon the posterior border; inner lip occupying a little more than half the under surface of the shell, smooth, slightly convex, apparently thick, but really thinned by absorption within; the free margin of the inner lip somewhat sharp, straight, plain; outer lip thickened, coarsely and somewhat obscurely crenulate; aperture subreniform, considerably less in size than one-half the under surface of the shell. The space between the shelf-like inner lip and the roof of the shell is partially divided by a thin, slightly-twisted process or vertical partition, which extends inward and backward from the antero-dextral corner directly toward, but not reaching, the apex, so that communication between the two portions of the space thus partially divided was around the posterior edge of the partition.

Surface marked by fifteen or twenty radiating costæ similar to those that mark *Cardium* or *Cardita*, and these are crossed by numerous distinct lines of growth.

Mr. Meek described this species from Cretaceous strata at Coalville, Utah, together with *N. bellatula*, another species possessing similar subgeneric characters, to designate which he proposed the subgeneric name of *Velatella*.

Position and locality.—Strata of the Cretaceous period; south of Last Bluff, Utah.

ORDER PECTINIBRANCHIATA.

SUBORDER TÆNIOGLOSSA.

FAMILY APORRHAIDÆ.

GENUS ANCHURA Conrad, 1860.

Anchura ? fusiformis Meek.

Plate XVIII, fig. 4 *a*.

Anchura ? fusiformis Meek, 1874 (Manuscript), Geol. Expl. 40th Parallel.

Shell of medium size; body subfusiform; spire somewhat elongated and tapering to a point; volutions eight or nine, convex; suture impressed; last volution moderately large, without a revolving angle. Wing moderately large, broad-oblong; outer border nearly straight and nearly parallel with a line produced from the slope of the opposite side of the spire; its posterior end terminating in a somewhat slender, slightly curved, sharp, backward-projecting spine-like process; its anterior end terminating in a somewhat distinct, but obtuse, angle; posterior border of the wing having a somewhat regular concave curve between the base of the spine-like process and the spire; anterior border of the wing curving with slight irregularity from the anterior angle of the outer border to the anterior canal; this canal is moderately long and slender.

Test thin and delicate, except at the borders of the wing, where it is considerably thickened, and there are also some indications upon one of our examples of a thickening of the posterior end of the inner lip.

Surface marked by fine, distinct striæ and numerous, somewhat irregular undulations of growth. Crossing these striæ of growth, the surface is covered with minute revolving striæ of uniform size, giving it a delicately-ornamented appearance under the lens. Upon some of our examples, however, the revolving striæ are obsolete. Occasionally also a few incipient vertical costæ are to be seen upon the body volution of large specimens.

Length of the largest example in the collection, from the apex of the spire to the end of the anterior canal, thirty millimeters.

Mr. Meek's type-specimens being incomplete, he was in doubt whether they ought to be referred to the genus *Anchura* or not. The examples under consideration will not enable me to decide the question now. The presence of a little callus preserved at the posterior portion of the aperture of one of our examples suggests the probable presence of a posterior canal; in which case the shell cannot be assigned to *Anchura*, but probably belongs to the genus *Helicaulax* Gabb.

Position and locality.—Strata of the Cretaceous period: east bank of Rio Puerco, six miles below Casa Salazan; six miles west of Seboetto; and Cerro Rotunda, New Mexico.

GENUS LISPODESTHES, *nov. gen.*

Etym.—λίσπος, smooth, and ἔσθης, a garment; in allusion to the callus-covered spire.

Shell fusiform; anterior canal straight or slightly curved, and more or less produced; posterior canal extending nearly or quite the whole length of the spire, from near the apex of which it may be a little deflected; aperture winged; wing rather large, bearing two processes; the posterior process spine-like or falciform; the anterior process either in the form of a lobe or tongue-shaped; inner lip and spire covered with callus.

This genus is related to *Helicaulax* Gabb, and may possibly prove to be only subgenerically distinct from it. It differs from that genus in having the callus enveloping the whole spire instead of extending along the under side only, and also in the presence of the moderately large anterior process of the wing. In some respects it is like *Calyptrophorus* Conrad, but it differs conspicuously from that genus in having two prominent processes to the wing instead of being plain, thickened, rounded, and smooth. Besides this, the form is not so elongate as is common in that genus.

Only two species of this genus, so far as I am aware, have been discovered in the Cretaceous strata of North America, both of which are described in this report.

Lispodesthes nuptialis White.

Plate XVIII, fig. 3 *a* and *b*.

Anchura nuptialis White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 24.

Shell small; body subfusiform; wing moderately large; spire somewhat prominent, acute, but so thickly encrusted with callus that the volutions are only obscurely shown, except where the callus is removed by exfoliation; revolving angle absent or obsolete upon the volitions of the spire, even when bared by exfoliation of the callus, but it is somewhat distinct upon the body-volution, being continued out upon the falciform process of the wing. This posterior falciform process diverges widely from the axis of the shell, but, by recurving, it extends nearly as far backward as the apex of the spire; anterior process of the wing somewhat thickened, its breadth throughout about equal to that of the falciform process at the base, its length and breadth about equal, its outer end obliquely rounded; space between the two processes very narrow; from the base of the anterior process the border of the wing extends forward with a concave curve to the base of, and ends at, the long, slender anterior canal; posterior border of the wing concave and continuous with that of the falciform process on the one hand, and with the callus-border of the posterior canal on the other.

Length, from the apex of the spire to the end of the anterior canal, twenty millimeters; breadth, measuring across from the base of the processes of the wing to the opposite side, nine millimeters; spire, falciform process, and anterior canal, each about seven millimeters.

Position and locality.—Strata of the Cretaceous period; fifty miles north of Camp Apache, five miles west of Mineral Spring, Arizona.

Lispodesthes lingulifera White.

Plate XVIII, fig. 2 *a* and *b*.

Shell rather small; body subfusiform; wing moderately large; spire of medium size, acute, nearly or wholly encrusted with callus, by which the form of the volutions is obscured; volutions six or seven, seen to be regularly convex where the callus is exfoliated; suture impressed; revolving angle distinct upon the body-volution, and forms a carina as it is continued out upon the spine-like posterior process of the wing. This process diverges widely from the axis of the shell, and curves gently backward; anterior process of the wing moderately large, linguliform, projecting straight outward, and a little forward, and separated from the other process by a notch of moderate width, which is abruptly rounded at the bottom. From the base of the spine-like process, the posterior border of the wing curves gently inward and backward against the spire; anterior border of the wing curving forward from the base of the anterior process and ending in the slender anterior canal; posterior canal or groove narrow, extending back nearly or quite to the apex of the spire. Surface of the wing marked by the ordinary lines of growth, and upon the outer volution of some specimens there are faint indications of revolving striæ.

Full length of the shell, from the apex to the end of the anterior canal, about thirteen millimeters; width across the last volution, including the whole wing, but not the processes, six millimeters.

This species is closely related to *L. nuptialis* of the preceding description, but differs from that species in its less robust form, comparatively smaller wing, more slender and less recurving posterior process, and in the linguliform, instead of lobe-shaped anterior process.

Position and locality.—Strata of the Cretaceous period; east of Mount Taylor, one mile south of Pajuate, New Mexico.

FAMILY TECTURIDÆ.

GENUS ANISOMYON Meek and Hayden, 1860.

Anisomyon borealis Morton, *sp.*

Plate XVIII, fig. 9 *a* and *b*.

Hipponyx borealis Morton, 1842, Jour. Acad. Nat. Sci. Phila., viii, pl. ii, fig. 6.
Helcion carinatus Meek and Hayden, 1856, Proc. Acad. Nat. Sci. Phila., 68.
Anisomyon borealis Meek and Hayden, 1860, Am. Jour. Sci., xxviii, 2d s., 35.

Shell obliquely conical; marginal outline broadly oval or suboval; breadth greater than the height; lateral slopes nearly straight or slightly convex; anterior slope concave; posterior slope convex. Surface marked by conspicuous lines of growth, which are crossed by numerous finer radiating lines. Besides the latter, there are eight slightly-raised radiating ridges extending from the apex to the border, which leave upon the internal cast faint shallow furrows, and where the shell is partially exfoliated they show as narrow linear grooves in its substance. These grooves or ridges are usually arranged with considerable regularity as to their relative distances from each other, but sometimes they are less symmetrically arranged than they are represented in figure 9 *a*. The margin is usually very slightly emarginate at each of the radiating ridges, and seems to have been elevated a little at the front.

Antero-posterior diameter, thirty millimeters; transverse diameter, twenty-five millimeters; height, about twenty millimeters.

Position and locality.—Strata of the Cretaceous period; Gallinas Creek, New Mexico.

Anisomyon centrale Meek.

Plate XVIII, fig. 8 *a* and *b*.

Anisomyon centrale Meek, 1870, Geol. Surv. Wyoming & Contiguous Territories, 312.

Among the collections made at Gallinas Creek, New Mexico, there is a single internal cast in indurated clay, which I refer with comparatively little doubt to *A. centrale* Meek. Its height is proportionally much less than that of typical examples of this species. This imperfection, together with the absence of the test, render it insufficient of itself to base a specific description upon; consequently, I give the substance of Mr. Meek's original description as follows:—

"Shell depressed-conical; apex nearly central; slopes nearly straight all around, but sometimes the anterior and sometimes the posterior slope is a little convex; marginal outline nearly circular or very broadly oval. Surface marked by concentric lines of growth, by slightly-raised radiating striæ, and also by somewhat irregular radiating furrows of unequal depth; the furrows being larger and deeper upon the anterior half of the shell.

"Breadth of the largest specimens seen, 1.16 inches; height, about 0.95 inch."

Our example is represented in figure 8 *a* and *b*, of natural size, by which it will be seen to be considerably smaller than the maximum size of Mr. Meek's specimens. It differs somewhat also from his description in having its radiating furrows more irregularly disposed upon the anterior part of the shell, but this is regarded as only an individual variation.

Family TURRITELLIDÆ.

Genus TURRITELLA Lamarck, 1801.

Turritella uvasana Conrad.

Plate XVIII, fig. 11 *a* and *b*.

Turritella uvasana Conrad, 1856, Pacific Railroad Surveys, v, 321.
Turritella uvasana Gabb, 1864, Paleontology of California, i, 134.

Shell of ordinary size, elongate, slender; sides straight; volutions numerous, apparently reaching eighteen or twenty in number when full-grown; the sides of the volutions nearly straight or only slightly convex; suture broad, deeply impressed.

Surface marked by numerous revolving raised lines, six or eight of which are moderately large, the smaller ones alternating with them. The larger lines are minutely nodose upon the larger volutions, and upon the last one they are sometimes even subspinulose.

All the specimens of this species in the collection are more or less broken, but, judging from the apical angle indicated by their sides, the largest one must have been about five and a half centimeters long, and its last whorl about thirteen millimeters in diameter.

I have referred this species to *T. uvasana* Conrad with some doubt, for several reasons. Both Conrad's and Gabb's descriptions are unsatisfactorily short: Conrad's figure is of only a fragment; Gabb's figure is proportionally more slender than any of our examples; and, finally, Conrad refers his species to the Eocene period. Gabb, however, obtaining his specimens from the typical locality, in Los Angeles County, California, refers the strata there to the Cretaceous period.

Position and locality.—Strata of the Cretaceous period; southeast of Paria, Utah.

GENUS CASSIOPE Coquand, 1865.

Cassiope Whitfieldi White.

Plate XVIII, fig. 1 *a*.

Cassiope Whitfieldi, White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 27.

Shell moderately large, elongate-conical, umbilicate; volutions apparently about twelve, prominent and prominently angular below the middle of the visible portion, slightly concave from the prominent revolving angle to the suture below, also very slightly and somewhat irregularly concave from that angle to the suture above. A little below the suture there is a rather small, shallow furrow, with its borders above and below raised into more or less distinct revolving ridges. Upon the under side of the last volution, which is rather strongly convex, there are three small revolving ridges, one of them bounding the umbilicus; the other two are placed near each other above the middle of the space, and are continuous to the apex of the shell. It is between the two last-named ridges that the hinder edge of each succeeding volution joins the preceding one. Umbilicus moderately large and deep; aperture subovate in outline; outer lip sinuate, having a broad, shallow notch above its middle, projecting somewhat anteriorly, and rounded abruptly into the umbilicus.

Surface marked by more or less strong undulating lines of growth, apparently without small revolving lines.

Diameter of the last volution of our largest example, nearly four and a half centimeters; the full height of the same, when entire, must have been not far from eleven centimeters.

This shell has nearly the general aspect of *Turritella Mortoni* Conrad, but the presence of an umbilicus separates it generically from that shell.

Dedicated to Mr. R. P. Whitfield, the accomplished paleontologist of Albany, New York.

Position and locality.—Strata of the Cretaceous period; at the head of LeVerken Creek, and also in Pace's Cañon, Utah.

GENUS EULIMELLA Forbes, 1846.

Eulimella funicula Meek.

Plate XVIII, fig. 6 *a*.

Eulimella? funicula Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, and Utah, 506.

Shell rather small, slender, elongate-conical; sides, from the last volution to the apex, slightly convex; volutions ten or twelve, their sides nearly flat or slightly convex; last volution subangular below the middle; suture linear; aperture oval, rounded anteriorly, subangular posteriorly; inner lip a little thickened; columella imperforate, nearly or quite straight, and in a line with the axis of the shell; surface smooth, apparently polished.

Length, about sixteen millimeters; angle of lateral divergence, eighteen or twenty degrees.

Mr. Meek referred this species to *Eulima* with much hesitation, and suggested (*loc. cit.*) that it might subsequently be found, through the discovery of more perfect specimens, to belong to the genus *Eulimella.* None of our examples show the apex, and it is, therefore, not known whether it is sinistral or not, but the one selected for figuring shows the columella to be simple, and nearly or quite straight, as in true *Eulimella.* I therefore refer it provisionally to that genus.

Position and locality.—Strata of the Cretaceous period; North Fork of Virgin River, Utah.

FAMILY PYRAMIDELLIDÆ.

GENUS TURBONILLA Leach, 1825.

SUBGENUS CHEMNITZIA Conrad, 1860.

Turbonilla (Chemnitzia) melanopsis Conrad (?).

Plate XVIII, fig. 10 *a*.

Among the fossils obtained from near the west crossing of Virgin River, Utah, are some imperfect examples of a shell that seems to be identical with *T. melanopsis* Conrad. As these are all too imperfect to base a full description upon, I copy that of the author from the Journal of the Academy of Natural Sciences of Philadelphia, (2d series, vol. iv, p. 287):—"*T.* (*Chem-*

nitzia) melanopsis.—Subulate; whorls nine, flattened on the sides; ribs regular, slightly curved, about seventeen in number on the body-whorl; revolving lines distinct, unequal, about seventeen in number on the penultimate whorl; suture impressed, slightly waved; aperture long, elliptical."

SUBORDER TOXOGLOSSA.

FAMILY ADMETIDÆ.

GENUS ADMETE Möller, 1842.

SUBGENUS ADMETOPSIS Meek, 1872.

Admete (Admetopsis) gregaria Meek.

Plate XVIII, fig. 5 *a* and *b*.

Admete? gregaria Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, and Utah, 506.

Shell rather small, subfusiform, excluding the outer lip; spire prominent, tapering to a small apex; volutions six or eight, convex, abruptly rounded in to the suture above; suture well defined; last volution moderately inflated, its length equal to, or a little greater than, one-half the full length of the shell; aperture of moderate size, about as long as the spire, narrowing posteriorly and ending anteriorly, at the base of the columella, in a distinct sinus; columella marked by two spiral folds, the larger one of which blends with the truncated extremity of the columella. The other fold is placed a little above the first and passes backward into the aperture a little more obliquely; inner lip a little thickened along its whole length; outer lip in adult shells moderately thick, its outer margin broadly rounded, and its anterior margin abruptly truncated to the base of the columella.

Surface marked by numerous, more or less strongly-elevated, longitudinal or slightly oblique folds, of regular but gradually-increasing size, coincident with the growth of the shell. These folds are quite distinct upon the middle volutions, scarcely observable near the apex, and sometimes obsolete upon the last volution, or visible only upon its posterior portion. Numerous small, revolving, raised lines cross these folds, often not perceptible between, but distinct upon, the folds, giving them a nodulose or corrugated appearance. These revolving lines are always present and usually conspicuous upon the anterior part of the last volution.

Length of a large example, nineteen millimeters; breadth of its last volution, including the outer lip, ten millimeters.

Mr. Meek described (*loc. cit.*) two other closely-related species, all from the Cretaceous strata at Coalville, Utah, which he proposed to group under the subgeneric name of *Admetopsis.* Their generic characters are very closely like those which distinguish the recent genus *Admete*, but I agree with Mr. Meek in regarding the differences as of at least subgeneric if not full generic value. In *Admetopsis* it is the lower fold upon the columella that is most prominent, being particularly so just where it blends with the truncated end of the columella. In *Admete*, on the contrary, it is usually the second fold that is most prominent. The inner lip also of the former, unlike that of the latter, is thickened along its whole length, and the shells throughout are a trifle more massive than those of *Admete* usually are.

Position and locality.—Strata of the Cretaceous period; North Fork of Virgin River, Utah.

CLASS CEPHALOPODA.

ORDER TETRABRANCHIATA.

FAMILY BACULITIDÆ.

GENUS BACULITES Lamarck, 1801.

Baculites ovatus Say.

Plate XIX, figs. 4 *a*, *b*, and *c*, and 5 *a*, *b*, and *c*.

Among the collections made from Cretaceous strata at a locality southeast of Paria, Utah, there are several specimens of a species of *Baculites.* They are all small, slender shells, and in all observable respects they agree with young examples of *B. ovatus* Say.

It is, however, a noticeable fact that, although a considerable collection of different species of fossils were obtained at that locality, only these very small examples of *Baculites* were found among them. This fact suggests the possibility that these examples may be adult forms and specifically different from *B. ovatus.* In want of further evidence upon this point, however, I do not at present feel warranted in referring them to any other species.

Numerous examples of *B. ovatus* were also obtained from Gallinas Creek, New Mexico, some of which were quite large. A large proportion of these were typical forms of the species. A transverse section of one of these is shown in figure 4 *a*, Plate XIX. Many of the examples, associated with these typical ones, were, however, quite constant in having their sides more flattened than those of typical form, giving an outline of transverse section, such as is shown in figure 5 *b*. The septa in all these last-named examples correspond so nearly with those of the typical forms of *B. ovatus* as described and figured by Hall and Meek that I am disposed to regard them as only a variety of that species. The plan of the septa in this variety is shown in figure 5 *a*, and still more clearly in figure 5 *c*.

Family SCAPHITIDÆ.

Genus SCAPHITES Parkinson, 1811.

Scaphites Warreni Meek and Hayden.

Plate XIX, fig. 3 *a*.

Scaphites Warreni Meek and Hayden, 1860, Proc. Acad. Nat. Sci. Phila., 177.

The collections contain a single specimen of this species from Cretaceous strata three miles southwest of San Mateo, New Mexico, which, although too imperfect for detailed description, is satisfactorily identified by its visible external characters.

The type-specimens of Meek and Hayden were obtained near the Black Hills, in Nebraska; the following being the substance of their description:—

"Shell small, transversely subovate, moderately compressed, rounded on the dorsum; volutions subcylindrical, increasing gradually in size; non-septate portion of the last turn slightly compressed laterally and deflected from the regular curve of the others so as to become nearly or quite disconnected at the aperture.

"Surface of the inner whorls ornamented by numerous small costæ, which increase chiefly by implantation, and all cross the dorsum very regularly without arching; on the sides of the nonseptate outer chamber, about every fourth or fifth costa is much more prominent and sharper than the others and extends quite across to the umbilical side, while those between die out or coalesce with the others at various distances.

"Length, 1.45 inches; height, about 1.22 inches; breadth, 0.57 inch."

FAMILY AMMONITIDÆ.

GENUS AMMONITES Bruguière, 1789.

Ammonites Lœvianus White.

Plate XIX, fig. 1 *a* and *b*.

Shell moderately large, robust; volutions four or more, increasing rapidly in size, especially the outer one, so that the umbilicus is rather deep but yet showing all the volutions; each volution embracing between one-quarter and one-third of the width of each preceding one; transverse section of outer volution, between the nodes, oval-subquadrate; surface, upon each side, marked by a row of moderately-elevated, transversely elongate nodes, situated about one-third of the distance from the umbilicus to the dorsum; and also by a row of very prominent nodes on each side of the dorsum. Each of these rows consist of the same number of nodes. The dorsal nodes diverge strongly, but are wholly embraced by each succeeding volution, and do not therefore appear in the umbilicus. Between these two rows of dorsal nodes, the dorsum is slightly convex and the outer surface of the shell appears to have been marked by a small median carina. Between these nodes and the umbilicus, the sides of the volution are broadly convex.

A greater transverse elongation of the lateral nodes than exists on our example would make each continuous with its corresponding dorsal node, which would give to each lateral pair of nodes the character of a rib. It is not improbable that this modification may be found to exist in some examples of the species.

Septa complex; dorsal lobe and part of dorsal saddle unknown; superior lateral lobe moderately large, bifid; lateral saddle about as large as the lateral lobe, but not bifid; inferior lateral lobe small, narrow, not bifid; accessory lobes and saddles few and small; the borders of all the lobes and saddles more or less deeply notched or dentate.

Diameter of the only example in the collections, the larger part of the outer chamber being broken away, fourteen centimeters.

Specific name given in honor of Dr. Oscar Lœw.

Position and locality.—Strata of the Cretaceous period; Ojo de los Cuervas, New Mexico.

Ammonites placenta Dekay var. intercalaris Meek and Hayden.

Some more or less imperfect specimens of this species are contained among the collections from Gallinas Creek, New Mexico. A small portion only of the external surface is shown, but this contains in part the characteristics by which Meek and Hayden separate the variety *intercalaris* from the typical forms of the species as published by Dekay. It agrees with the variety above referred to also in being less compressed than the typical forms of *A. placenta* are.

GENUS BUCHICERAS Hyatt, 1875.

Buchiceras Swallovi Shumard.

Plate XX, fig. 1 *a*, *b*, and *c*.

Ammonites Swallovi Shumard, 1860, Trans. St. Louis Acad. Sci., i, 591.

Shell moderately large, flattened-discoid; sides gently convex; dorsum narrowly flattened, the flattened space bordered on each side by a row of more or less distinct nodes; volutions three or four, partially embracing; umbilicus broad, its outline not clearly defined, deep for so discoid a shell, although it has a shallow aspect because of its breadth and want of definite outline, and exhibiting a large part of each of the inner volutions; aperture subovate in outline, its longest diameter directed from the center of the shell, narrowest at the outer end, where it is truncated by the flattening of the dorsum; sides of the volutions marked by prominent, somewhat flexuous, rounded costæ, extending from the inner to the outer edge; the space between each two of these principal costæ is occupied by one or two short ones which do not reach the umbilicus, but they end at the dorsum like the others; upon each costa, near its dorsal end, there is an obtuse node, which, together with the dorsal nodes before mentioned, constitute a double row of nodes at each side of the dorsum. Saddles all broader, and simpler in outline than the lobes; none of the former being really digitate, and those near the ventral side of the volutions, especially the inner volutions, are nearly as simple in outline as they are in *Ceratites*.

This shell presents some differences from the description by Dr. Shumard of *A. Swallovi*, the principal of which is the absence of the nodes at the umbilical side of the volutions and of the distinct transverse ribs of the dorsum mentioned by him; but these are not regarded as essential specific characters.

Full diameter of the shell, about eighteen centimeters; transverse diameter of the aperture, nearly five and a half centimeters; long diameter of the same, about eight and a half centimeters.

Professor Hyatt writes me, after an examination of the specimen figured on Plate XX, that he regards it as a species of his genus *Buchiceras*, but that "it differs from *B. Syriacum*, the type of the genus, in having the larger lobes and cells more Ammonite-like."

Position and locality.—Strata of the Cretaceous period; Glendale, Long Valley, Utah.

FAMILY TURRILITIDÆ.

GENUS HELICOCERAS d'Orbigny, 1842.

Helicoceras Pariense White.

Plate XIX, fig. 2 *a*, *b*, *c*, and *d*.

Shell dextral; spire much depressed; whorls distinct, subcircular or very broadly oval in transverse section, increasing somewhat rapidly in size; surface marked by comparatively strong, rather abruptly-rounded annulations, which cross the whorls obliquely; annulations only slightly prominent upon the inner side of the whorls, but more prominent upon the upper and under sides; upon the outer side of the whorl each annulation bears a pair of prominent nodes, one on each side of the siphuncle, forming two dorsal rows of nodes along the whole length of the shell, the portion of the annulation between each pair of nodes being straightened and slightly flattened upon the beak. The annulations are apparently always simple, never coalescing, and never failing to completely encircle the volution. The nodes are moderately prominent upon exfoliated specimens, and where the test is preserved they are seen to be subspinous or sharply nodose.

Septa moderately distant, sometimes embracing two annulations, but toward the aperture only one. Lobes all smaller than the saddles, the size in each transverse series gradually diminishing from the dorsal to the ventral one; the smallest saddle, the ventral, not being larger than the largest lobe, the dorsal; lobes all bifurcate, except the ventral, the inferior lateral lobe being but slightly so; the anterior portion of the space between the branches of the dorsal lobe occupied by two backward-projecting points; the ventral lobe is simple, small, narrow, and serrate upon both sides. The saddles of the different longitudinal series all similar in shape, diminishing gradually in size from the dorsal to the ventral series; all broader than long, except the ventral one, the length and breadth of which are about equal; each partially parted at the middle; edges of all the lobes and saddles serrated or toothed.

The longest fragment in the collection measures about seven centimeters. At the larger end of this the long diameter is fifteen millimeters and the short diameter fourteen millimeters; at the smaller end the long diameter is eight and a half millimeters.

This species is similar in aspect to *H. Mortoni* Hall and Meek, but differs from it in diminishing in caliber much more rapidly toward the apex, in the presence of a double series of nodes along the dorsum of the volutions, and in the proportions and details of its lobes and saddles.

Position and locality.—Cretaceous strata; southeast of Paria, Utah.

ARTICULATA.

CLASS VERMES.

ORDER TUBICOLA.

FAMILY SERPULIDÆ.

GENUS SERPULA Linnæus, 1758.

Serpula intrica White.

Plate XV, fig. 5 *a*.

Tubes small, slender, cylindrical, smooth, very long and very tortuous, not perceptibly increasing in size, so far as our examples show, but neither the distal nor proximal extremity of the tube has been found unbroken.

Diameter of the tube, a little more than one millimeter.

This species is remarkable for the great length and uniform size of the tubes, and for the intricacy of their contortions.

Position and locality.—Strata of the Cretaceous period; southeast of Paria, Utah.

CHAPTER X.

CENOZOIC AGE.

TERTIARY PERIOD.

MOLLUSCA.

CLASS CONCHIFERA.

ORDER DIMYARIA.

FAMILY UNIONIDÆ.

GENUS UNIO Retzius, 1788.

Unio vetustus Meek.

Plate XXII, fig. 12 *a*, *b*, *c*, and *d*.

Unio vetustus Meek, 1860, Proc. Acad. Nat. Sci. Phila., 312.
Unio priscus Meek, 1870, Geol. Surv. Wyoming & contiguous Territories, 298.

Shell somewhat elongate-ovate, some examples a little compressed, but old shells usually somewhat gibbous; test moderately thick; beaks placed near the anterior extremity; anterior margin regularly rounded down to the basal margin, which is only slightly convex or a little straightened; dorsal margin nearly straight or a little convex, and nearly parallel with the base; posterior margin obliquely sloping downward and backward from the dorsal margin, and abruptly rounded below to meet the basal margin.

Surface of young shells marked by numerous small, undulating concentric wrinkles, which cease to form as the shell increases in size, and are then seen only upon the beaks; surface of adult shells marked by the ordinary lines of growth; umbonal ridge rounded, not prominent; two somewhat sharply raised lines radiate from just behind the beak obliquely downward and backward upon the space between the umbonal ridge and the dorsal margin.

Cardinal tooth of right valve moderately strong, prominent, conical, curved slightly upward and forward; depressions upon each side of it shallow; cardinal teeth of left valve not very prominent, nearly vertical; the pit between them for the reception of the tooth of the other valve rather deep; lateral teeth narrow, moderately prominent, very slightly curved; anterior adductor scars deep, placed close before and a little below the cardinal teeth; anterior pedal scars so close together as to form a single depression, and placed immediately below the adductor scars.

Some of the specimens in the collection are a little wider posteriorly than anteriorly, and some are also more gibbous than others, which differences are thought to be sexual rather than varietal, since such sexual differences of form are usual among living species of *Unio*.

Length, sixty-seven millimeters; breadth, thirty-nine millimeters. These measurements are of examples that appear to be of medium adult size. Some fragments indicate that the species reaches a considerably larger size, and also that some of them had a greater proportionate length.

Mr. Meek has expressed the opinion, (Geological Survey of Wyoming and contiguous Territories, p. 298,) that this species is identical with *U. priscus* Meek and Hayden, but a still later development of facts leads me to think the strata from which the two forms respectively come, belong to different periods. Therefore I prefer to retain separate names for the two forms at present, although they are so similar.

Position and locality.—Strata probably of Eocene Tertiary age; Wales, Utah.

FAMILY CYRENIDÆ.

GENUS CYRENA Lamarck, 1818.

SUBGENUS VELORITINA Meek, 1872.

Cyrena (Veloritina) Durkeei Meek.

Plate XXI, fig. 13 *a* and *b*.

Cyrena (Corbicula) Durkeei Meek, 1870, Proc. Amer. Philo. Soc. Phila., xi, 431.
Corbicula (Veloritina) Durkeei Meek, 1871, Geol. Surv. Montana and adjacent Territories, 376.
Cyrena (Veloritina) Durkeei Meek, 1874 (manuscript).

Shell rather large for one of the genus, subtrihedral in outline, gibbous, especially the upper median portion; posterior and postero-ventral portions somewhat compressed laterally; front margin abruptly and basal margin broadly rounded; posterior side sloping downward and backward to the postero-basal margin, where it is narrowly rounded to meet the basal margin; beaks elevated, pointed, curving inward and forward, and nearly meeting each other across the hinge. The dorsal margin of each valve behind the beak is bent more or less deeply and sharply inward and downward, forming a prominent curved umbonal ridge, which extends from the beak to the postero-basal border, and completely obscures the line of union of the two valves along the postero-superior margin, as the shell is viewed laterally. This last-named character is a marked feature of the shell, and gives the appearance of unusual elevation to the umbonal ridges.

Surface marked by distinct, concentric lines of growth.

Length from front to postero-basal margin, forty-nine millimeters; height, from base to top of umbo, forty-two millimeters.

Position and locality.—Strata probably of Eocene Tertiary age; plateau near the west crossing of the north fork of Virgin River, at Pace's Cañon, and at the north fork of Virgin River, Utah.

GENUS SPHÆRIUM Scopoli, 1777.

Sphærium ——— (?).

Among the collections made from Tertiary strata west of Fairview, Utah, are some specimens of *Sphærium* that appear to belong to *S. formosum* Meek and Hayden, the type-specimens of which species were obtained from Tertiary strata near Fort Union, Nebraska. They are, however, too imperfect, and the specific characters too inconspicuous to allow their identity to be recognized with certainty.

CLASS GASTEROPODA.

SUBCLASS PULMONIFERA.

ORDER PULMONATA.

SUBORDER BASOMMATOPHORA.

FAMILY LIMNÆIDÆ.

GENUS PLANORBIS Guettard, 1756.

Planorbis Utahensis Meek.

Plate XXI, fig. 8 *a*.

Planorbis Utahensis Meek, 1860, Proc. Acad. Nat. Sci. Phila., 314.

Shell moderately large, discoidal, compressed, slightly convex above; test thin; the first two or three volutions often depressed a little below the general surface of the outer ones, making the top slightly concave at center; umbilicus broad, not very deep, showing all the inner volutions plainly; volutions from four to five and a half, rather slender, wider than high, sub-elliptical in transverse section, convexity of the upper side slightly less than that of the lower side; upper side of the outer volution slightly sloping outward and downward to the periphery, which is somewhat narrowly rounded; suture distinct, but not very deep above, deeper and more distinct below; a small part of each volution concealed by the next succeeding one; aperture suboval, slightly expanded laterally.

Surface marked by small oblique lines and occasional small wrinkles of growth. These lines extend obliquely outward and backward, the margin of the aperture also having the same direction.

Greatest breadth of the largest specimen in the collection, twenty-four millimeters. Mr. Meek's type-specimens were obtained from Tertiary strata, which he was disposed to regard as Eocene, in the valley of Ham's Fork, latitude, 41° 40′ north; longitude, 110° 10′ west.

Position and locality.—Strata of Tertiary age; east slope of Pine Mountain and at Castle Valley, Utah.

Planorbis ——— (?).

From strata, probably of Eocene Tertiary age, at the head of Soldier's Fork, Utah, some specimens of dark carbonaceous shale were obtained, containing *Unio vetustus* Meek, and which are also crowded with shells of a small *Planorbis*. The shells are of nearly uniform size, averaging about three millimeters in diameter; slightly convex above, narrowly umbilicate below; volutions about three, broader than high, not angulated, marked by ordinary lines and small wrinkles of growth. They appear to be mature shells, but they present too few prominent specific characters to satisfy me of the present propriety of giving them a specific name.

FAMILY PHYSIDÆ.

GENUS PHYSA Draparnaud, 1801.

Physa Bridgerensis Meek.?

Plate XXI, fig. 2 *a*.

Physa Bridgerensis Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, and Utah, 516.

The collections contain a number of imperfect examples of a species of *Physa*, which seem to belong to *P. Bridgerensis* Meek, the type-specimens of which he obtained from Tertiary strata at Church Buttes, fourteen miles from Fort Bridger, Wyoming Territory. They, however, present some differences which may prove to be of specific importance. The following is the substance of Mr. Meek's description, which I use because none of our specimens shows all the details mentioned by him with clearness, although they are sufficient for the identification of the species. The specimen figured, while it presents the surface-markings and the character of the spire with more clearness than any of the others, is not so large nor quite so robust as most of the other examples are. "Shell large, subovate; spire prominent, conical; volutions from four and a half to five, moderately convex; last one large, but not ventricose; suture well defined; aperture narrow-subovate, arcuate, acutely angular above, and about twice as long as the spire; columella twisted into a rather prominent fold; surface with fine sharp lines of growth."

Position and locality.—Strata of the Tertiary period; San Pete Valley, Utah.

Physa pleromatis White.

Plate XXI, fig. 1 *a* and *b*.

Shell large, ovoid, ventricose; test thin; spire short; whorls five or six, moderately convex, last one inflated; suture distinct, somewhat impressed; aperture narrowly subovoid, slightly arcuate, its length nearly equal to three-fourths that of the shell; columella a little twisted, so as to produce a slightly prominent fold. Surface rather smooth, but marked by the usual lines of growth.

Length, thirty-two millimeters; greatest breadth, twenty-two millimeters. Some fragments indicate that the shell often reached a still greater size.

This species differs from *P. Bridgerensis* Meek in its more robust form, shorter spire, more ventricose outer whorl, and in having the upper part of its aperture less acutely angular. It closely resembles the recent species *P. Sayi* Tappan, but the outer whorl of our shell is rather more ventricose and the aperture proportionally narrower, especially its anterior portion.

Position and locality.—Tertiary strata; Last Bluff, Utah.

SUBORDER GEOPHILA.

FAMILY HELICIDÆ.

GENUS HELIX Linnæus, 1758.

Helix Leidyi Hall and Meek.

Plate XXI, fig. 3 *a*, *b*, and *c*.

Helix Leidyi Hall and Meek, 1856, Mem. Amer. Acad. Arts and Sci., v, new series, 394.

Shell rather large, subglobose in form; spire moderately elevated; volutions about six in mature shells, ventricose, especially the outer one; suture distinct, that of the outer volutions more or less impressed; umbilicus small, probably nearly closed; aperture oblique, broad-subovate in outline; outer lip apparently reflexed; surface marked by very numerous uniform, distinct, closely-arranged lines of growth and also by occasional shallow wrinkles.

Position and locality.—The type-specimens of Hall and Meek were obtained from the Eocene Tertiary strata, near the head of Bear Creek, Mauvaises Terres, Nebraska. Ours were collected at Moo-se-ne-ah Peak and Pownsagunt Plateau, Utah.

SUBCLASS DIŒCA.

ORDER PECTINIBRANCHIATA.

SUBORDER TÆNIOGLOSSA.

FAMILY MELANIIDÆ.

GENUS GONIOBASIS Lea, 1862.

Goniobasis tenuicarinata Meek and Hayden.

Plate XXI, fig. 10 *a* and *b*.

Melania tenuicarinata Meek and Hayden, 1857, Proc. Acad. Nat. Sci. Phila., 136.

Shell conical, turreted, moderately elongate; apex somewhat acute; volutions six or seven, convex, but the upper portion of the outer side is a little flattened obliquely; suture deeply impressed; aperture ovoid, obtusely angular at the posterior part, where the outer lip joins the inner one; outer lip sinuous, somewhat prominent below the middle; columella slightly curved; surface marked by the usual regular lines of growth, and also along the middle of the volutions by elevated revolving lines, which vary in number and distinctness in different shells, but in all they are obsolete near the apex. The upper one of these lines is constantly more prominent than any of the others, its prominence sometimes being sufficient to give a somewhat tabulated appearance to the upper part of the whorls; the next most prominent line is a little below the one just mentioned, and in some shells these two only are to be distinctly seen; in other shells the whole surface below these two is marked by other similar but a little less distinct revolving lines.

Length of the largest example in the collection, sixteen millimeters; breadth of body-whorl of the same, nearly eight millimeters.

Position and locality.—Strata of Tertiary age; Wales, Utah.

Goniobasis tenera Hall, *sp.*

Plate XXI, fig. 11 *a*, *b*, and *c*.

Cerithium tenerum Hall, 1845, Expl. Exp. Oregon and Northern California, 308.

Shell turreted, very slender; volutions about twelve, moderately convex, longitudinally plicate; suture impressed; aperture suboval, considerably extended forward; columella curved; outer lip thin.

The longitudinal plications vary somewhat in character and distinctness in different shells and also in different parts of the same shell; they are smaller and more numerous upon the small volutions, and become large, distant, and prominent on the larger ones; all are curved a little outward and forward, none having the exact direction of the axis.

The surface of the shell is marked by numerous small, raised, revolving lines, which are more prominent, and sometimes even slightly spinous, where they cross the longitudinal plications.

Length of the largest specimen in the collection, thirty-two millimeters; breadth of the last volution, nine millimeters.

This shell closely resembles the figure given by Hall of *G. tenera* (=*Cerithium tenerum* Hall, Expl. Exp. Oregon and Northern California, 308), and is, not without some hesitation, referred to that species. There is, however, great variation among the related forms of this genus, as found in the Tertiary rocks of that part of the country, and satisfactory specific discrimination is often impracticable.

Position and locality.—Strata probably of Eocene Tertiary age; head of Soldier's Fork, Utah.

*Goniobasis Nebrascensis Meek and Hayden.

Plate XXI, fig. 9 *a*, *b*, and *c*.

Goniobasis Nebrascensis Meek and Hayden, 1856, Proc. Acad. Nat. Sci. Phila., 124.

Shell pointed-subovate, elongate; spire moderately elevated, conical; volutions five to seven, depressed-convex; suture distinct, impressed; aperture subovate, narrow behind, abruptly rounded in front; outer lip sinuous, somewhat prominent toward the front; columella curved.

Surface marked by the usual fine lines of growth, and also by a number of more or less distinctly raised revolving lines, which are more distinct upon the middle of the volutions than elsewhere; one line about the middle of the volution is usually a little more prominent than any of the others, which gives it an angulated or subcarinate appearance.

Length of the largest example in the collection, seventeen millimeters;

*The general form of this shell differs somewhat from the typical forms of *Goniobasis*, and approaches somewhat that of *Lioplacodes;* but, so far as I have been able to observe, the aperture is much more nearly like that of the former genus than the latter.

breadth of body-volution, nine millimeters; apical angle varying from forty to forty-five degrees.

Position and locality.—The type-specimens of Meek and Hayden were obtained from Tertiary strata, near Fort Union. Ours are from strata of the same period, Wales, Utah.

FAMILY VIVIPARIDÆ.

GENUS VIVIPARUS Montfort, 1810.

Viviparus trochiformis Meek and Hayden.

Plate XXI, fig. 4 *a*, *b*, and *c*.

Paludina trochiformis Meek and Hayden, 1856, Proc. Acad. Nat. Sci. Phila., 122.
Viviparus trochiformis Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, and Utah, 478.

Shell trochiform; spire somewhat broadly conical; apex acute; volutions five or six, moderately convex, marked by a greater or less number of slightly raised revolving lines; the last volution angular or abruptly rounded below the middle; suture linear, usually indistinct, especially between the larger volutions, but rather more distinct between those near the apex; aperture subcircular or subtetrahedral; lip thin, reflexed against the columella in front, by which a small umbilical suture or groove is produced; columella arcuate.

This species presents considerable variation in form and appearance, and also in the character of the revolving lines; upon some examples these lines are few and indistinct, especially upon the body-whorl, but upon others they are numerous, and sometimes one or two of them are found to assume the character of small carinæ.

Surface marked also by the ordinary lines of growth.

Length, about twenty-three millimeters; breadth of body-whorl, eighteen millimeters; apical angle, about seventy-five degrees, but the spire is a little convex-conical.

Position and locality.—Strata of Tertiary age at the following localities in Utah: Last Bluff; Ephraim City; south of Last Bluff; east of Joe's Valley; and at the head of Soldier's Fork.

Viviparus trochiformis, var.

Plate XXI, fig. 5, *a* and *b*.

Associated with typical forms of *V. trochiformis* at a locality south of

Last Bluff, Utah, are some that differ considerably from them. They, however, possess the general characteristics of the species, and are, therefore, regarded as only varietal examples. One of these is figured as indicated above. It is more elongate, sutures more distinct, and the revolving lines more obscure than they usually are in typical examples.

Length, twenty-two millimeters; breadth of body-whorl, fourteen millimeters.

Viviparus ionicus White.

Plate XXI, fig. 6 *a* and *b*.

Shell of medium size, broadly trochiform; spire moderately elevated; volutions five or six, prominent; inner ones convex; outer one more or less flattened upon the upper side, forming thus a more or less distinct angle with the rounded outer side; under side broadly rounded; suture distinct.

Surface marked by the usual lines of growth and apparently also by small raised revolving lines. Upon the outer volution below its middle there is a prominence made more or less conspicuous by the presence upon it of a revolving raised line. In some examples this prominence amounts almost to an angulation of the lower portion of the body-whorl.

Length, about nineteen millimeters; breadth of body-whorl, seventeen millimeters.

The examples contained in the collections are all preserved in a fine-grained sandstone and the surface-markings are not distinctly shown; but its broadly turbinate form and the more or less distinctly tabulated character of the upper part of the body-whorl sufficiently distinguish the species.

Position and locality.—Strata probably of Tertiary age; east side of Joe's Valley, Utah.

Viviparus ? ——— ?

Plate XXI, fig. 7 *a* and *b*.

Associated with the other species just described, at Wales, Utah, numerous examples of a small shell were obtained which are probably the young of a species of *Viviparus* or some nearly allied shell. They are possibly adult, but the features by which they might be specifically characterized are too indefinite to justify a specific description and name before the associated forms have all been carefully studied.

ARTICULATA.

CLASS CRUSTACEA.

ORDER OSTRACODA.

FAMILY CYPRIDINIDÆ.

GENUS CYPRIS Müller, 1785.

Cypris ——— ?

At a locality west of Fairview and another at the head of Soldier's Fork, Utah, associated with some of the foregoing species, the minute shells of a species of *Cypris* are very abundant. They are all compressed in shale and too much injured to allow of a satisfactory specific determination, but they are probably identical with *Cypris Leidyi* Evans and Shumard. The type-specimens of that species were obtained from the "vicinity of Reno Creek, a tributary of Teton or Little Missouri, about ninety miles from Fort Pierre Chouteau."

INDEX OF PART I.

*The names in *italics* are those of new species described in either this or the Preliminary Report.

EXPLANATION OF PLATE I.

FIG. 1. CRUZIANA RUSTICA. (Page 33.)
- *a.* A large but imperfect specimen.
- *b.* A still smaller fragment, showing the manner of the breaking-up of the bodies before they became embedded.

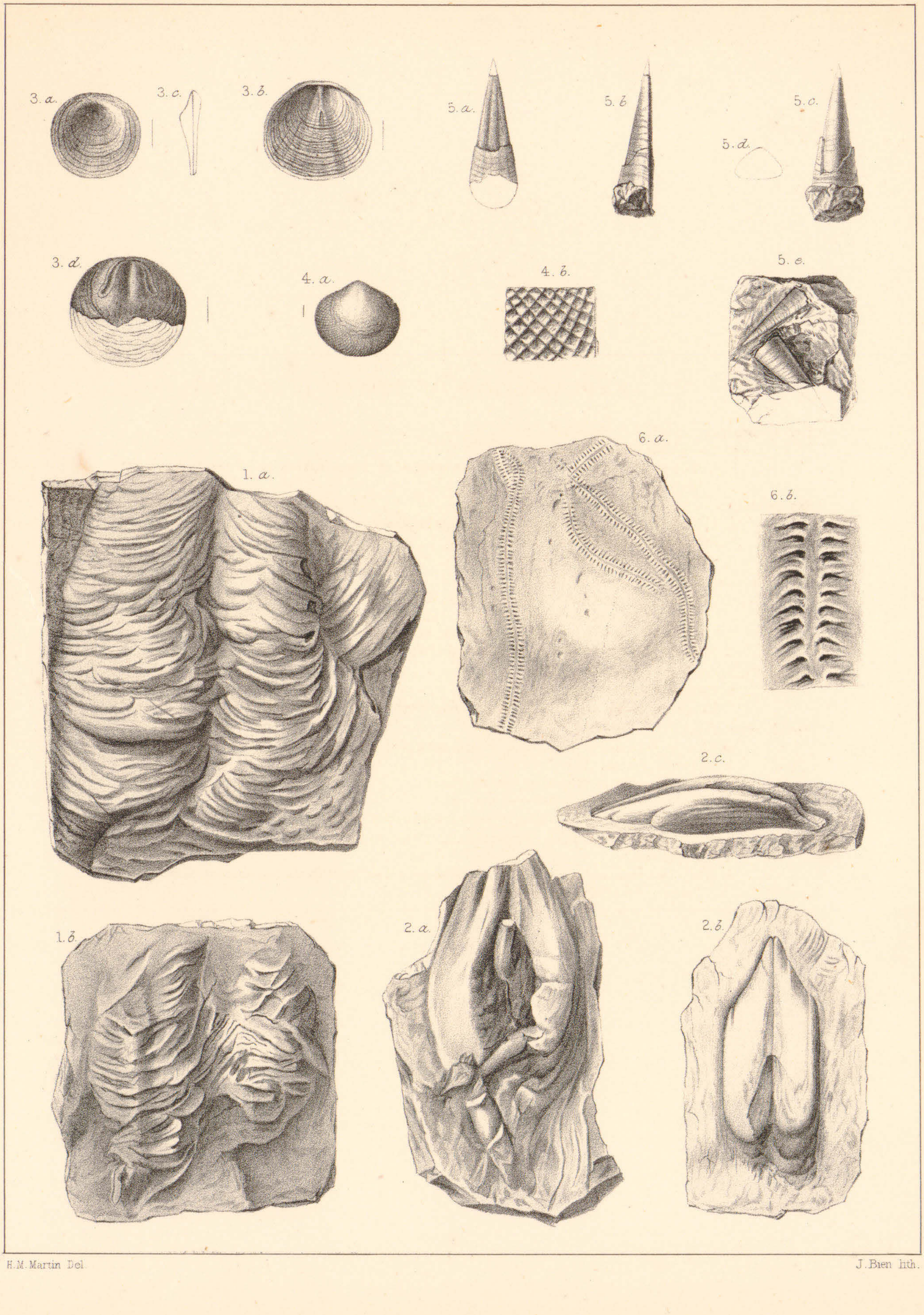
FIG. 2. CRUZIANA LINNARSSONI. (Page 32.)
- *a.* Typical form of the species, showing stipe in place.
- *b.* Probably the same species as 2 *a*.
- *c.* Same as 2 *b*, side view.

FIG. 3. ACROTRETA ? SUBSIDUA. (Page 34.)
- *a.* Interior view of ventral valve, enlarged; details impaired by weathering.
- *b.* Interior view of dorsal valve, enlarged; similarly impaired by weathering.
- *c.* Profile view, showing the thickness of the shell and convexity of the valves.
- *d.* Internal cast of part of a dorsal valve, probably of the same species.

FIG. 4. TREMATIS PANNULUS. (Page 36.)
- *a.* View of one valve, enlarged.
- *b.* Fragment of the same, magnified, to show character of surface-markings.

FIG. 5. HYOLITHES PRIMORDIALIS ?. (Page 37.)
- *a.* View of flattened or dorsal side, a little enlarged.
- *b.* The same, lateral view.
- *c.* The same, view of ventral or convex side.
- *d.* The same, outline of transverse section.
- *e.* Fragment of rock containing two specimens partly embedded.

FIG. 6. TRACKS, PROBABLY OF A SMALL CRUSTACEAN. (Page 49.)
- *a.* Natural size.
- *b.* The same, enlarged, showing each track to have been more than once impressed by organs of locomotion of similar shape and size.



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EXPLANATION OF PLATE II.

FIG. 1. ASAPHISCUS WHEELERI. (Page 43.)

a. A full-sized individual, outlines restored.

b. Young individual.

c. Fragment, showing course of facial suture and characters of the glabella.

d. Individual of medium size, showing thorax and pygidium complete.

e. Separate thoracic segment, enlarged.

f. Pygidium; crust of broad border partly removed, showing the character of the striation upon its under surface.

FIG. 2. CONOCORYPHE (PTYCHOPARIA) KINGII. (Page 40.)

a. Adult individual.

b. Young individual, showing its greater proportionate size of head and length of cheek-spines.

c. Another young individual, much enlarged, showing the faint lines passing from the front end of each eye to the glabella; movable cheeks separated at the facial sutures.

FIG. 3. OLENELLUS GILBERTI. (Page 44.)

a. Head, full size, broken outlines restored.

b. Head, not full-grown.

c. Head, young.

d. Long third pleura, with remainder of thoracic segment restored.

e. Pleura of another segment; missing parts restored.

FIG. 4. OLENELLUS HOWELLI. (Page 47.)

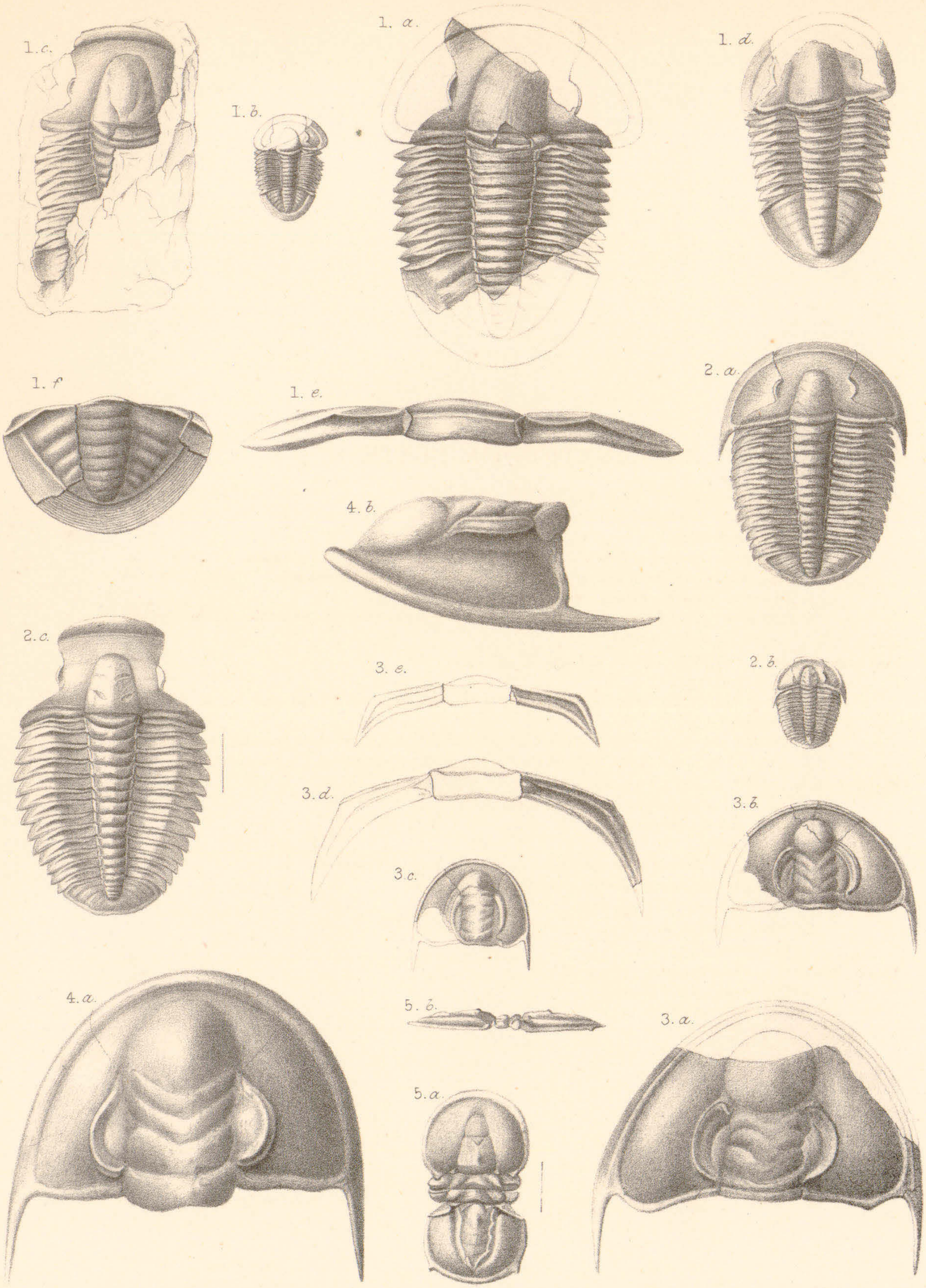
a. Head, full size, top view.

b. The same, side view.

FIG. 5. AGNOSTUS INTERSTRICTUS. (Page 38.)

a. Top view, much enlarged.

b. The same, side view.



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EXPLANATION OF PLATE III.

FIG. 1. PHYLLOGRAPTUS LORINGI. (Page 51.)
- *a.* Side view of stipe, natural size.
- *b.* Portion of same, enlarged, showing shape of cell-apertures.

FIG. 2. LINGULA ? MANTICULA. (Page 52.)
- *a.* Dorsal valve.
- *b.* Ventral valve.

FIG. 3. ACROTRETA PYXIDICULA. (Page 53.)
- *a.* Exterior view of ventral valve.
- *b.* Posterior view of the same.
- *c.* Side view of the same.
- *d.* Dorsal valve.—All very much enlarged.

FIG. 4. STROPHOMENA FONTINALIS. (Page 54.)
- *a.* Dorsal valve.
- *b.* Ventral valve of another and smaller shell.
- *c.* Fragment of *a*, enlarged, showing bifurcation of striæ and their fine crenulation.

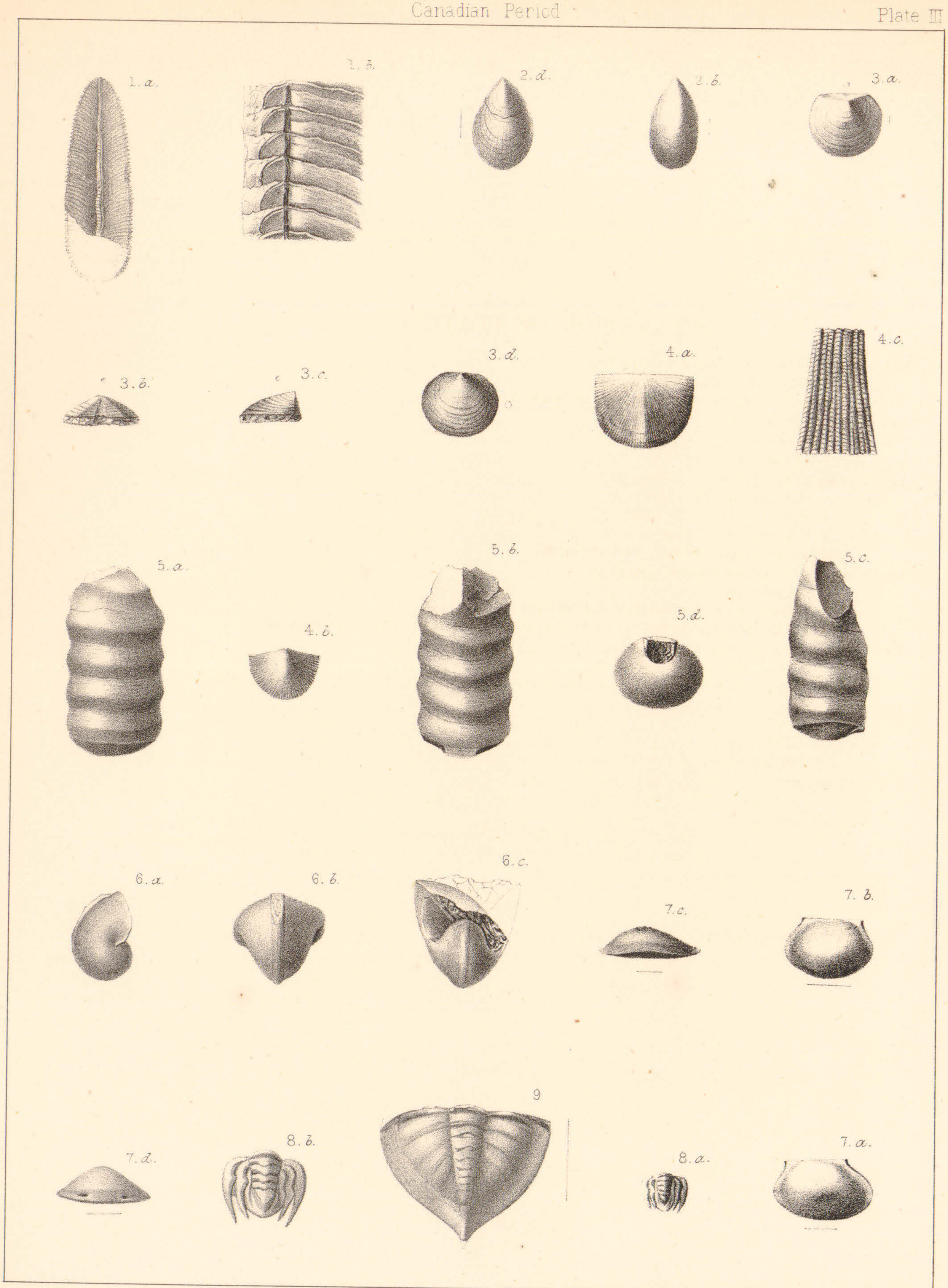
FIG. 5. ORTHOCERAS (CAMAROCERAS) COLON. (Page 56.)
- *a*, *b*, and *c*. Different lateral views.
- *d.* View of the convex side of a septum, showing shape, size, and position of the siphuncle.

FIG. 6. BELLEROPHON ALLEGORICUS. (Page 55.)
- *a.* Side view.
- *b.* Dorsal view.
- *c.* Posterior view.

FIG. 7. LEPERDITIA BIVIA. (Page 58.)
- *a.* Left valve.
- *b.* Right valve.
- *c.* View of lower edge of left valve, showing the beveled border.
- *d.* View of lower edge of right valve, showing the position of the two pores.

FIG. 8. DICELLOCEPHALUS ? FLAGRICAUDUS. (Page 60.)
- *a.* Natural size.
- *b.* The same, enlarged.

FIG. 9. MEGALASPIS BELEMNURUS. (Page 59.)



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EXPLANATION OF PLATE IV.

FIG. 1. GRAPTOLITHUS QUADRIMUCRONATUS ?. (Page 65.)
- *a.* View of one side of a stipe, enlarged two diameters.
- *b.* Same, still more enlarged from gutta-percha impression, showing shape of the cells.

FIG. 2. GRAPTOLITHUS (DIPLOGRAPTUS) PRISTIS ?. (Page 65.)
- *a.* Natural size.
- *b.* Same, enlarged.

FIG. 3. GRATOLITHUS RAMULUS. (Page 62.)
- *a.* Natural size.
- *b.* Part of same, enlarged.
- *c.* Another part of the same, enlarged from gutta-percha cast, the specimen being a natural mold in shale.

FIG. 4. GRAPTOLITHUS (DIPLOGRAPTUS) HYPNIFORMIS. (Page 63.)
- *a.* Natural size.
- *b.* Same, enlarged.

FIG. 5. MONTICULIPORA DALII. (Page 66.)
- *a.* Side view of stem, showing its broken end.

FIG. 6. FAVISTELLA STELLATA. (Page 67.)
- *a.* Top view, natural size.
- *b.* Side view of cells, showing longitudinal striation of the walls.
- *c.* Single cell, enlarged, showing rays.

FIG. 7. LEPTÆNA SERICEA ?. (Page 70.)
- *a.* Interior view of dorsal valve.

FIG. 8. STROPHOMENA FILLITEXTA. (Page 69.)
- *a.* Interior view of ventral valve.

FIG. 9. ORTHIS BIFORATA var. LYNX. (Page 74.)
- *a.* Ventral valve.
- *b.* Another ventral valve, having hinge-line shorter, and mesial sinus deeper at front than usual.

FIG. 10. ORTHIS PLICATELLA ?. (Page 72.)
- *a.* Exterior of ventral valve.
- *b.* Interior of dorsal valve.
- *c.* Interior of another dorsal valve, enlarged.
- *d.* Fragment, enlarged, showing concentric striæ.

FIG. 11. ORTHIS OCCIDENTALIS. (Page 70.)
- *a.* Ventral valve, exterior view.
- *b.* Dorsal valve, exterior view.

FIG. 12. RHYNCHONELLA ARGENTURBICA. (Page 75.)
- *a.* Dorsal view.
- *b.* Ventral view.
- *c.* Side view.
- *d.* Front view.
- *e.* Fragment, enlarged, showing concentric, raised lines.

FIG. 13. RAPHISTOMA TROCHISCUS. (Page 77.)
- *a.* Top view.
- *b.* Umbilical view.
- *c.* Side view.

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EXPLANATION OF PLATE V.

FIG. 1. ACTINOCRINUS VIATICUS. (Page 82.)
Basal view; partly embedded in stone.

FIG. 2. PLATYCRINUS ——— ?. (Page 81.)
Side view; partly embedded in stone; the radial plates in part restored.

FIG. 3. GRANATOCRINUS LOTOBLASTUS. (Page 80.)
a. Side view, enlarged.
b. Basal view of same.

FIG. 4. FAVOSITES DIVERGENS. (Page 79.)
a. Top view, showing form of the cells.

FIG. 5. STROPHOMENA RHOMBOIDALIS. (Page 85.)
Ventral valve, partially exfoliated.

FIG. 6. PRODUCTUS PARVUS. (Page 83.)
a. Front view of ventral valve.
b. Side view of the same.

FIG. 7. SPIRIFER (MARTINIA) PECULIARIS. (Page 90.)
a. Ventral valve.
b. Side view of the same.

FIG. 8. SPIRIFER CENTRONATUS. (Page 86.)
a. Dorsal view.
b. Ventral view of the same.
c. Lateral view of the same.

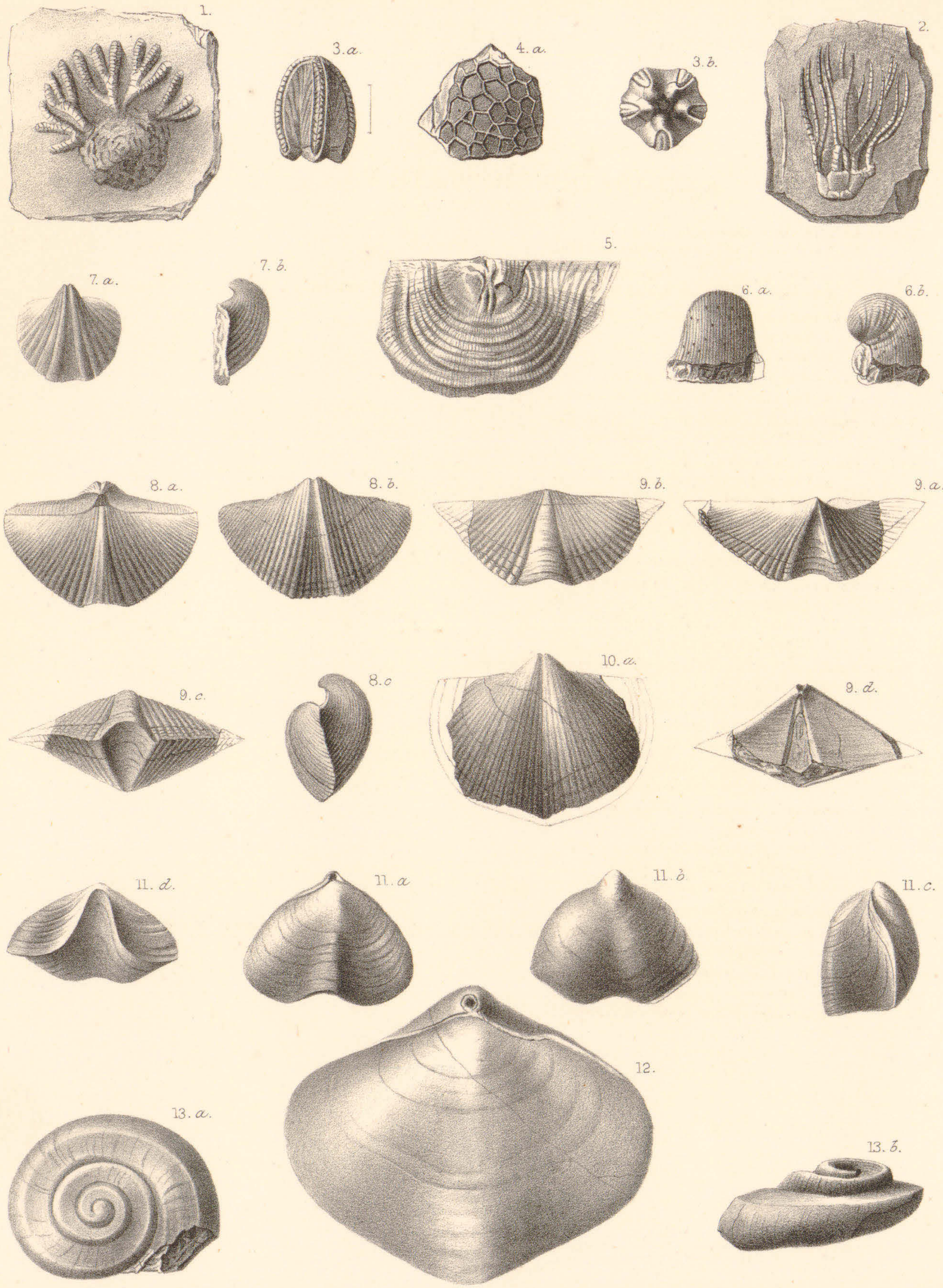
FIG. 9. SPIRIFER (SYRINGOTHYRIS) EXTENUATUS. (Page 88.)
a. Ventral view.
b. Dorsal view of the same.
c. Front view of the same.
d. Posterior view of the same.

FIG. 10. SPIRIFER STRIATUS. (Page 88.)
a. Exterior view of ventral valve.

FIG. 11. SPIRIGERA MONTICOLA. (Page 91.)
a. Dorsal view.
b. Ventral view of the same.
c. Lateral view of the same.
d. Front view of the same.

FIG. 12. SPIRIGERA OBMAXIMA. (Page 92.)
The part to the left of the oblique line has been restored by use of fragments of other examples.

FIG. 13. EUOMPHALUS LUXUS. (Page 94.)
a. Top view.
b. Lateral view of another example.



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EXPLANATION OF PLATE VI.

FIG. 1. LITHOSTROTION WHITNEYI. (Page 103.)
- *a.* Mass of embedded corallites, natural size.
- *b.* Longitudinal section of a corallite, showing vesicles, tabulæ, and, in part, the columella.
- *c.* A similar section, made a little to one side of the columella, so that the tabulæ seem to be plain.

FIG. 2. CHÆTETES MILLEPORACEUS. (Page 98.)
- *a.* Side view of broken specimen, showing capilliform tubes.

FIG. 3. ZAPHRENTIS EXCENTRICA. (Page 101.)
- *a.* Side view, showing a part of the calyx, the greater part being broken away.

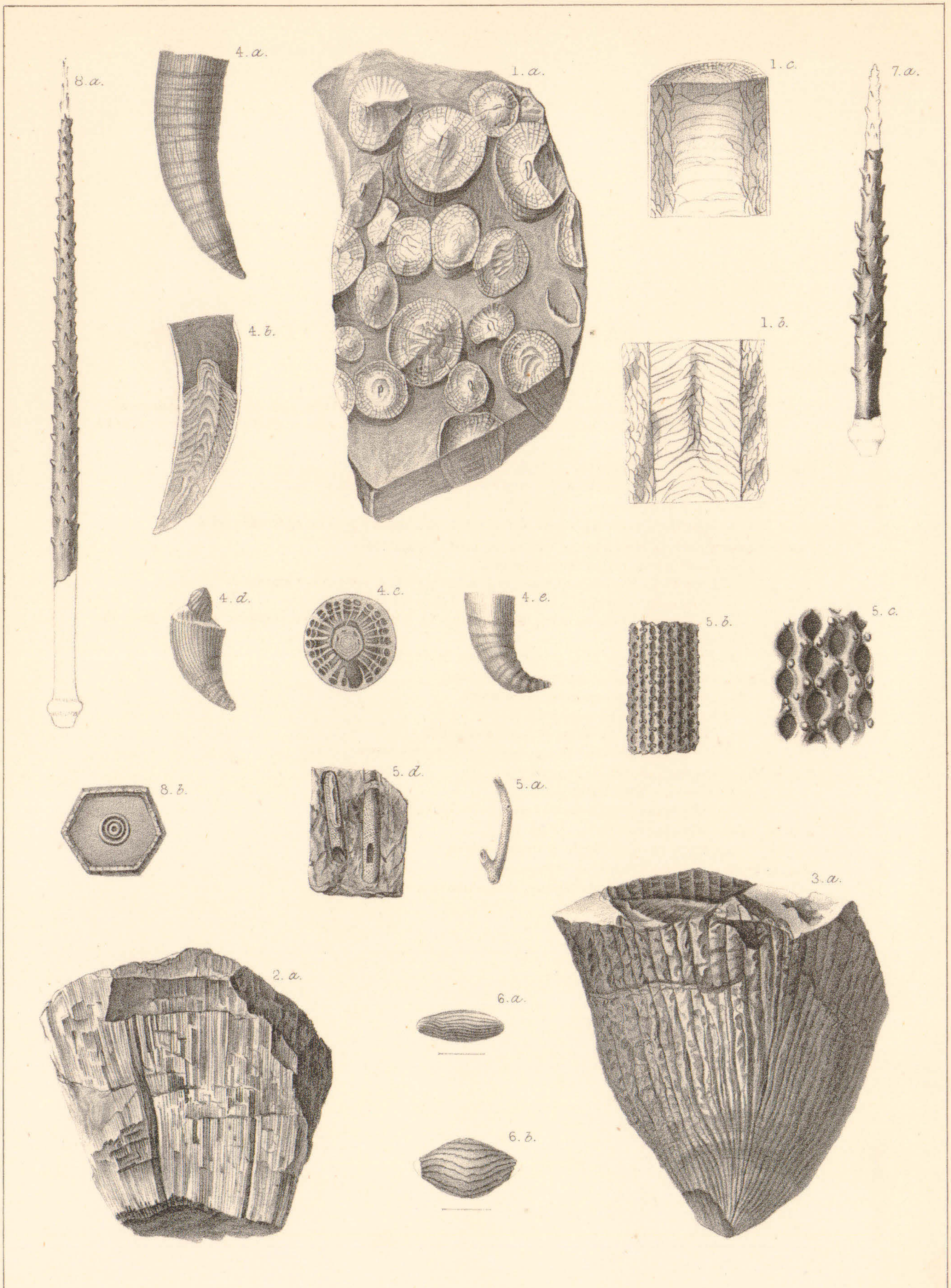
FIG. 4. LOPHOPHYLLUM PROLIFERUM var. SAURIDENS. (Page 101.)
- *a.* Side view of rather large example.
- *b.* Longitudinal section of the same, the calyx filled with stony material.
- *c.* Transverse section of a corallum, just below the calyx.
- *d.* Broken example, showing the manner in which the outer portions separate from the columella.
- *e.* Typical example of *L. proliferum* from Springfield, Ill.

FIG. 5. RHOMBOPORA LEPIDODENDROIDES. (Page 99.)
- *a.* Fragment of a corallum, natural size.
- *b.* Part of the same, enlarged.
- *c.* Small part of the same, still more enlarged.
- *d.* Portions of silicified stems, having calcareous cores.

FIG. 6. FUSULINA CYLINDRICA. (Page 96.)
- *a.* Elongate form, natural size.
- *b.* Subglobose form, natural size, a little broken at each end.

FIG. 7. ARCHÆOCIDARIS ORNATUS. (Page 104.)
- *a.* Side view of one of the principal spines.

FIG. 8. ARCHÆOCIDARIS TRUDIFER. (Page 104.)
- *a.* One of the principal spines, rather above average size.
- *b.* Interambulacral plate.



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EXPLANATION OF PLATE VII.

FIG. 1. PRODUCTUS PRATTENIANUS. (Page 113.)

a. Ventral view of a large example.
b. Side view of an average-sized example.
c. Posterior view of the same.

FIG. 2. PRODUCTUS PUNCTATUS. (Page 114.)

a. Ventral view of a typical example from Iowa.
b. Dorsal view of the same.
c. Lateral view of an example distorted by pressure.

FIG. 3. SYNOCLADIA BISERIALIS. (Page 107.)

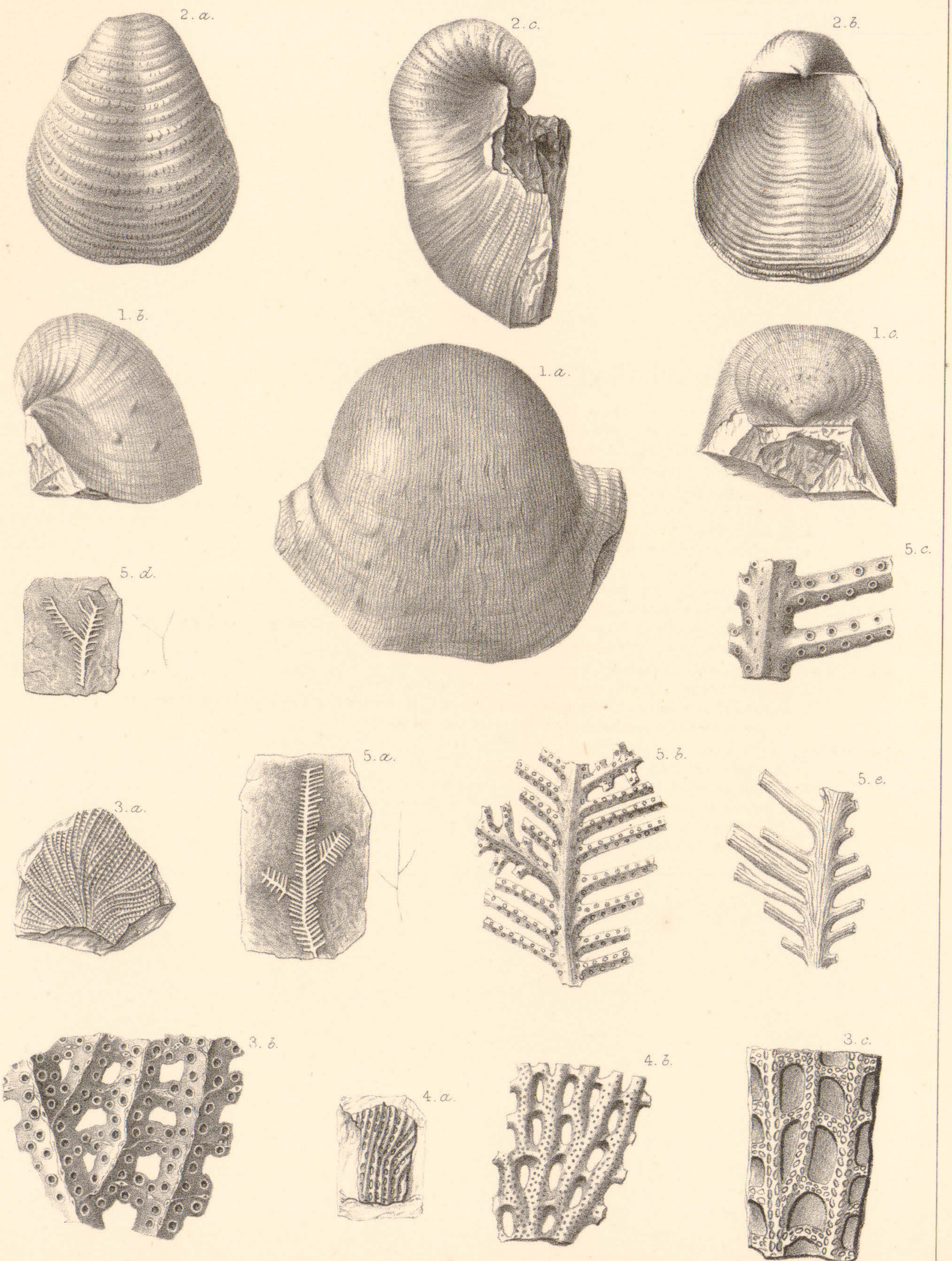
a. Portion from near the base of the polyzoary, natural size.
b. Portion of another example, enlarged, showing pores (after Meek).
c. Enlarged view of a specimen split through all the cells, showing them to be larger below than they are at the apertures.

FIG. 4. POLYPORA STRAGULA. (Page 108.)

a. Fragment from near the base of the polyzoary, natural size.
b. Portion of the same, enlarged, showing the pores. The rows of pores as shown in the figure are too distinct vertically, and not enough so obliquely.

FIG. 5. GLAUCONOME NEREIDIS. (Page 105.)

a. Fragment of a polyzoary, a little enlarged.
b. Part of the same, more enlarged.
c. A portion, still more enlarged, showing the dimorphous pores.
d. View of non-poriferous side, a little enlarged.
e. Same, more enlarged.



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EXPLANATION OF PLATE VIII.

FIG. 1. PRODUCTUS SEMIRETICULATUS var. IVESII. (Page 111.)

a. Ventral view of specimen of ordinary size.

b. Lateral view of the same.

c. Dorsal view of a typical example of *P. semireticulatus* from Southern Iowa; introduced for comparison.

FIG. 2. PRODUCTUS COSTATUS. (Page 109.)

a. Ventral view of a typical example of the American form of this species.

b. Dorsal view of the same.

c. Ventral view of another example.

d. Lateral view of the same.

FIG. 3. PRODUCTUS NEBRASCENSIS. (Page 116.)

a. Typical example from Nebraska, ventral view. The spines are represented a little too coarse in the figures.

b. Dorsal view of the same.

c. Partially-exfoliated example from near Santa Fé.

d. Lateral view of the same.

FIG. 4. PRODUCTUS MURICATUS. (Page 120.)

a. Ventral view of a partially-exfoliated example.

b. Posterior view of the same.

c. Lateral view of the same.

FIG. 5. PRODUCTUS LONGISPINUS. (Page 118.)

a. Ventral view of a typical form of the American shell.

b. Dorsal view of the same.

c. Ventral view of a variety from near Santa Fé.

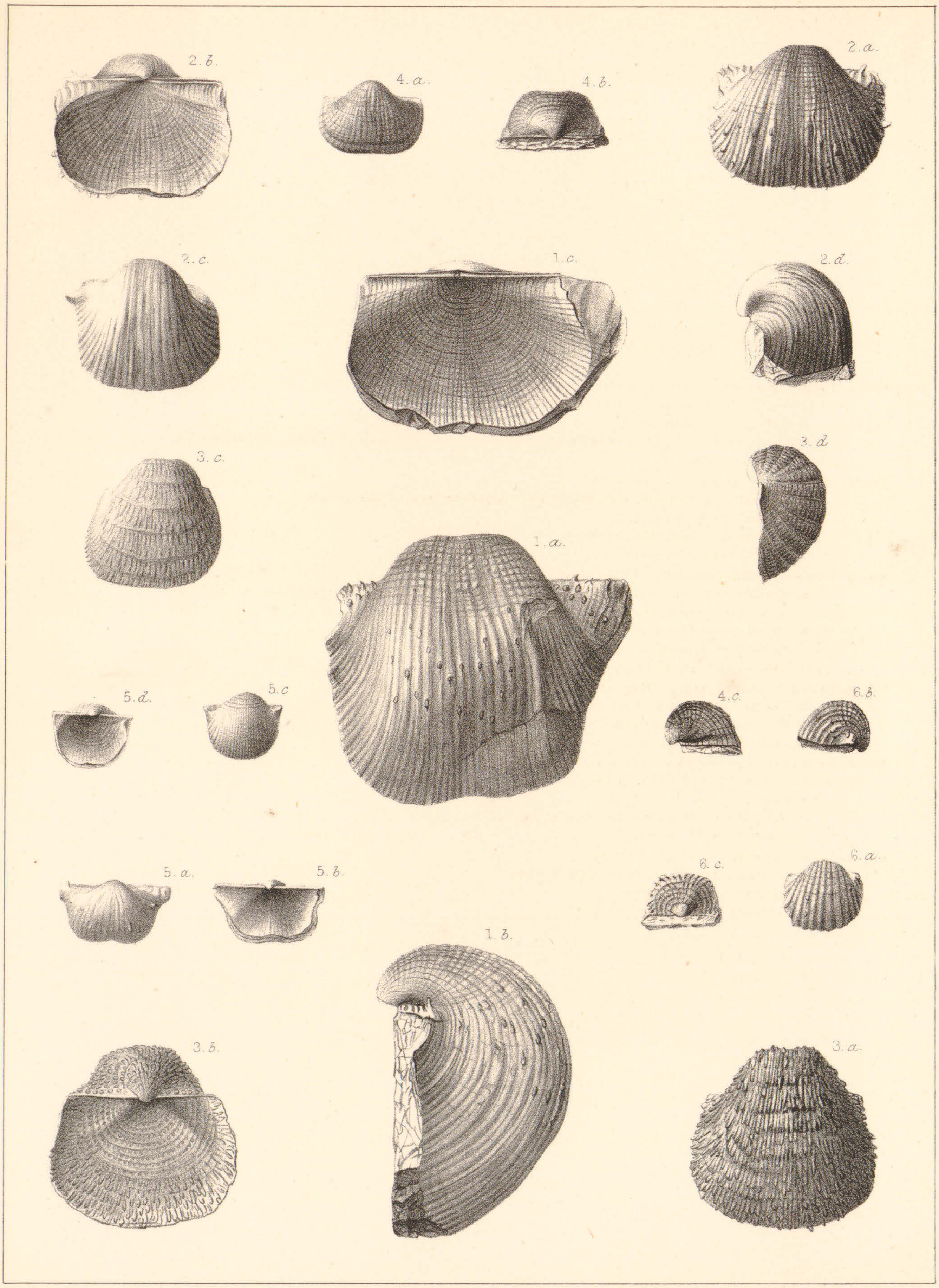
d. Dorsal view of the same.

FIG. 6. PRODUCTUS MEXICANUS. (Page 120.)

a. Ventral view of a specimen from Nevada.

b. Lateral view of the same.

c. Posterior view of the same.



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EXPLANATION OF PLATE IX.

FIG. 1. RHYNCHONELLA ROCKYMONTANA. (Page 131.)
- *a.* Ventral valve, having only two plications in the sinus.
- *b.* Another ventral valve, having four plications in the sinus.
- *c.* Lateral view of another example.
- *d.* Front view of the same.

FIG. 2. RHYNCHONELLA UTA. (Page 128.)
- *a.* Ventral view of a large example.
- *b.* Dorsal view of the same, partially restored.
- *c.* Lateral view of the same.

FIG. 3. RHYNCHONELLA ? WASATCHENSIS. (Page 130.)
- *a.* Ventral view of an example from the Wasatch range.
- *b.* Dorsal view of the same.
- *c.* Lateral view of the same.
- *d.* Front view of the same.

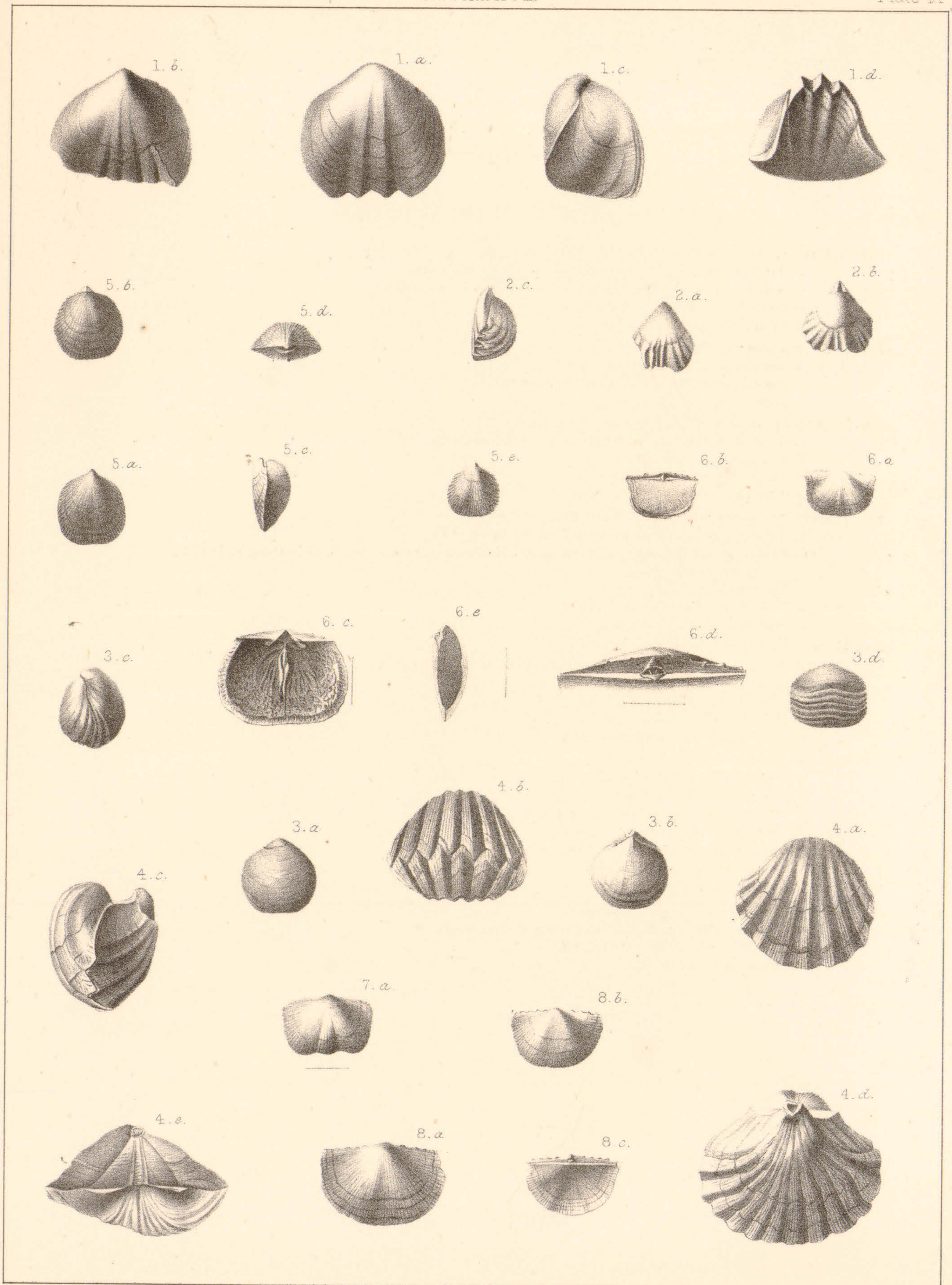
FIG. 4. MEEKELLA STRIATOCOSTATA. (Page 126.)
- *a.* Ventral view of a globose form from Southern Iowa.
- *b.* Front view of the same. Convergence of striæ near the margins of the valves imperfectly shown in the figure.
- *c.* Lateral view of the same.
- *d.* Ventral view of expanded variety.
- *e.* Posterior view of the same.

FIG. 5. ORTHIS PECOSII. (Page 125.)
- *a.* Ventral view of an example a little above average size.
- *b.* Dorsal view of the same.
- *c.* Lateral view of the same.
- *d.* Posterior view of the same.
- *e.* Dorsal view of a smaller example.

FIG. 6. CHONETES PLATYNOTA. (Page 121.)
- *a.* Ventral view of an averaged-sized example.
- *b.* Dorsal view of the same.
- *c.* Interior of a ventral valve, enlarged.
- *d.* Posterior view of areas, enlarged.
- *e.* Vertical section along the median line, enlarged.

FIG. 7. CHONETES MESOLOBA. (Page 123.)
- *a.* Ventral view, enlarged.

FIG. 8. CHONETES GRANULIFERA. (Page 122.)
- *a.* Ventral view; hinge-line less extended than usual.
- *b.* Ventral view of another example.
- *c.* Dorsal view of the same.



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EXPLANATION OF PLATE X.

FIG. 1. SPIRIFER CAMERATUS. (Page 132.)
- *a.* Dorsal view of an example from near Santa Fé.
- *b.* Similar view of another example from Northern Missouri.
- *c.* Ventral view of the same.
- *d.* Lateral view of the same.

FIG. 2. SPIRIFER (MARTINIA) GLABER var. CONTRACTUS. (Page 136.)
- *a.* Ventral view of an example, near average size.
- *b.* Dorsal view of the same. The specimen has been a little compressed.
- *c.* Lateral view of a large example; a little distorted by growth.

FIG. 3. SPIRIFER (MARTINIA) PLANOCONVEXUS. (Page 135.)
- *a.* Ventral view of a specimen, enlarged.
- *b.* Dorsal view of the same.
- *c.* Lateral view of the same.

FIG. 4. SPIRIFERINA KENTUCKENSIS. (Page 138.)
- *a.* Ventral view of a specimen, enlarged; one hinge-extremity naturally longer than the other.
- *b.* Posterior view of the same.
- *c.* Dorsal view of another example.

FIG. 5. SPIRIGERA PLANOSULCATA. (Page 143.)
- *a.* Ventral view of average size of those contained in the collections.
- *b.* Dorsal view of the same.
- *c.* Lateral view of the same.
- *d.* Dorsal view of another example.

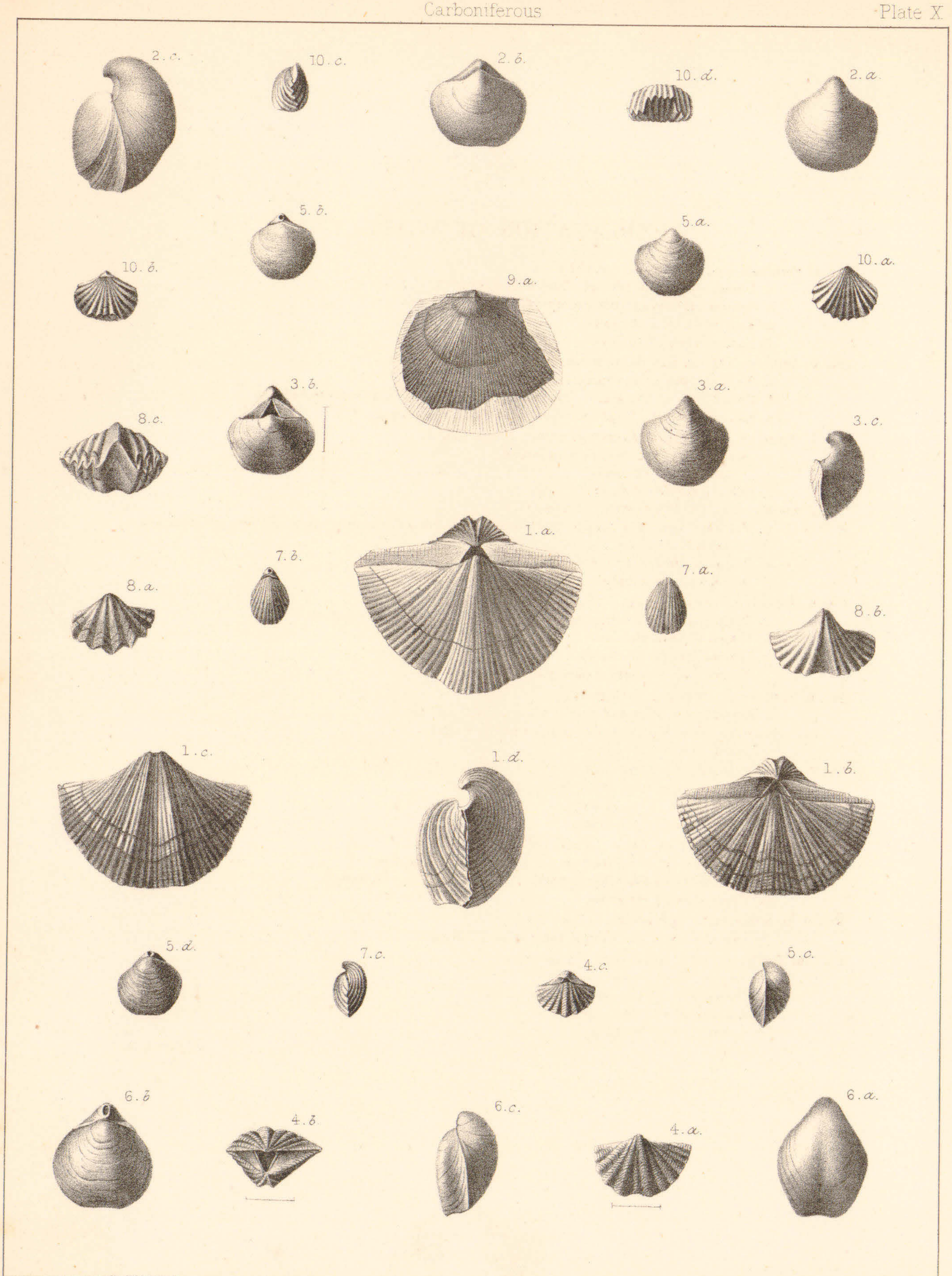
FIG. 6. SPIRIGERA SUBTILITA. (Page 141.)
- *a.* Ventral view of an example of ordinary size and form.
- *b.* Dorsal view of an example proportionally shorter.
- *c.* Lateral view of the same.

FIG. 7. RETZIA MORMONII. (Page 141.)
- *a.* Ventral view of an example of ordinary size.
- *b.* Dorsal view of the same.
- *c.* Lateral view of the same.

FIG. 8. SPIRIFERINA OCTOPLICATA. (Page 139.)
- *a.* Ventral view of an example a little below average size.
- *b.* Ventral view of another example; test removed by exfoliation.
- *c.* Front view of the same.

FIG. 9. HEMIPRONITES CRINISTRIA. (Page 124.)
- *a.* Dorsal view of an example somewhat compressed.

FIG. 10. RHYNCHONELLA METALLICA. (Page 129.)
- *a.* Ventral view, natural size.
- *b.* Dorsal view of the same.
- *c.* Lateral view of the same.
- *d.* Front view of the same.



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EXPLANATION OF PLATE XI.

FIG. 1. AVICULOPECTEN COREYANUS. (Page 147.)
- *a.* Left valve, a natural cast; the test wanting.
- *b.* Left valve of similar character, somewhat distorted by pressure.

FIG. 2. AVICULOPECTEN M'COYI. (Page 149.)
- *a.* Left valve. The example is incomplete, but the full size of the ears is either shown or indicated. The free border should be extended about one-third more for ears of that size.

FIG. 3. AVICULOPECTEN? INTERLINEATUS. (Page 149.)
- *a.* Left valve.

FIG. 4. MONOPTERIA MARIAN. (Page 151.)
- *a.* Right valve. Some examples show a little greater proportionate elongation, and some have the median angle raised into a distinct carina.
- *b.* Front view, showing lunule.
- *c.* Fragment of surface enlarged, showing striæ of growth.

FIG. 5. PINNA PERACUTA? (Page 151.)
- *a.* Fragment of the right valve. The outline shows the supposed shape of the whole valve

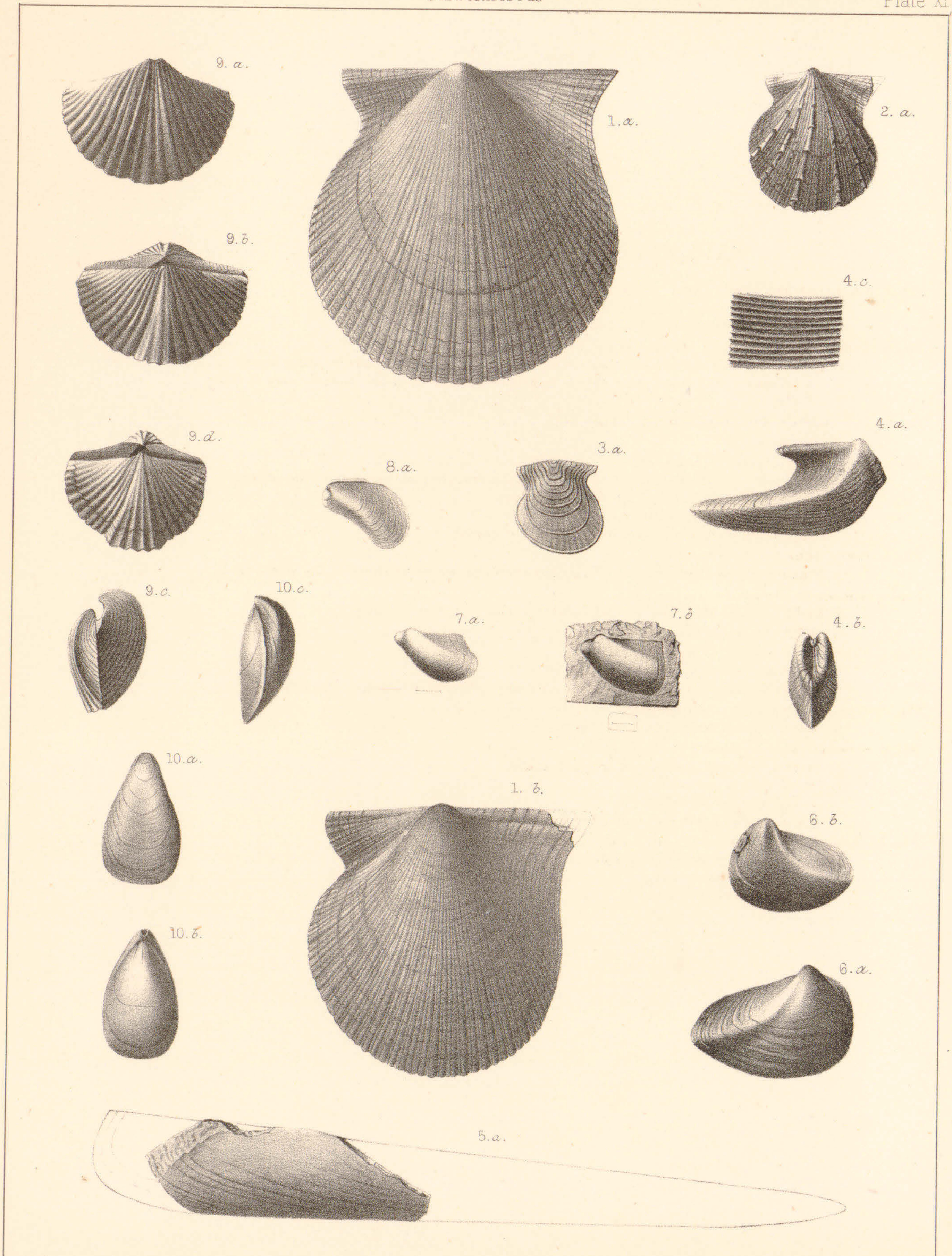
FIG. 6. SCHIZODUS WHEELERI. (Page 154.)
- *a.* Right valve, of about ordinary size. Natural cast; the test wanting.
- *b.* Left valve, in a similar condition.

FIG. 7. BAKEVELLIA PARVA. (Page 153.)
- *a.* Left valve, enlarged. From New Mexico.
- *b.* Left valve, enlarged. From Arizona. Probably of the same species as the other.

FIG. 8. MYALINA? SWALLOVI. (Page 152.)
- *a.* Natural cast of left valve, natural size.

FIG. 9. SPIRIFER ROCKYMONTANUS. (Page 134.)
- *a.* Ventral view of a specimen of ordinary size.
- *b.* Dorsal view of the same.
- *c.* Lateral view of the same.
- *d.* Dorsal view of another example, having plications a little more angular.

FIG. 10. TEREBRATULA (DIELASMA) BOVIDENS. (Page 144.)
- *a.* Ventral view of more than usually elongate example.
- *b.* Dorsal view of the same.
- *c.* Lateral view of the same.



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EXPLANATION OF PLATE XII.

FIG. 1. BELLEROPHON CRASSUS. (Page 157.)
 a. Dorso-lateral view.

FIG. 2. EUOMPHALUS PERNODOSUS. (Page 158.)
 a. View of upper side.
 b. Umbilical view, showing the nodes.

FIG. 3. MACROCHEILUS ANGULIFERUS. (Page 160.)
 a. A large example, having the angle unusually prominent and distinct.
 b. Another view of the same.
 c. A smaller example; the angle less distinct.
 d. Another example, with angle distinct.
 e. Young example, in which the angle is hardly perceptible.
 f. Another example, in which the flattened upper side of the angle is very narrow.

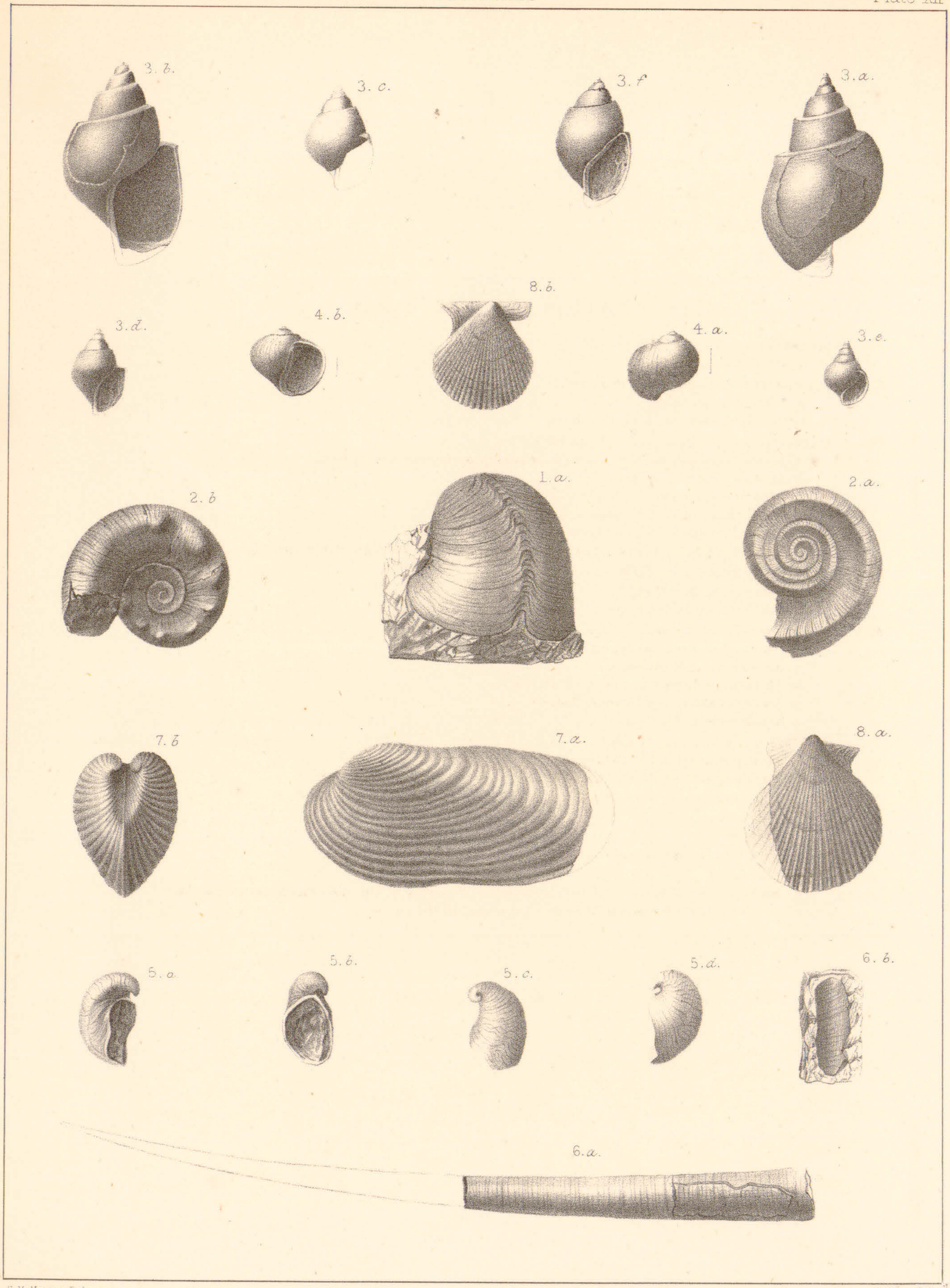
FIG. 4. NATICOPSIS NANA. (Page 159.)
 a. Example from Nevada.
 b. Another view of the same.

FIG. 5. PLATYCERAS NEBRASCENSE. (Page 159.)
 a. An example from the typical locality in Nebraska.
 b. Another view of the same.
 c. An example from near Santa Fé, N. Mex.
 d. Another example, with angle distinct.
 e. Another view of the same.

FIG. 6. DENTALIUM CANNA. (Page 156.)
 a. A large example; the outline showing the supposed full form.
 b. A mold of part of the surface, showing the minute longitudinal striæ.

FIG. 7. ALLORISMA SUBCUNEATA var. (Page 155.)
 a. Left valve.
 b. Front view.

FIG. 8. AVICULOPECTEN OCCIDENTALIS. (Page 146.)
 a. Left valve.
 b. Right valve. The specimen was imperfect. The body of the shell should be at least one third larger for ears of the size represented in the figure.



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EXPLANATION OF PLATE XIII.

FIG. 1. NERITINA ? PHASEOLARIS. (Page 167.)
- *a.* View of upper side of example of medium size.
- *b.* Lateral view of the same.
- *c.* View of the under side of the same.
- *d.* Small example, showing the small fold against the spire.
- *e.* Large example, showing the aforenamed fold, and also the obtuse revolving angle.

FIG. 2. CAMPTONECTES STYGIUS. (Page 164.)
- *a.* Adult example, right valve.
- *b.* Small example, interior of right valve.
- *c.* Same, enlarged.

FIG. 3. OSTREA STRIGILICULA. (Page 163.)
- *a.* Exterior of the deeper valve, natural size, showing scar of attachment.
- *b.* Lateral view of the same.
- *c.* Inside view of the same, showing parts about the hinge.
- *d.* Interior view of the upper valve.

FIG. 4. INOCERAMUS CRASSALATUS. (Page 166.)
- *a.* Right valve, the largest in the collections.
- *b.* Another example, right valve.
- *c.* Left valve, natural cast, showing the faint auricular furrow.

FIG. 5. MYOPHORIA AMBILINEATA. (Page 166.)
- *a.* Right valve, natural size.
- *b.* The same, enlarged.

FIG. 6. PENTACRINUS ASTERISCUS. (Page 162.)
- *a.* Articular face of a segment of the column.
- *b.* Portion of a column, showing the alternating larger and smaller segments.

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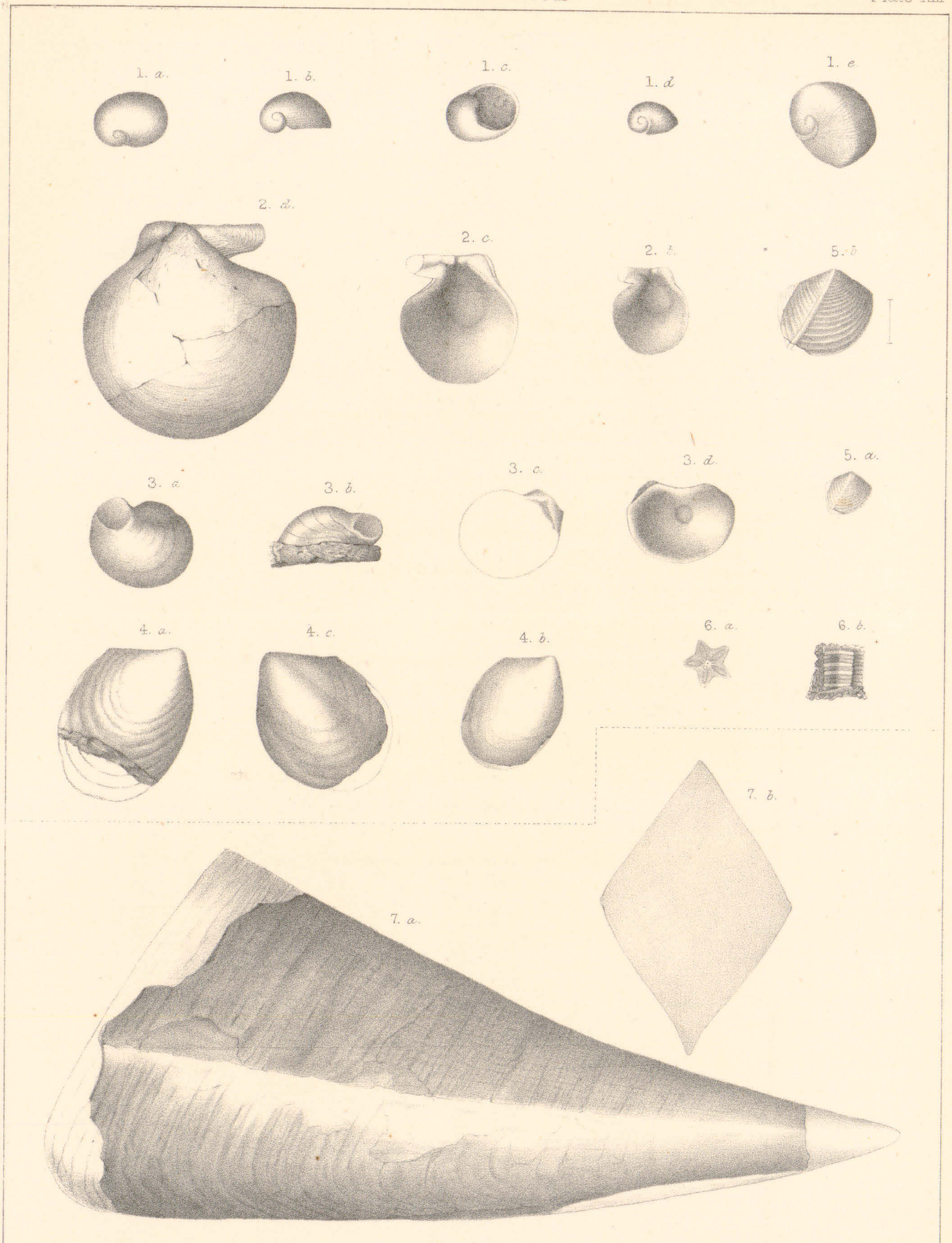
FIG. 7. PINNA PETRINA. (Page 182.)
- *a.* Right valve, natural size.
- *b.* Transverse section of the shell a little behind the midlength.



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EXPLANATION OF PLATE XIV.

FIG. 1. EXOGYRA PONDEROSA. (Page 172.)

a. Exterior view of the larger valve; less than average adult size.

b. Interior view of the same.

c. Longitudinal section of the same, showing thickness of test.

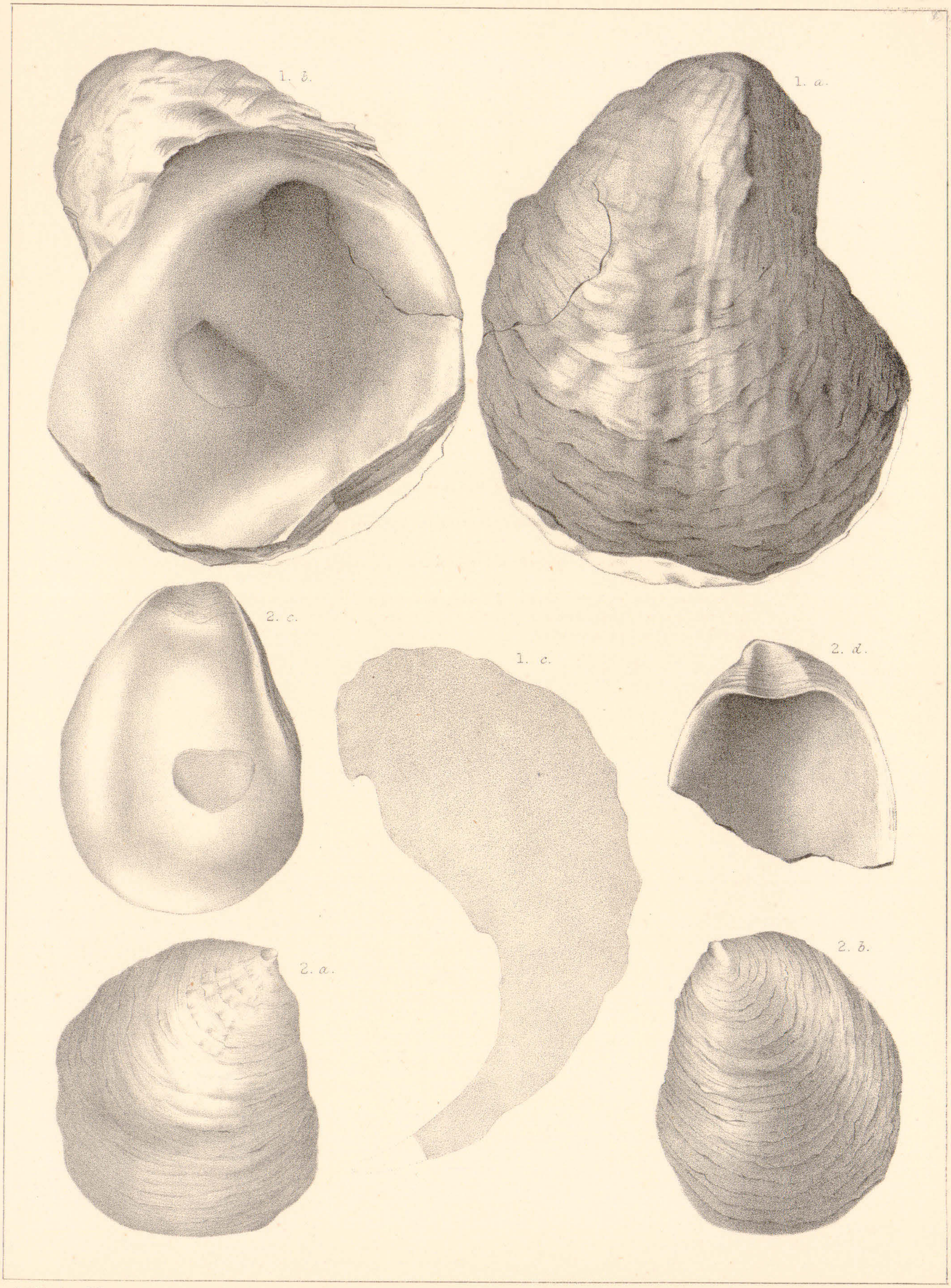
FIG. 2. OSTREA PRUDENTIA. (Page 171.)

a. Exterior view, natural size, of the lower or more capacious valve, showing very small scar of attachment.

b. Exterior view of upper valve of the same, showing small prominent beak.

c. Interior view of upper valve.

d. Interior view of lower valve.



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EXPLANATION OF PLATE XV.

FIG. 1. INOCERAMUS DEFORMIS. (Page 179.)

a. Exterior view of left valve, showing portion of the test.

b. Section of the test of a large example, showing its prismatic structure and great thickening at the borders.

FIG. 2. OSTREA CORTEX. (Page 170.)

a. Exterior of upper valve.

b. Interior of the same.

c. Interior of lower valve, showing hinge and area.

FIG. 3. INOCERAMUS FRAGILIS. (Page 178.)

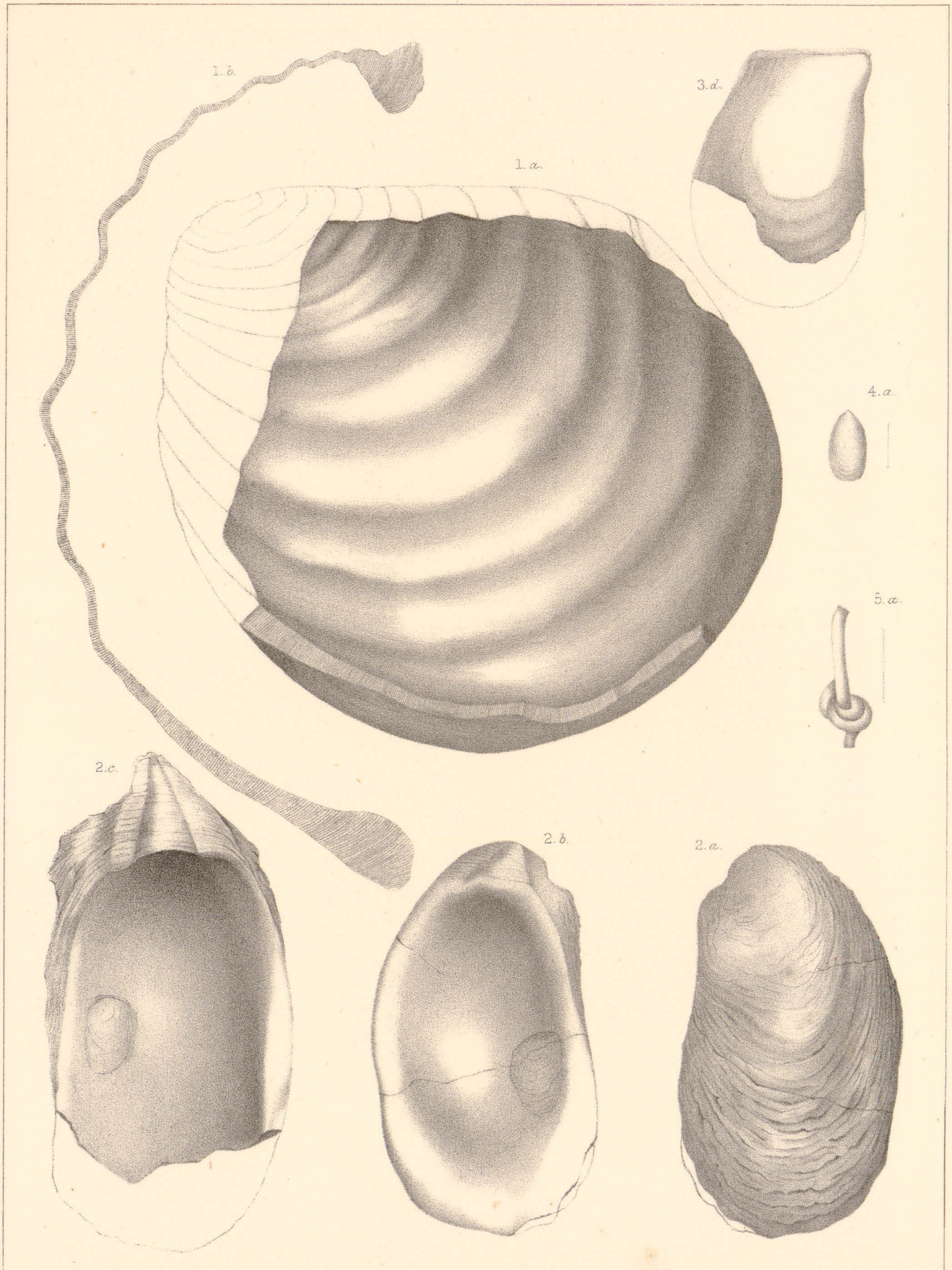
a. Right valve.

FIG. 4. LINGULA SUBSPATULA. (Page 169.)

a. Dorsal valve.

FIG. 5. SERPULA INTRICA. (Page 205.)

a. Example, twice enlarged, showing unusual contortion.



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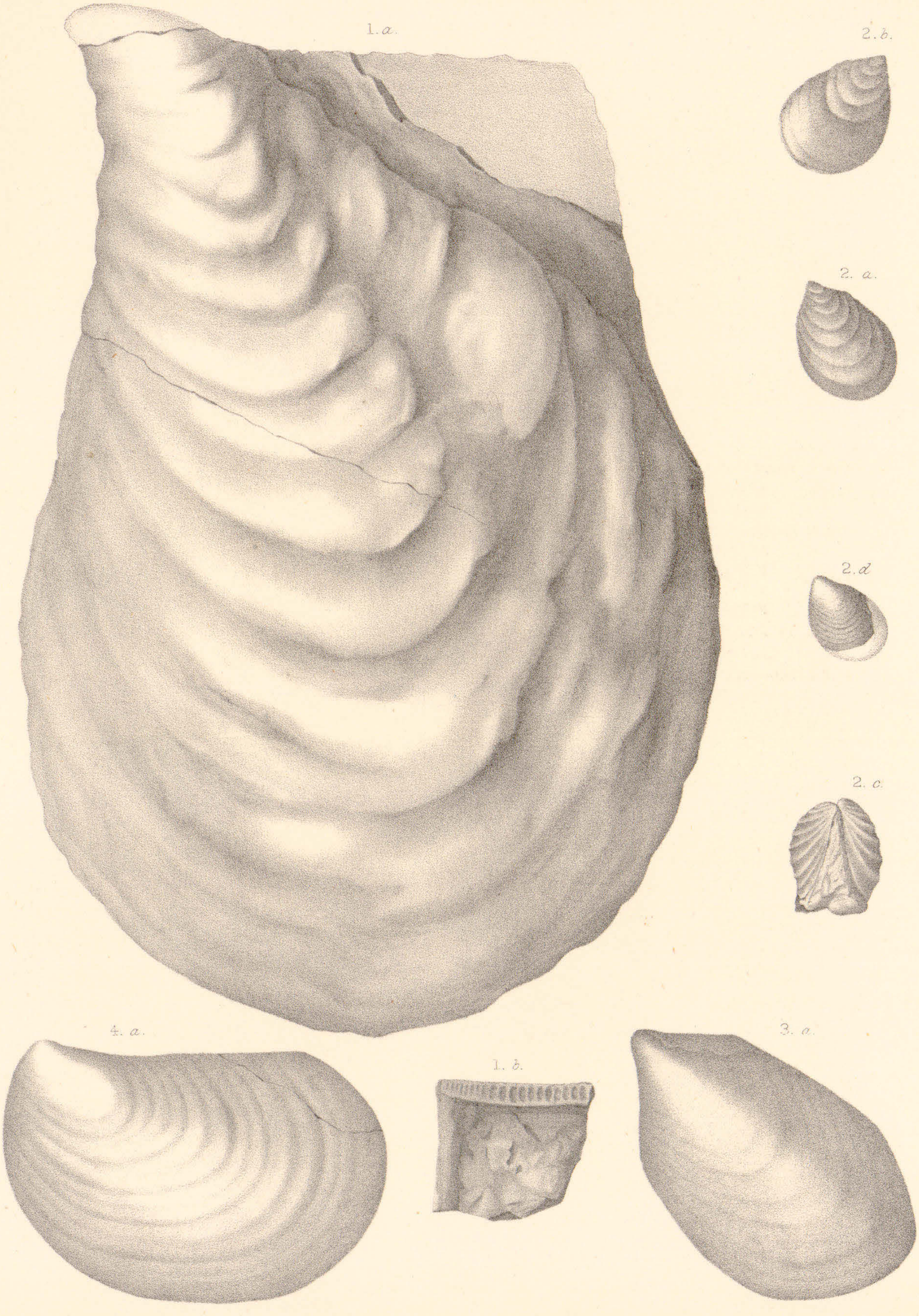
EXPLANATION OF PLATE XVI.

FIG. 1. INOCERAMUS FLACCIDUS. (Page 178.)
- *a*. Left valve, natural size, but some examples are larger.
- *b*. Interior view of beak and hinge, right valve.

FIG 2. INOCERAMUS DIMIDIUS. (Page 181.)
- *a*. Left valve, ordinary natural size.
- *b*. Right valve. Part of the shell without concentric folds.
- *c*. Front view, showing convexity of both valves.
- *d*. Left valve, showing unusually small concentric folds.

FIG. 3. INOCERAMUS PROBLEMATICUS. (Page 177.)
- *a*. Left valve.

FIG. 4. INOCERAMUS BARABINI. (Page 180.)
- *a*. Left valve.



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EXPLANATION OF PLATE XVII.

FIG. 1. GRYPHEA PITCHERI var. (Page 171.)

a. Interior view of the convex or lower valve.
b. Exterior view of the same.
c. Lateral view of the same, showing the curvature.
d. Less elongate example of a convex valve.
e. Exterior of upper or flat valve.
f. Interior of the same.

FIG. 2. EXOGYRA LÆVIUSCULA. (Page 173.)

a. Lateral view of a moderately large example.
b. Inner view of a smaller example.
c. Lateral view of the same.
d. External view of the same.

FIG. 3. EXOGYRA COSTATA var. FLUMINIS. (Page 174.)

a. Lateral view of the largest example in the collection.
b. Dorsal view of the same.
c. View of the flat valve connected with the deep one.
d. Exterior view of small example.

FIG. 4. LIMA WACOENSIS. (Page 176.)

a. Right valve, natural size.
b. Left valve of another example.
c. Lateral view of the same, showing its convexity.

FIG. 5. CAMPTONECTES PLATESSA. (Page 176.)

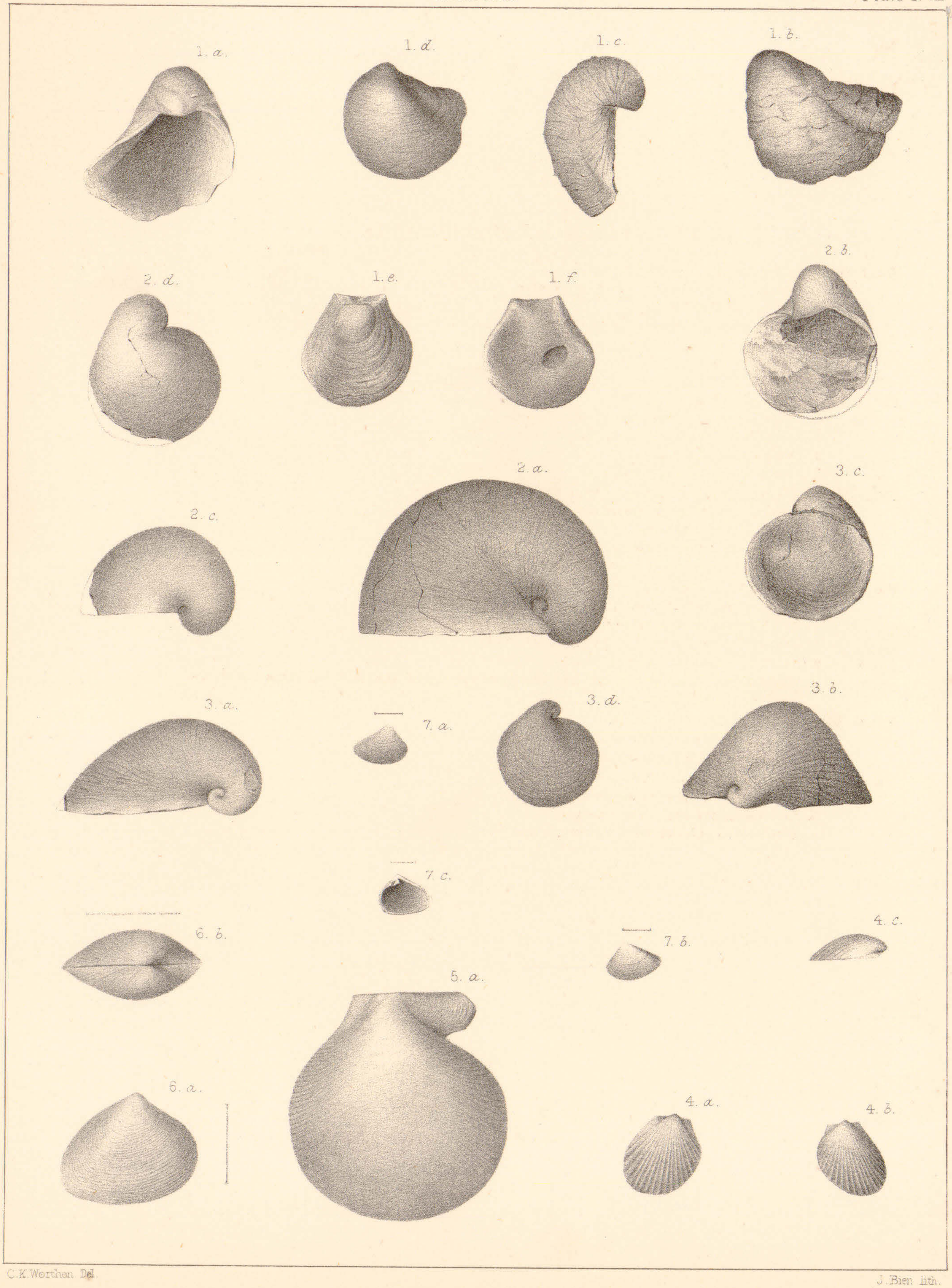
a. Right valve. The surface-markings mostly removed, and the radiating striæ a little too strong in the figure.

FIG. 6. MACTRA? INCOMPTA. (Page 185.)

a. Right valve, enlarged one-half.
b. Dorsal view of the same example.

FIG. 7. CORBULA NEMATOPHORA. (Page 188.)

a. Right valve, external view, enlarged.
b. Left valve, external view, enlarged.
c. Right valve, interior view, showing hinge.



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EXPLANATION OF PLATE XVIII.

FIG. 1. CASSIOPE WHITFIELDI. (Page 196.)
  a. Lateral view, showing the umbilicus.

FIG. 2. LISPODESTHES LINGULIFERA. (Page 192.)
  a. Specimen enlarged; callus and test mostly exfoliated. This, however, shows the volutions of the spire and the posterior canal, which would otherwise be hidden.
  b. Outline of the same, natural size.

FIG. 3. LISPODESTHES NUPTIALIS. (Page 192.)
  a. Specimen, natural size; test partially exfoliated.
  b. Same, enlarged.

FIG. 4. ANCHURA? FUSIFORMIS. (Page 190.)
  a. Natural size; test mostly removed by exfoliation.

FIG. 5. ADMETOPSIS GREGARIA. (Page 198.)
  a. Natural size, showing aperture and folds of the columella.
  b. Another example, enlarged.

FIG. 6. EULIMELLA FUNICULA. (Page 197.)
  a. Specimen, a little enlarged, showing aperture and straight columella.

FIG. 7. NERITINA (VELATELLA) CARDITOIDES. (Page 189.)
  a. View of upper side, natural size.
  b. Lateral view of the same.
  c. View of under side of the same, showing the broad inner lip.

FIG. 8. ANISOMYON CENTRALE. (Page 194.)
  a. Upper view of natural cast of the interior; summit broken off.
  b. Lateral view of the same. The specimen has been somewhat compressed vertically.

FIG. 9. ANISOMYON BOREALIS. (Page 193.)
  a. Summit view.
  b. Lateral view of the same.

FIG. 10. TURBONILLA (CHEMNITZIA) MELANOPSIS?. (Page 197.)
  a. Portion of the spire of an imperfect example.

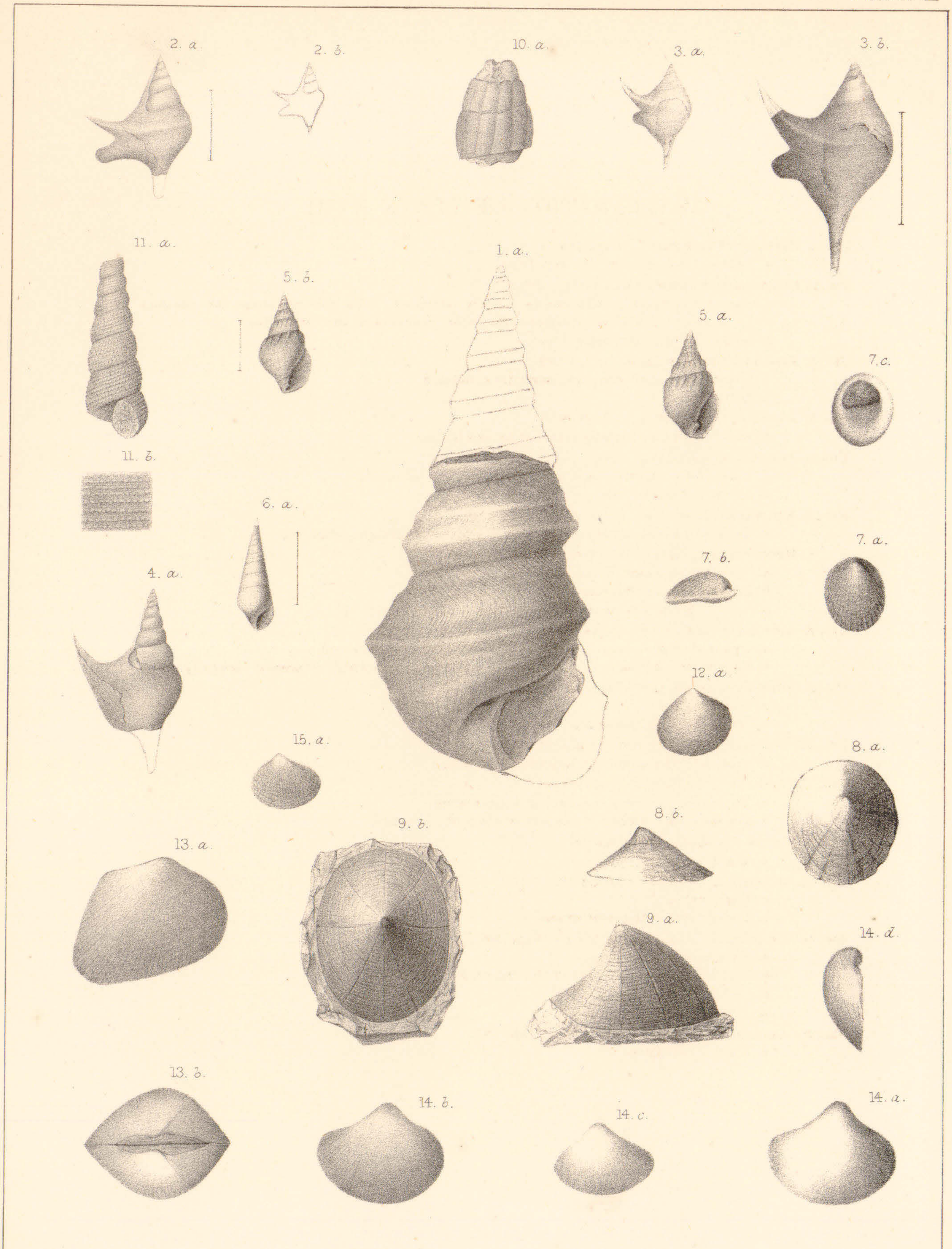
FIG. 11. TURITELLA UVASANA. (Page 195.)
  a. Example of ordinary size, broken at both ends.
  b. Portion of the surface of the last volution of the same.

FIG. 12. LUCINA SUBUNDATA. (Page 184.)
  a. Right valve.

FIG. 13. IDONEARCA DEPRESSA. (Page 183.)
  a. Right valve.
  b. Dorsal view of the same example.

FIG. 14. LEIOPISTHA (PSILOMYA) MEEKII. (Page 186.)
  a. Natural cast of right valve.
  b. Right valve, showing part of the fine surface-markings.
  c. Left valve.
  d. Front view of *a.*

FIG. 15. LEIOPISTHA (CYMELLA) UNDATA. (Page 187.)
  a. View of left valve.



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EXPLANATION OF PLATE XIX.

FIG. 1. AMMONITES LŒVIANUS. (Page 201.)

a. Side view, the outer chamber partly broken away.
b. Portion of the plan of a septum.

FIG. 2. HELICOCERAS PARIENSE. (Page 203.)

a. Upper view of part of one volution.
b. Dorsal view of part of the same, showing double row of nodes.
c. Transverse section of the latter through the nodes.
d. A similar section made between the nodes.

FIG. 3. SCAPHITES WARRENI. (Page 200.)

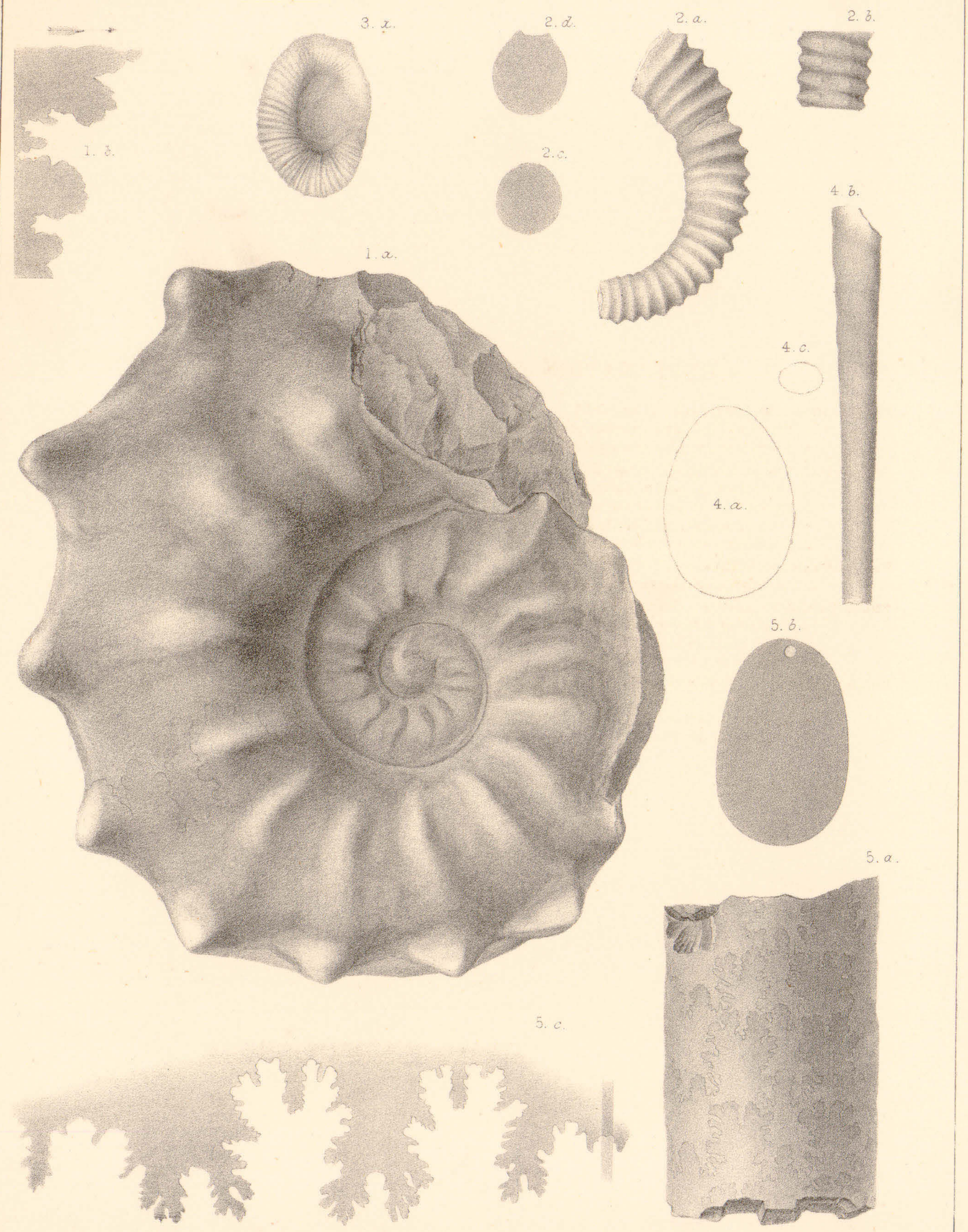
a. Imperfect example, showing only part of the last turn.

FIG. 4. BACULITES OVATUS. (Page 199.)

a. Outline of transverse section of outer chamber, near the last septum.
b. Small example from near Paria, Utah.
c. Transverse section of the same.

FIG. 5. BACULITES OVATUS var. (Page 200.)

a. Fragment of the chambered portion.
b. Transverse section of the same example, about midlength.
c. Plan of one of the septa.



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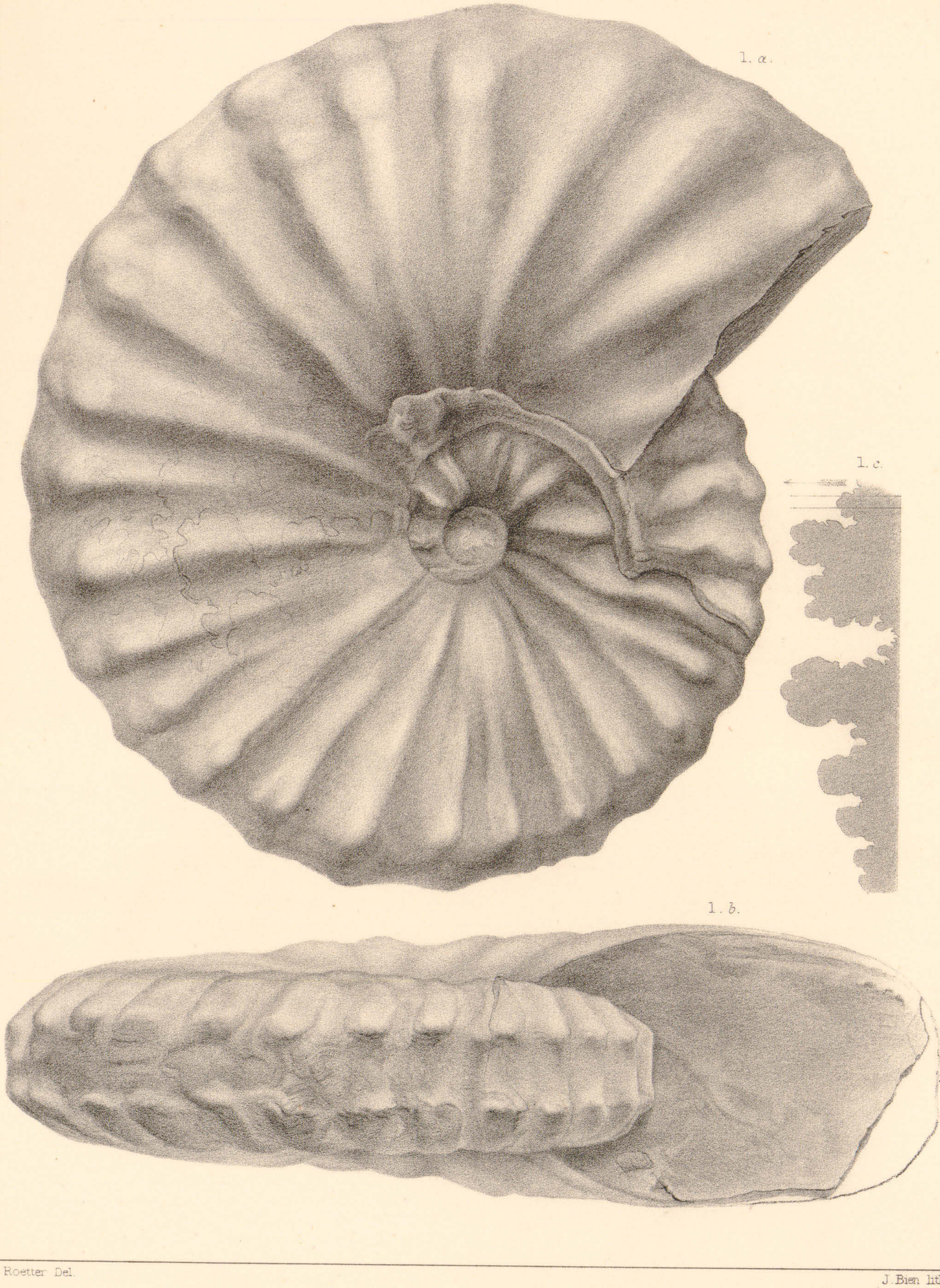
EXPLANATION OF PLATE XX.

FIG. 1. BUCHICERAS SWALLOVI. (Page 202.)

a. Side view, full size, except that about one-half of the outer chamber has been broken away.

b. Front view of the same.

c. Plan of septum.



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EXPLANATION OF PLATE XXI.

FIG. 1. PHYSA PLEROMATIS. (Page 211.)
- *a.* Example from Utah.
- *b.* Another view of the same.

FIG. 2. PHYSA BRIDGERENSIS. (Page 210.)
- *a.* An example rather less robust than the typical forms.

FIG. 3. HELIX LEIDYI. (Page 211.)
- *a.* A natural cast, the test being entirely removed.
- *b.* Another view of the same.
- *c.* An example showing the surface-markings of the test.

FIG. 4. VIVIPARUS TROCHIFORMIS. (Page 214.)
- *a.* Typical form; a medium-sized example.
- *b.* Another example.
- *c.* Another, showing the apex quite complete.

FIG. 5. VIVIPARUS TROCHIFORMIS var. (Page 215.)
- *a.* Medium-sized example, showing aperture.
- *b.* Opposite view of the same.

FIG. 6. VIVIPARUS IONICUS. (Page 215.)
- *a.* Upper view of rather small example.
- *b.* Side view of the same.

FIG. 7. VIVIPARUS ? ——— ?. (Page 215.)
- *a.* Side view of example of ordinary size, enlarged.
- *b.* Opposite view of the same.

FIG. 8. PLANORBIS UTAHENSIS. (Page 209.)
- *a.* Upper view of specimen, adult size.

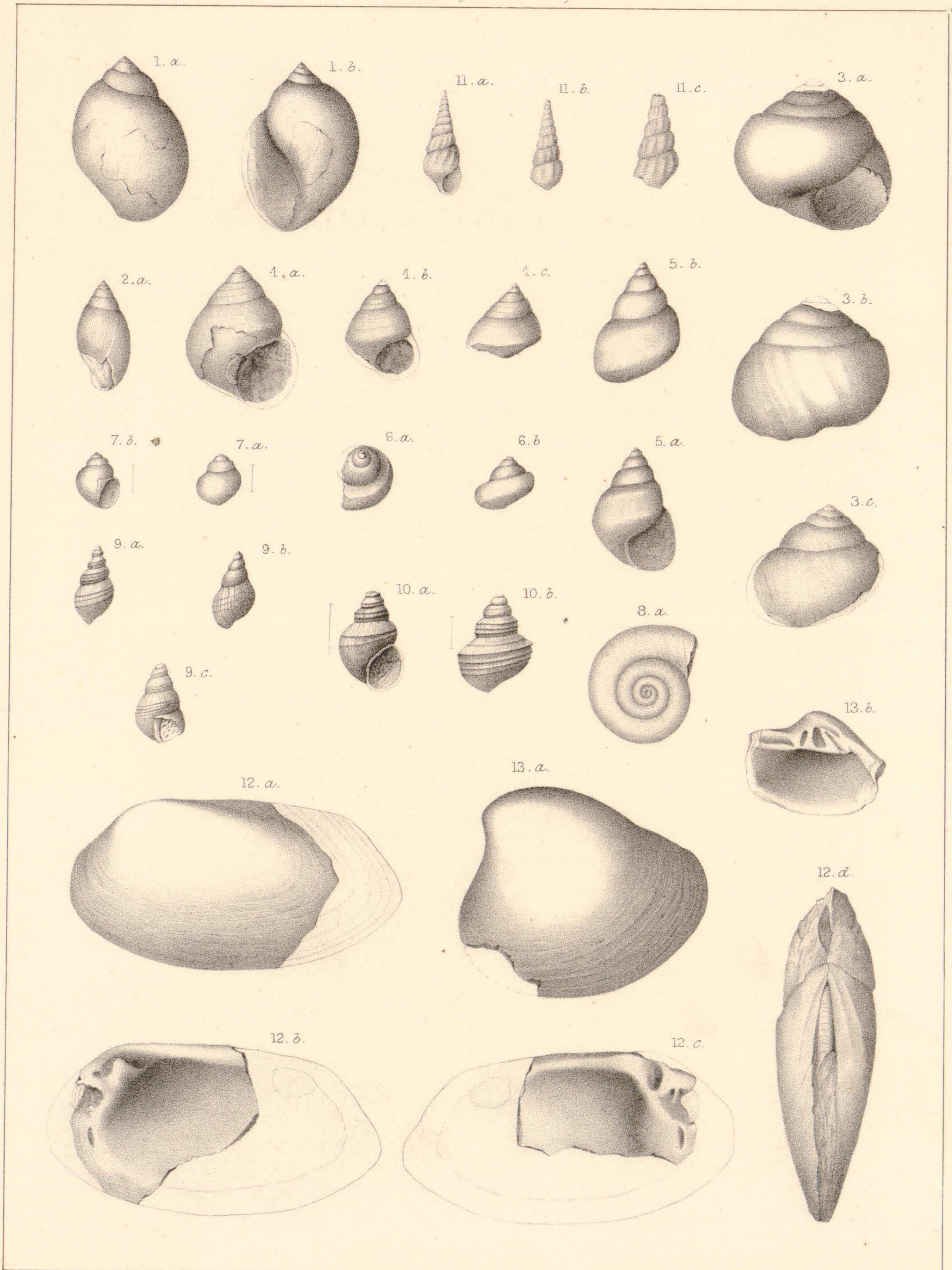
FIG. 9. GONIOBASIS NEBRASCENSIS. (Page 213.)
- *a.* Example with revolving lines more than usually distinct.
- *b.* Another example, differently and more faintly lined.
- *c.* Another, still differently lined.—All natural size.

FIG. 10. GONIOBASIS TENUICARINATA. (Page 212.)
- *a.* Example with two carinæ. Also showing nearly full form of aperture.
- *b.* Another with carinæ more than usually distinct and numerous.

FIG. 11. GONIOBASIS TENERA. (Page 212.)
- *a.* A complete example, rather less than average size.
- *b.* Another similar example, opposite view.
- *c.* Another example, full average size.

FIG. 12. UNIO VETUSTUS. (Page 206.)
- *a.* Left valve.
- *b.* Interior, right valve.
- *c.* Interior, left valve.
- *d.* Dorsal view of a partially-crushed example.

FIG. 13. CYRENA (VELORITINA) DURKEEI. (Page 207.)
- *a.* Left valve, ordinary size.
- *b.* Hinge of right valve.



C.K.Worthen Del. J.Bien lith.

ENGINEER DEPARTMENT, U. S. ARMY.

GEOGRAPHICAL SURVEYS WEST OF THE ONE HUNDREDTH MERIDIAN.
1ST LIEUT. GEO. M. WHEELER, CORPS OF ENGINEERS, U. S. ARMY, IN CHARGE.

PART II.

REPORT

UPON

THE EXTINCT VERTEBRATA OBTAINED IN NEW MEXICO BY PARTIES OF THE EXPEDITION OF 1874.

BY

PROF. E. D. COPE.

COMPRISING

LETTER OF TRANSMISSION.

PHILADELPHIA, *June* 10, 1876.

SIR: I send herewith the report on the extinct *Vertebrata* obtained in New Mexico by the United States Geographical Surveys West of the One Hundredth Meridian, under your direction, during the season of 1874. By means of the provision which you placed at my disposal while acting in the field as paleontologist, I was enabled to procure the results which are here set forth. I present you with a brief synopsis of these, which may be included under two heads: stratigraphical and paleontological.

Of stratigraphical results, I may mention three: first, the elucidation of the structure of the western slope of the Rocky Mountains and the plateau to the westward of them, in Northwestern New Mexico; secondly, the determination of the fresh-water character of the "Triassic" beds in that region; thirdly, the discovery of extensive deposits of the Lower Eocene, equivalent to the Suessonien of Western Europe.

The paleontological results are numerous. They are included in the determination of the faunæ of four periods, in basins which had not previously been explored, viz: in the Trias, the Eocene, the Loup Fork epoch, and the Postpliocene of the Sandia Mountains. The first vertebrate fossils ever determined from the Trias of the Rocky Mountains are included in the report. The first discovered were obtained by Professor Newberry while attached to Captain Macomb's expedition, and are now described for the first time. The determination of the ages of the respective horizons necessarily follows the first determination of the fossils.

An especial advantage enjoyed in the preparation of this report consists in the fact that the author obtained the fossils himself, and is thus familiar with their local relations. This is a point of much importance, since the fragmentary condition in which the skeletons of extinct vertebrata are usually found, furnishes opportunities for error or doubt which greatly curtail the value of the work. In the present instance, the author has admitted no correlation of fragments without the clearest evidence, and, where any uncertainty exists, has stated it.

The number of species of extinct vertebrata obtained during the season of 1874 may be enumerated as follows:

? Triassic	4
Cretaceous	13
Eocene	87
Upper Miocene (Loup Fork)	30
Postpliocene	2
	136

I desire to return my acknowledgments for the many courtesies which I have experienced, during my connection with the Survey, from yourself and from all of its officers; and also to the following gentlemen, to whom I am under obligations for assistance of various kinds: General August Kautz, in command at Fort Garland, Colorado; Lieutenants Blair and Delany and Drs. Moffatt and Collins, of the same post; also to General Gregg, in command of the District of New Mexico.

I am, with much respect,

E. D. Cope.

First Lieut. George M. Wheeler,

Corps of Engineers, U. S. A., in Charge.

CHAPTER XI.

FOSSILS OF THE MESOZOIC PERIODS, WITH A SKETCH OF THE GEOLOGY OF THE MESOZOIC AND TERTIARY BEDS OF NORTHERN NEW MEXICO.

The remains of vertebrate animals described in the following pages were derived from five horizons, two of which are Mesozoic and three Tertiary. Of these, the former are the supposed Trias, and the Cretaceous of the Niobrara group, or No. 3; the latter are the Lower or Wahsatch Eocene, the Loup Fork beds of the Rio Grande Valley, and the Placita marls of "Postpliocene" age.

As preliminary to the description of the fossils, a general account of the positions and relations of these beds is given* in the order of age. The fossils of the Trias are few, and were obtained on the western side of the Gallinas Mountains. Those from Cretaceous beds were mostly obtained from outcrops along the eastern base of the Rocky Mountains in Colorado.

1.—THE MESOZOIC BEDS OF THE WESTERN SLOPE OF THE SIERRA MADRE.

The close of Chapter II of my preliminary report to you (see Annual Report Chief of Engineers, 1875, p. 988) describes the first appearance of the variegated red and yellow beds of Mesozoic age, as the exploration was carried from the valley of the Rio Grande to the dividing axis of the Sierra Madre. As these strata rise, forming large hills on the north side of the Rio Chama,

* See Annual Report of the Chief of Engineers, 1875, II, p. 981, for my account of the geology of Northwestern New Mexico.

the road, rising less rapidly, passes over lower horizons, finally reaching a bed of hard, light, and rather coarse sandstone. At this point, the route turns to the northward, leaving the river, and climbs a low, long hill, whose surface is sandstone without soil. A few miles beyond, the summit is reached, and is found to present a sage-brush plain, many miles in extent, which is bordered by hills of remarkable beauty. To the south, the cañon of the Chama, with the Abiquiu Peak and other mountains beyond it, bound the plain; while, to the east and north, the brilliantly-colored strata above described form a perpendicular wall of about five hundred feet elevation. The upper third or more of this precipice is of a lemon-yellow, the remaining and lower portion of a sub-vermilion-red, forming a beautiful combination. The rock is fissured by ravines, and the intervening portions rise as huge buttresses of varied proportions, sometimes especially prominent near the summits, often forming regular bastions. Near the base, certain bluish strata form naked mounds and hills of bad-land character; but I failed to discover any fossils on them. The southern face of this wall presents a tremendous fissure, the "puerta" of the Cañon Cangilon. Our route laid through this defile for many miles, and we thus obtained an excellent section of the higher level of the region.

The yellow beds above mentioned were described at the close of Chapter III (of Ann. Rept.) as being overlaid with a shale, and this again by an arenaceous conglomerate. These formations increase in thickness northward, and near the mouth of the Cañon Cangilon a bed of fractured gypsum appears above the shale; the former soon becoming 25 feet in thickness, the latter only 3 feet. Along the sides of the southern part of the cañon, the gypsum forms a snow-white bed of 50 feet in thickness, overlying the walls of yellow and red, and its borders are cut into fissures by the atmospheric erosion. From these points, the stain produced by the dissolved gypsum forms stripes or fan-shaped shades of a beautiful mauve tint, which gives these rocky walls the appearance of a changeable silk; the mauve representing the shadows, and the red and yellow the lights. Altogether, the picturesque forms, brilliant hues, and regular cleavage of the precipices which for miles bound this cañon, form a scene of unusual beauty. The beds soon present a northwest dip. The gypsum descends from its elevated position, and a mud-brown sandstone appears on the summit of the walls. Six or seven miles beyond the mouth of the cañon, the gypsum bed is at the level of its bottom, forming low, rounded hills at the base of the sandstone cliffs, which rise to a height of 700 feet. From this point, the bottom of the cañon slowly rises between the sandstone walls, which, continuing their northwest dip, add perhaps 150 feet of thickness before the road reaches their summit-level. The road issues from the cañon on to an elevated country, which is covered with more grass than the regions previously traversed, with large patches of sage-brush. A short distance from this point, a line of low hills runs parallel to the direction of travel, with a northwest and southeast strike. They support groves of piñones, and examination showed that they form the outcrop of the bed of Cretaceous No. 2, and doubtless rest immediately on the sandstone below. They consist of lead-colored shales, which whiten on exposure, and contain *Inoceramus* and *Ostrea* in abundance.

Having determined this horizon, I recur to those previously described with the view of identifying them with a known standard of comparison viz: Doctor Hayden's section at Colorado Springs. The resemblance is at once seen to amount to an identity. The sandstone of the northern half of the Cañon Cangilon is the Cretaceous No. 1; thickness, 800 feet. Below it, the gypsum is that usually referred to the Jurassic, 50 feet, and doubtless inseparable from the brilliantly-colored beds below (400 feet), which are stated by Hayden to be Jurassic beds. The hard sandstone underlying these is the upper member of the beds that correspond to the Trias of the Colorado section. Their thickness on the Chama was not determined. The feature of this section is the increased thickness of the beds of the Jurassic and Cretaceous No. 1.

Continuing the route, we reach a second line of low hills of yellowish, soft sandstone with *Ostrea*, probably Cretaceous No. 3, and then descend into the shallow valley of Nutria Creek. From this point, the level of the country rises to Tierra Amarilla, which was determined by the topographers to stand 7,480 feet above the sea. To the south and east of this town, high hills of yellowish sandstone present escarpments to the north, which are apparently Cretaceous No. 3, and contain numerous *Inocerami*. The Rio

Chama flows two miles west of the town, in a south by west course, through a bed cut in the dark lead-colored shales of Cretaceous No. 2. Eight miles northeast, an enormous vertical mass of rock rises abruptly 1,274 feet above the stream below its base, and is continued to the north and west in a less precipitous mountain-flank. This mass of rock is a land-mark over a great extent of country; it is cleft to the base by the cañon of the Brazos Creek, one of the heads of the Chama. I took occasion on my return to traverse this upthrust, taking the trail which leads from Tierra Amarilla across the mountain-axis, of which it is the western border, to Conejos, on the edge of the Rio Grande Valley.

The road follows the course of the Brazos River, and for some distance the Cretaceous beds are in sight and nearly horizontal. Near the precipice above mentioned, these are lifted into high hills at an angle of 70° and 80°. On the north side of the river, sandstones of No. 1 rise with a similar dip, forming the foot-hills of the mountain, which rises perpendicularly to 1,500 feet. This mass is largely composed of a dense breccia of quartzite fragments, closely cemented into a uniform rock of a general pink color, and not variegated. Its characteristics and position refer it with probability to the Trias; but I could not detect any indication of the Jurassic beds between it and Cretaceous No. 1. After reaching the summit, we traversed the upturned edges of the formation, which have a strike varying from northwest and southeast to north and south. The elevated region now traversed by the trail is perhaps thirty miles in width, and is worn into rounded hills. The highest point indicated by the barometer is 10,400 feet. On the upper waters of the San Antonio Creek, high hills come into view, which have flat tops composed of a bed of trachyte, and their sides are often covered with pink and purple fragments of this rock. Within twenty miles of Conejos, the intervals between these hills are occupied by a heavy deposit of the Santa Fé marls, which, with masses of intrusive basalt rising in irregular masses, reminded us that we had once more reached the forbidding scenery of the Rio Grande Valley.

The bluffs that border the Chama near Tierra Amarilla are, as before observed, composed of the shales of No. 2, and they contain abundance of *Ostreæ* and *Inocerami*. Near the upper part of the series, there are several thin beds of a light-brown color, containing numerous broken fish-bones and *Ostrea congesta*, &c.; the appearance resembling closely fish-bearing shales found by Professor Mudge near Stockton, Kansas. From Tierra Amarilla, the route of my party laid southwestward. After crossing the river, and the bluffs which bound its immediate valley five miles beyond it, the sandstone of Cretaceous No. 1 rises from beneath the Cretaceous No. 2 with a southeast dip. In some places, it rises abruptly like the wall of a fault, forming vertical bluffs of greater or less elevation, facing the east. This axis of elevation is at this point narrow, and the sandstone is soon found to dip to the southwest, west, and northwest. The route continued for forty miles along the western base of this line of elevation, which increases in importance as we proceed southward. At first, the Cretaceous No. 1 sandstone forms extensive barren slopes of 15° to 20°, constituting the northwest flank of the gradually-rising Gallinas Mountains; but farther south, where the mountain reaches its greatest elevation, it is steeper and more broken.

The structure of the region west of the Sierra Madre from this point as far as my investigation extended (fifty miles) is a beautiful repetition of that observed and described on the east slope of the Rocky Mountains, so far as the Mesozoic strata are concerned. The mountain-axis itself exhibits great variations in its surface-formation and elevation; but the position of the beds on its flanks is remarkably uniform. These form a series of hog-backs, formed by Cretaceous Nos. 1 and 3, and occasionally by harder beds of Nos. 2 and 4, which are separated by parallel valleys, which are often grassed and timbered, and rarely occupied by sage-brush. The most important of these is that lying between Nos. 1 and 3. The upper portion of the Chama flows through a similar valley on the eastern side of the Gallinas axis, and is turned aside by that line of elevation, and then cuts through the beds of No. 1 and the overlying formations, and finally through the axis of elevation farther eastward, reaching the Trias before entering the Santa Fé marls. On the western side of the axis of the Gallinas, the valley of Cretaceous No. 2 exhibits two points of elevation. The most northern is near the Rio Chama; the southern and highest, at the head of the Rio Puerco. From the latter, the drainage is carried through the Gallinas Creek northward, which flows along the valley until it is turned aside by the rise toward the northern divide already mentioned, when it flows to the east through a cañon of the Gallinas Mountains, and joins the Chama below.

The appearance of the No. 2 valley is as follows: On the left (east), the barren slopes of brown sandstone rise, marked with regular cleavage-fissures, from which scattered piñones gain subsistence. On the west, perpendicular bluffs extend in a regular line parallel with the mountain-axis. They reach 700 feet and more in height; but the strata are undulating in long waves, reaching the valley-level at intervals of several miles, where the depression opens a view of the country to the west. The face of the bluffs is the outcrop of the bluish shaly beds of No. 2, which are full of *Ostrea* and *Inoceramus.* The summit of the bluffs is the light-yellow sandstone of No. 3. This sandstone varies much in thickness, increasing toward the south, where it constitutes the entire bluff. The valley widens to the south for a distance, and a line of low hills of the shales of No. 2 rises from its surface. Another line of hills, less constant and less elevated than that of No. 3, is formed by the yellow beds of No. 4, and first appears near the mouth of Gallinas Cañon, and continues to approach No. 3, until, to the south, the two combined form a single hog-back.

The axis of the Gallinas range appears to be undulating; at least, a series of undulations of the strata on its flanks are due to axes of elevation at right angles to the principal one. The side of the Gallinas Mountain at the north appears to be composed mainly of Cretaceous No. 1; but, at the cañon of the Gallinas, the colored beds of the Jurassic appear in its summits. South of this point, these beds, capped with the white gypsum, extend entirely across the anticlinal; the sandstones of Cretaceous No. 1 appearing on the eastern as well as the western flank. Farther south, these are abruptly removed, leaving a plateau of the hard "Triassic" sandstone at a somewhat lower level, this bed resting in turn on the deep-red marls of the same age. Farther south, the Triassic sandstone forms the summit of the highest line of the range; the Jurassic and Cretaceous No. 1 reposing on its sides. Still farther south, the Nacimiento Mountain rises to a greater height, and is composed of the red feldspar-porphyry of the Rocky Mountain axis. It forms the culmination of the Sierra Madre, and extends southward as far as my examination was carried.

The first and most northern section was carried across the flank of the mountain twelve miles south of the entrance of the cañon of the Gallinas Creek. The oldest beds of this section form a plateau surrounded by greater elevations, from which it is separated on the south and east sides at least by deep ravines. The walls of these are composed of a deep-red marl of the Trias, capped by the usual heavy bed of gray sandstone. The north side of this plateau is bounded by an abrupt precipice of Jurassic strata, the red below, yellow in the middle, and the bed of snowy gypsum on top; the relations of the Triassic and Jurassic here being precisely as described above at the entrance of the Cañon Cangilon. The sandstones of Cretaceous No. 1 are observed on both east and west flanks of this open anticlinal; on the eastern side, without the intervention of the gypsum-bed. The yellow bed is also deeply scored, and in some places isolated, showing that a stronger eroding action had been at work on this side than on the west, prior to the deposit of the Cretaceous No. 1. Immediately to the west of the plateau, a more elevated wave is also covered with the Jurassic beds; the entire summit of the mountain for many miles being composed of the gypsum. This soft material is worn into innumerable gullies. It is separated from the plateau by a gorge which is the seat of a fault. The Triassic plateau has evidently been thrust upward to the level of the yellow beds of the Jurassic at this point; the fault thus amounting to not more than three hundred feet. But the Jurassic beds dip southward, forming the descending slope of a longitudinal wave of their axis of elevation. As the Triassic is level at the point of descent of the Jurassic gypsum to the valley-level, the fault amounts to a thousand feet. At the junction of the two, the evidence of faulting is to be seen in the vertical escarpments of the middle bed of Triassic sandstone, which is here on edge, with the deep-red marls on both east and west sides of it. The gypsum does not descend southward to the valley-level, however; the end of the anticlinal having been cut transversely by a line of drainage, marked in summer by a deep arroyo. Immediately to the west, the sandstone of Cretaceous No. 1 forms the usual line of hog-backs; but at this point it does not lie immediately on the Jurassic, its softer lower beds having been cut out by the passage of the Gallinas Creek. This stream cuts through the hog-back, escaping from the valley of No. 2, and returns to it again, after pursuing a short course between No. 1 and the gypsum. Southward five miles, the Triassic beds with the sandstone cap have been lifted to a greater elevation, of at least 1,000 feet above the level of the Gallinas. This has naturally been accompanied with a greater lateral extension. The foreground consists of its red bed and intercalated sandstones, which extend to the valley of the Gallinas; the Jurassic beds being undiscoverable on its flanks, and even Cretaceous No. 1 is lost for a short distance. This projection, or angle, is opposite to an isolated mass of this formation, which, in the absence of another name, I called Red Peak. The area of the Trias is concentric with its base; the boundary retiring eastward on the south side. Here the Jurassic beds re-appear, the gypsum standing vertical, and forming a line of narrow, steep hills; the lower beds are not visible, but form the bottom of a valley which separates the Jurassic hills from the mountain. The relation of the two formations is here clearly seen. The elevation of the Red Peak and adjacent mountain-axis has fractured the Triassic beds, so that the upper sandstone, which is horizontal on their summits, also lies at a steep angle (45°) on their southwestern flanks. An interesting example of curved strike is here exhibited. The tilted sandstone at the left strikes northwest and southeast; the same ledge in the middle foreground, north and south. These beds lie immediately on the blood-red Triassic marls, as in the mountains and elsewhere.

Two miles south, the Jurassic and Cretaceous No. 1 beds disappear through the erosion of a drainage-valley; but, south of the latter, the Jurassic rises steeply, with a dip northwest 25°, to an elevation of 700 feet above the valley. The upper surface is composed exclusively of the gypsum, and the eastern is precipitous, exhibiting the usual three strata of white, yellow, and red in descending order. But below these appear the deep-red marls of the Trias, which occupy the valley separating the Jurassic hill from the Trias mountain, and form a body of Triassic bad-lands. The surface of this tract is eroded into cañons, ravines, and arroyos, with irregular masses of a deep-red color between them. Perhaps three-quarters of a mile separate the vertical sides of the valley; the Triassic beds forming the western wall, with the marl below, and a very heavy bed of hard sandstone on top, the whole rising to 900 feet by barometer. In the bad-land tract, I obtained satisfactory evidence of the lacustrine character of the formation, a point of much importance, inasmuch as the nature of these beds has remained very obscure up to the present time. The evidence consists of numerous specimens of species of Unio from a number of distinct localities, and fragments of bones and teeth of two or three species of Saurians, one of which at least was of terrestrial habits, according to our present knowledge. I have submitted the Unios to my friend Mr. F. B. Meek, who informs me that they belong to five species, which he has described* three of them under the names, *U. cristonensis*, *U. gallinensis*, and *U. terrærubræ*. He observes, "supposing that these shells really come from the horizon of the Trias, they are the oldest Unios yet found, so far as I am informed, in this country."

The Saurian remains above mentioned are those of *Dinosauria*, *Crocodilia*, and perhaps *Sauropterygia*. The first named is represented by a tooth of the type of that of *Lælaps;* the Crocodile is a Belodont, which I have described under the name of *Typothorax coccinarum.*

The evidence derived from the vertebrate fossils is favorable to the identification of this horizon with that of the Trias, although it cannot, of course, be regarded as conclusive until more perfect specimens are obtained.

Besides the overlying sandstone bed, the red marls are traversed below it by a conglomerate, which is in some localities of a bluish tint. At some points, it weathers to gravel, and near this horizon the vertebrate remains occur. At other points, it forms a very hard Potomac marble, containing pebbles of various colors. Near the same level, I obtained specimens of impure copper-ore, which simulate petrified wood in form. The sandstones, especially those lying obliquely on the mountain-side, I found to contain obscure vegetable remains, some of which are replaced by oxide of iron. They reminded me of similar remains observed in the same horizon near Taos.

On passing a mile to the south of the locality which has been described, the opposite masses of the Jurassic and Triassic rocks are seen to descend at

*Annual Report of Chief of Engineers, 1875, ii, p. 1003 an angle of 20° and 25° to the south, marking the terminus of another longitudinal wave of the axis, of which the one immediately to the north has already been described. The valley caused by this descent is the drainage-level of the Upper Gallinas Creek, which issues from the mountains at this point. This locality is instructive as furnishing the third example of the fault existing between the Triassic and Jurassic. The Triassic sandstone is also faulted at several points at right angles to the principal fault, as seen in the north and south escarpment. The fragments of the fractured sandstone bed strew the west slope of the Triassic mountain, and disappear in the red marls.

From this depression, the mountain rises gradually, first in a lower ridge, and then to the long and regular crest of the Nacimiento Mountain. The axis of this new elevation forms an open angle with that of the range of the Gallinas proper, running northeast and southwest, the consequence of which is a change of strike of all the elevated beds on its flanks. The Cretaceous hog-backs make a very regular angle in their direction; its apex being the point of change of axis at the cove I have described above in detail. At the same time, the hog-backs approach nearer to the mountains, and the variegated and gypsum beds of the Jurassic are not seen. The southward route passed over the divide which separates the drainage of the Gallinas from that of the Puerco. South of this divide, the Cretaceous beds, including their highest members, Nos. 3 and 4, disappear on the sides of the Nacimiento Mountain. The mountain itself is the feldspathic porphyry of the true Rocky-range axis, which, rising through the Mesozoic beds which cap the northern part of the Sierra Madre, forms its most elevated portion. At the village of Nacimiento, the red Triassic beds are visible on the mountain-side, and its upper sandstone dips south as well as west from an elevated position. The range extends south from this point as far as my observation reached. The valley is occupied, in localities near the mountains, with the red feldspathic gravel usual along the Rocky ranges. Some of the Mexicans spoke of copper-mines, with ancient stone buildings, in the ravines of the Nacimiento.

I conclude this chapter by a little further allusion to the Cretaceous hog-backs, of which the most important is that formed by No. 3. At one of the depressions in this line, the erosion has displayed a considerable bed of lignite. It appears in four beds, which are represented in the following section:

	Feet.
Sandstone No. 3	00
Limonite	2½
Carbonaceous shale	10
Lignite	10
Sandstone	00
Lignite	3
Sandstone	00
Lignite	3
Sandstone	00
Lignite	3
Total	80

This lignite bed extends throughout the region west of the Rocky Mountains wherever No. 3 occurs, and is the bed which has been mistaken for the true lignite, or No. 6, by some geologists. It appears in this horizon wherever access is obtained, but is generally impure and of little or no value. The beds differ in thickness at different localities; their combined mass, with rather thin layers of slate, at one point reaching 50 feet. It is overlaid by a heavy bed of yellow sandstone, from which I obtained teeth of Sharks of the species *Oxyrhina?* and *Galeocerdo pristodontus*, Agassiz. These yellow beds are observable for a mile to two miles west of the hog-back of Cretaceous No. 3, forming lines of low hills, from which I obtained numerous fossil *Mollusca*. These include *Baculites*, *Ammonites* of two species, including *A. placenta*, *Inoceramus*, and a number of well-preserved *Dimyaria* and *Gastropoda*. I suppose these beds to represent Cretaceous No. 3.

A portion of their lowest member lies on the hard portion of No. 3, at some points, as already stated, forming the upper part of the hog-back; at least, I obtained the *Baculites*, an *Ammonite*, and the usual form of *Inoceramus* from such

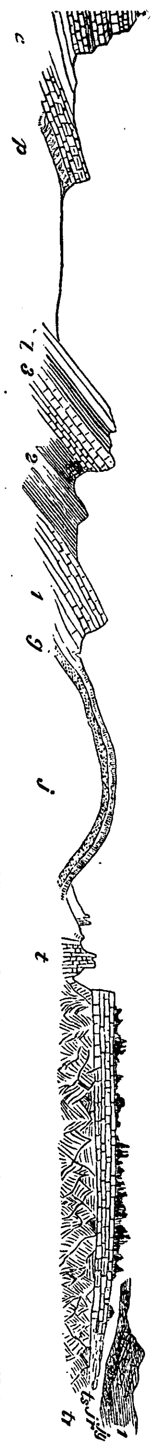


FIG. 1.—Section nearly east and west from the Gallinas to the Eocene bluffs. Horizontal scale about an inch to two miles. *t*, Triassic: *s*, sandstone; *r*, red beds; *j*, Jurassic: *g*, gypsum; *y*, yellow bed; *r*, red bed. 1, Cretaceous No. 1; 2, Cretaceous No. 2; 3, Cretaceous No. 3; *p*, Puerco marls; *e*, Eocene sandstone; *g*, Gallinas Creek; *l*, Lignite.

a locality. The two horizons are separated by the lignite, and, when this is eroded, a double line of hog-backs results. Several miles to the westward of this locality rise the horizontal beds of the Eocene, and the arroyo which drains their slope pursues its way eastward into the Gallinas Creek. Immediately bordering its valley is a detached hill of Cretaceous No. 3, on whose summit stands a large stone building, one of the many which strew the crests of all these hog-backs. An account of these is given in my report on archæology.* Further observations on the Cretaceous beds are deferred until the Eocene deposits are considered.

The following is an approximate estimate of the Mesozoic beds in the same locality. As they were not accurately measured, the numbers will have to undergo revision. Their relative thickness is nearly as given:

	Feet.
Uncertain (concealed in the sage-plain)	500
Cretaceous No. 3	1,500
Cretaceous No. 2	1,500
Cretaceous No. 1	500
Jurassic	600
"Trias" (bottom not seen)	1,000
Total	5,600

The Mesozoic beds of this section (excepting some of the higher members of the Cretaceous) have been examined over extensive areas to the west and south by Messrs. Marcou and Newberry, whose valuable reports accompany those of Lieutenants Whipple and Ives, on the routes surveyed by them through Arizona and New Mexico. The horizon here termed after Hayden "Triassic" has been referred previously to this formation by Professor Marcou also, who had the opportunity of examining it in Texas and the Indian Territory. So far as the latter region is concerned, I can confirm the identification, having examined bones from the red beds of that country which appear to be those of Belodonts. Dr. Newberry terms it in Arizona the "salt group", or "saliferous sandstones", referring to it as probably including both Triassic and Permian strata. The formations here called Jurassic are partially included by Professor Marcou in his Triassic series, and are termed by Dr. Newberry the "variegated marls", who is inclined to refer them to the Jurassic.

* Annual Report Chief of Engineers, 1875, II, p. 1086.

The published notices of the paleontology of the Mesozoic formations explored by me are the following:

1875.—Annual Report of Chief of Engineers, 1875, II, 983. Cretaceous No. 3 of the Sangre de Cristo Pass.

1875.—Proceedings of Academy of Philadelphia, 1875, p. 265. Trias of Gallinas Mountains.

2.—THE EOCENE PLATEAU.

The discovery of the Eocene deposit and its contained fossils was the realization of an anticipation of its existence, which I embodied in a report to Dr. Hayden the previous year (1873), and which was published* before I left for the field in 1874. Investigations into the stratigraphy of the southern Rocky Mountain region had demonstrated that the elevation of this part of the continent took place earlier than the corresponding regions in the north; in other words, that the elevation extended from the south to the north. This is shown by the greater exposure of the Mesozoic beds in the south, in connection with the abundance of lignite and other indications of extended land-surfaces during the Cretaceous period, and by the absence of lignite of the upper or Fort Union epoch, which is the coal-producing horizon of Colorado and the north.

Supposing that the sudden appearance of faunæ and floræ is not due to creation, but to migration, I was led to look for the origin of the rich vertebrate fauna of the Bridger Eocene in connection with the abrupt disappearance of the Saurian fauna of the Fort Union Lignite Cretaceous, whose strata in Wyoming immediately underlie it. The change of fauna is strikingly abrupt, passing from a Mesozoic to a Tertiary character without the intervention of extensive non-fossiliferous deposits. The succession of beds from the one to the other is in many places uninterrupted, and, according to Dr. Hayden, without non-conformity. There is no evidence whatsoever of terrestrial disturbance, such as would produce a great destruction and re-introduction of life. In fact, physical evidence, as well as biological law, is in favor of the view that the Tertiary fauna migrated from another region, and replaced the Mesozoic type of Saurians which had until then occupied the field. And in view of these facts I remarked (*l. c.*, p. 16; Annual Report

*Bulletin of the United States Geological Survey of the Territories, No. 2, 1874.

of the United States Geological Survey of the Territories, 1873, 422), that "there is good reason for believing that this incursion of *Mammalia* came from the south".

In Wyoming, the Bridger beds are immediately underlaid by the Wahsatch formation (which includes the Green River shales), whose fauna presents characteristic peculiarities when compared with that of the Bridger epoch (see summary at end of Chapter XII). The result of my exploration in New Mexico was the discovery of an extensive area of Wahsatch beds, with their fossils. The latter represent the fauna which immediately succeeded the Fort Union Saurians and preceded the Mammalian life of the Bridger. According to Dr. Peale (Hayden's Annual Report for 1874, published in 1876), the Wahsatch beds ("Green River beds") become much heavier in Western Colorado, and I did not find the Bridger beds in New Mexico. New Mexico was then no doubt the source from which the fauna of Wyoming was derived, and the extension of the Wahsatch fauna probably proved fatal to the latest representatives on the American continent of the Dinosaurian and other Reptilian forms of Mesozoic time.

The relations which the Eocene bears to the Mesozoic formations in New Mexico are as follows:

West of the hog-back of Cretaceous No. 3, with an interval of perhaps two miles, at a point just north of the Gallinas Mountain, a sandstone bluff presents a bold escarpment to the northeast. This is the angle of a mass of rock whose eastern face extends southward parallel to the mountain-axis, and whose strata dip first 15°, then 10° south, and soon disappear beneath a similar mass. This series also presents an escarpment to the northeast, and its beds also dip 10° south, nearly opposite the cañon of the Gallinas. This façade rises to from 600 to 900 feet elevation, and is cleft to the base by a deep gorge, the Cañoncito de las Yeguas. I traversed this fissure, passing entirely through to the elevated country to the westward. Six miles from its mouth is a large pool, fed by a spring known as the Mare's Spring. The cañon is narrow, and the walls almost perpendicular. They are composed, at the "puerta", or entrance, of a moderately hard, reddish-brown sandstone. The cañon is twenty miles in length; its bottom has a gentle rise; and, as the sandstone has a gentle dip toward the west as well as south, its upper beds reach the level of the bottom at about the middle of the length of the cañon. Above them, softer beds appear, alternating with strata of sandstone; the beds are first gray, but others soon appear which are striped with red. The red-striped marls increase in relative thickness toward the west, and the sandstone strata diminish, until, at the head of the cañon, the highlands fall off into hills of bright-colored marls eroded into rounded and picturesquely-formed masses. These extend in a long line to the north and south, facing westward. To the west, a wide, elevated plain spread before us, varied with a few hills, and stretching away with a gentle slope to Cañon Largo and the country of the San Juan River. The discovery of the variegated marls was one of no little interest to the writer, inasmuch as I had made special efforts to find Eocene beds in this region, and they were then crowned with success. The position of these marls, with their close physical resemblance to the Wahsatch beds of Bear River, Wyoming, together with the evidence furnished by a lower molar of *Coryphodon*, found by my guide, indicated that I had discovered the sediments of the great body of fresh water which during successive stages of the Eocene period occupied the drainage-basin of the Great Western Colorado. The thickness of the strata exhibited in the walls of the Cañoncito de las Yeguas, I estimated at 1,200 feet.

On leaving the mouth of this cañon, and proceeding southward, the southern dip of the red sandstone brings their summit to the ground-level in about ten miles distance. The red and gray marls, with alternating beds of white and yellowish sandstone, appear on their summits, and at a point twenty miles south of the cañon form a mass of bad-land bluffs of from 600 to 1,000 feet elevation. This escarpment retreats and then turns to the east, forming an extensive horseshoe, the circumscribed area being occupied with hills and picturesque masses of sediment, with all the peculiar forms and desolation of bad-land scenery. I remained in camp for about a month near this circle, and obtained many fossil remains of *Vertebrata*. Ten miles south of this point, another horseshoe of bad-lands covers an extensive area, and proved to be as rich in fossil remains as the first. Here I made my second camp, remaining in it for three weeks. The southern boundary of the northern tract extends to within six miles of the Cretaceous hog-backs, while the corresponding part of the second approaches nearer, forming a line of bluffs of considerable height running north and south parallel with, and half a mile from, the hog-backs. Beyond the Puerco divide, hills of this formation rise on both sides of the trail, and near the Ojo de San José the Eocene beds repose on the foot of the Nacimiento Mountain several miles to the east.

Below the sandstones which form the portals of the Cañoncito de las Yeguas, another stratum of marls shows itself in hills of 100 feet and higher, in the sage-brush plain that separates them from the Cretaceous hog-backs. They are soft and of mixed black and dark-green colors near the locality in question, and capped by light and yellowish sandstones. These conform to the beds of the Eocene, and I traced them for forty miles to the south along the belt of country intervening between Cretaceous No. 4 and the reddish sandstone. At the locality just mentioned, they conform to the sandstones above, having a dip of 10° southwest, while they do not conform to the hog-back of Cretaceous No. 3, the nearest available outcrop, which dips at 25° west. Farther south, this marl is represented by low hills of generally lighter color. Near Nacimiento, it has an increased importance, as it rises both to the east and south. The valley of the Upper Puerco is excavated in it for some distance, and its blackish, greenish, and gray hills are seen on both sides of the river. At a point on the river about six miles below the village of Nacimiento, the lower sandstone of the Eocene forms a perpendicular bluff, which terminates in an escarpment of 500 feet elevation facing the south. The red-striped marls, having acquired a gentle northern dip, disappear from view some miles to the north, and the termination of the underlying sandstones warned us that we were approaching the southern border of the basin.

The border of the sandstone turned to the west at this point, the line of bluffs continuing as far as vision extended. Below and south of it, the varied green and gray marls formed the material of the country, forming bad-land tracts of considerable extent and utter barrenness. They formed conical hills and flat meadows, intersected by deep arroyos, whose perpendicular walls constituted a great impediment to our progress. During the days of my examination of the region, heavy showers of rain fell, filling the arroyos with rushing torrents, and displaying a peculiar character of this marl when wet. It became slippery, resembling soap in consistence, so that the hills were climbed with difficulty, and on the levels the horses' feet sank at every step. The material is so easily transported that the drainage-channels are cut to a great depth, and the Puerco River becomes the receptacle of great quantities of slimy-looking mud. Its unctuous appearance resembles strongly soft-soap, hence the name Puerco, grease. These soft marls cover a belt of some miles in width, and continue at the foot of another line of sandstone bluffs, which bound the immediate valley of the Puerco to a point eighteen miles below Nacimiento. Here the sandstone again turns to the westward, presenting a southern escarpment of 500 to 1,000 feet elevation. This forms the southern boundary of the Eocene basin. I could not be sure whether this sandstone is identical with that of the escarpment twelve miles north, but suspected it to be such. Immediately south of it, low hills of Cretaceous No. 3 extend across the Puerco and continue south of the Eocene bluffs at a distance of a mile or two with a western strike. They were as elsewhere of a soft yellowish sand and clay, including shale beds, and contained abundance of *Inoceramus*, like those found on the Gallinas.

Ten miles to the southward, the underlying Cretaceous beds are capped by a horizontal table of basalt, thus forming a mesa, through which the Puerco passes in a cañon. I supposed this to be the forerunner of the great basaltic plateau, which, according to Lieutenant Wheeler, constitutes the country south of the Rio Chaco for a great distance one of little promise to the agriculturist. These tracts are known as the Mesa Fachada and Mesa de los Lobos. The season being well advanced (October 22), I thought best to commence the return march, which we accordingly did.

The soapy marls, or, as they may be called, the Puerco marls, have their principal development at this locality. I examined them throughout the forty miles of outcrop which I observed for fossil remains, but succeeded in finding nothing but petrified wood. This is abundant in the region of the Gallinas, and includes silicified fragments of dicotyledonous and palm trees. On the Puerco, portions of trunks and limbs are strewn on the hills and ravines; in some localities the mass of fragments indicating the place where some large tree had broken up. At one point east of the river, I found the stump of a dicotyledonous tree which measured five feet in diameter.

As already remarked, the Puerco marls may belong to the Eocene series in view of their strict conformability to the superincumbent rocks of that age. But they may represent the Fort Union or lignite beds of the Upper Missouri, some of whose strata they resemble in color and consistence. They contain no lignite nor coal, although their occasional black color may be due to a small amount of carbonaceous matter. They have no resemblance to the Bitter Creek beds in mineral character or fossils. The presence of such quantities of petrified wood gives weight to the probability that the Puerco marls are a lacustrine formation. In exploring the hills of this formation along the Puerco, I found the horns of an Elk (*Cervus canadensis*). This locality must be near the southern limit of its range. I learned that it is not uncommon on the high plateau near Tierra Amarilla on the northeast.

I made a second section of the upper or Wahsatch beds to the west, starting from opposite the middle of the northern bad-land cove. About the middle of the marl series, there is usually present a bed of nearly white sandstone, frequently quite hard, in which the fossils have generally a worn or rolled appearance. Here occurred the greater number of Sharks' teeth, but not all. Above this horizon, the most abundant fossils are the gars and crocodiles, while the greater number of the Mammals come from below it; but this distinction is of a very general character. On climbing the eastern escarpment of these marls, the summit is found to be a plain sloping at a slight angle to the south and west. Escarpments composed of the upper beds of marl and sandstones extend mostly in east and west lines.

The most important of these is, first, an outcrop of sandstone, ten miles west of the bluffs. Here I found characteristic fossils. The trail follows a cañada, or narrow shallow valley, for perhaps forty miles. Branches pass to the right and left between the hills, affording beautiful park-like views. The drainage of this Eocene plateau from the summits of its eastern escarpment is to the west, reaching the San Juan River by Cañon Largo and Cañon Amarillo. Along the cañada, the marls re-appear; their red and gray colors contrasting with alternating beds of sandstone. These sink, and are followed by a soft, yellow sandstone, which forms the face of the Gabilan Hill, eighteen miles west of the bad-lands. Other bad-lands appear beyond; the sandstone resting on them. For many miles, the alternating marls and sandstones form steep hills on each side, of 100 to 300 feet elevation, until about thirty miles west of the Gallinas bad-lands they terminate in bold headlands, the escarpment of the formation sweeping right and left to the north and south. From high, bold hills, they drop off in lower terraces, and the general level of the country slopes off rapidly to the west. From this point, a fine view toward the cañons of the San Juan is had over a descending plain studded with irregular hills. A low tableland, perhaps forty miles distant, is deeply notched at two points, which my guide, who is familiar with the region, termed the Puertas, or Gates of the Cañons Largo and Amarillo, with the Mesa de Chaco to the left. The point on which we camped is termed on the maps the Alto del Utah, and is placed at 6,648 feet elevation, although there are more elevated hills nearer to the bad-land façade of the Gallinas. The entire region is devoid of springs, but is covered with grass and good timber. The country is, therefore, a favorite resort for the shepherds, with large flocks, from the valley of the Rio Grande, in winter; otherwise, it is without resident inhabitants. Myself and guide depended on pools of water of a rain which had fallen a week or more previously, and found it palatable, although muddy. In several of them, I found young individuals of *Spea stagnalis*, Cope, with their tadpoles, which had evidently but a short time for incubation, metamorphosis, &c. As usual in this group, the tadpoles attain a large size before changing. I found also, on a number of the bad-land hills, as far as the Alto del Utah, pottery of the ancient people who appear to have once inhabited this country in large numbers. An account of these has been given a special chapter of the annual report.

In review, I give the following section of the Eocene rocks of the region west of the Sierra Madre:

	Feet.
Red and gray marls, Wahsatch group	1,500
Sandstone, Wahsatch group	1,000
Green and black marls, Puerco group	500
Total	3,000

The descriptions of fossils of this horizon have been published at the following dates and places:

1874, November 28.—Report upon vertebrate fossils discovered in New Mexico, with descriptions of new species; by E. D. Cope Annual Report of the Chief of Engineers. Appendix F F.

1874.—Annual Report of the Chief of Engineers, part 2, p. 591.

1875, April 17.—Systematic catalogue of Vertebrata of the Eocene of New Mexico, collected in 1874; by E. D. Cope. Geographical and Geological Explorations and Surveys West of the One hundredth Meridian, 1875.

1875.—Proceedings Philadelphia Academy, p. 255. On fossil Lemurs and Dogs.

1875.—Proceedings of the Philadelphia Academy, p. 444. On the supposed Carnivora of the Eocene of the Rocky Mountains; extras published December 22.

1876.—Proceedings Philadelphia Academy, p. 10. On a gigantic bird from the Eocene of New Mexico; extras published April 18.

1876.—Proceedings Philadelphia Academy, p. 39. On the *Tæniodonta*, a new group of Eocene Mammalia; extras published April 18.

1876.—Proceedings Philadelphia Academy, p. 63. On the geologic age of the vertebrate fauna of the Eocene of New Mexico; extras published April 26.

1876.—Proceedings Philadelphia Academy, p. 88. On supposed Lemurine forms of the Eocene period.

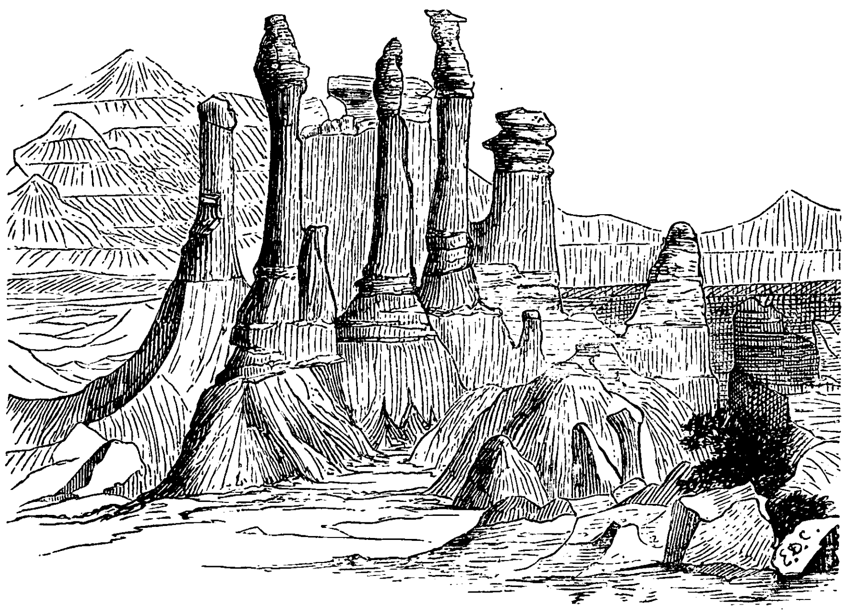


FIG. 2.—Sketch taken in the Eocene bad-lands of the Gallinas.

3.—THE LOUP FORK BEDS OF THE VALLEY OF THE RIO GRANDE.

The ravines of the south side of the Picuris Mountains, on the east side of the Rio Grande, are filled with the arenaceous beds of the Santa Fé marls, as already described by Dr. Hayden. The erosive forces have cut deep valleys and gorges from their mass, leaving tremendous castellated and bastioned escarpments of a thousand feet elevation. Interesting views of these beds may be had by following the valley of the Embuda Creek, and the cañadas which extend from it to the southward and eastward. After careful examination of this region, I could only find a single fossil, namely, a penultimate phalange of a lateral digit of probably a three-toed horse.

Crossing the Rio Grande by a ford not far from the mouth of the Embuda Creek, I climbed the rugged face of the lava mass that forms the sides of the cañon of the river, and which underlies the surface on its eastern side, and found myself at the base of the "Pliocene" sands, which there form bad-land hills of some elevation. Some of them are worn into castellated forms of much beauty; one in particular reminding me of the Eocene Church Buttes of Wyoming. From their summits, an extensive view was had of the triangular area inclosed on two sides by the Rio Grande and the Rio Chama, with the two drainage-areas of the Ojo Caliente and El Rito Creeks. On traversing this region, it was found to be entirely composed of the "Pliocene" sands, and to be very arid, with cedars scattered irregularly over the surface. The springs of Ojo Caliente number three, the most important issuing from a vertical ledge of gneiss, which is there traversed by a wide quartz-vein. The temperature of the warm springs is from 116° to 120°; they contain abundance of a Confervoid Alga. In the creek below, I saw a Cyprinoid Fish (*Gila pandora*, Cope), taken with the hook. Near to this point I first observed the Blue Partridge (*Callipepla squamata*, Vig.), which is readily distinguished, as it runs, by the white under side of its erect top-knot.

In descending the Rio Chama, the arenaceous bluffs are continually in view on the north side, and occasionally display layers of basalt alternating with the sandstones. In this situation, the basalt is at times concretionary. The bed which bounds the Rio Grande on the west terminates at the junction with the Chama in a high point. On the southwest side of the Chama, a similar stratum gives the mesa-form to the hills, nearly to its mouth. South of these, the Jemez Mountains rise in impressive proportions, and, extending southward, bound the Rio Grande Valley on the west.

The wide valley between the Jemez and the Sangre de Cristo ranges is almost entirely filled with the Santa Fé marls. Their sandy character is not favorable to agriculture, being scarcely preferable to the basalt, so that cultivation is confined to the narrow valleys of the tributaries of the Rio Grande. The intervening country is either absolutely naked or covered with cedars. Occasionally, as near San Ildefonso and near San Felipe, a fragment of the lava remains, protecting the underlying Pliocene beds, forming a flat-topped butte, generally termed a huerfano. The beds of the Santa Fé marls are alternately softer and harder calcareous sandstones and conglomerates, varying from white to greenish-gray and light rufous. They dip generally 10° to 15° toward the east, and away from the basaltic mass of the Jemez range. They contain the remains of extinct *Vertebrata*, mostly *Mammalia*, which have enabled me to correlate them with the Loup Fork Tertiary of Colorado and Dakota. The species discovered by our party number thirty-one, of which twenty-six are Mammals, three Birds, and two Reptiles. An enumeration of them is given in the last chapter of this report.

Twenty-five miles west of the Rio Grande, at San Ildefonso, the eastern masses of the Jemez Mountains rise. The greater part of this interval is occupied by a plateau which is traversed by more or less parallel ravines, which issue in the trough of the Rio Grande. The mesas which separate the ravines terminate abruptly, like the wharves of a city front. Their material consists of sandstone, conglomerate, and arenaceous marl, of whitish, gray, and drab colors, having a gentle dip to the northwest. Many of their upper beds contain numerous pieces of pumice, which readily disintegrate, and the resulting siliceous dust, under the influence of wind, excavates the surrounding sandstones into caverns and pigeon-holes of many sizes and shapes. Nearer the mountains, the northwest dip of the beds is distinct, and they accordingly present escarpments to the southeast and gentle pine-covered slopes to the northwest. The ravines have a northeast and southwest direction, and extend to the base of the mountain. The escarpments are composed of orange-colored and reddish rock of uniform constitution, which breaks into prism-like masses as it falls, forming taluses below. It is entirely distinct in character from that of the bluffs nearer the river, which form part of the Santa Fé Tertiary marls, as proven by the occurrence of the bones of *Mastodon* and *Aceratherium jemezanum*, Cope, near Santa Cruz.

The orange beds are doubtless older, and were afterward seen on the Chama River; but I was unable to determine their age or their precise relation to the overlying sands and marls. They are covered near the mountains by a mass of basalt, which forms the floor of a higher mesa, from which rise the basaltic cones of the Jemez Mountains. Some of their peaks were doubtless sources of discharge of lava at a former period. I did not observe that the orange beds were tilted, or rested other than nearly horizontally against them.

In the ascent of the Rio Chama, we pass over the Santa Fé marls exclusively until reaching the town of Abiquiu. Here are bluffs of 700 feet elevation, of a soft sandstone, having the same character and dip (10° to 15° northwest) as those above described as at the eastern base of the Jemez Mountains. In a bay on the western side of one of these bluffs is a patch of picturesque bad-lands of the Santa Fé marls. Five miles above Abiquiu, the brilliantly-colored yellow and red beds, which form such an important feature in the geology of Western New Mexico, appear in high bluffs on the north side of the river. They are several hundred feet in thickness, but, near the Rio Chama, descend so as to permit of a view of their relations to the superincumbent beds. The brightly-colored beds are cut by a ravine to a depth of about one hundred and fifty feet. The upper portion is yellow, and they dip 25° southwest. They are overlaid by a shale of fifteen feet in thickness, whose laminæ are frequently contorted. The lower part of the bed is finely laminated, and the upper portion consolidated into a very hard rock. Above it is a bed of twenty feet, of a very coarse conglomerate, whose cement is arenaceous.

These details are entered into for the purpose of exhibiting the unconformability between the late Tertiary beds of the Rio Grande Valley and the formations constituting its western shores. The beds just described are believed to correspond with those called Jurassic in the section taken at Colorado Springs, and quoted earlier in this chapter. Red beds, supposed to correspond with the Trias of the same section, were observed by me to form the northern boundary of the basin a few miles north of the town of El Rito, east of the Rio Chama. These beds crop out in high bluffs, and doubtless formed the precipitous western shore of the fresh lake which, during the Loup Fork epoch, filled the valley of the Rio Grande from its upper waters to an unknown distance toward Mexico.

These red and variegated beds cover the stratigraphical axis of the Sierra Madre at this point, although not the water-shed between the waters of the Rio Grande and Rio Colorado. The geology west of this point has been considered in the divisions devoted to the Mesozoic formations of the Sierra Madre and the Eocene area west of it.

The earliest information which we possess respecting the existence of Vertebrate remains in the lacustrine deposits of the Rio Grande Valley is due to the interest displayed by Hon. William F. M. Arny, then governor of New Mexico. He obtained, from the region northwest of Santa Fé, the fragments of a lower jaw of a *Mastodon productus*, Cope, and sent them to the Smithsonian Institution. This specimen formed the subject of a description by Dr. Leidy, who referred the species to his *Mastodon obscurus*. The next observations of Vertebrate fossils were made by the members of the Wheeler survey of 1873. Francis Klett and Dr. O. Loew obtained a number of specimens from near San Ildefonso. Following the directions of these gentlemen, I made the examination during the season of 1874 which resulted in the discovery of thirty-one species of *Vertebrata*, of which all but four are determinable. Some of these have been already described in my report, published in the Annual Report of the Chief of Engineers for 1874, page 603.

The Placita marls, alluded to in the beginning of this chapter, were examined by me during an exploration of the eastern base of the Sandia Mountains. Facilities for the accomplishment of this purpose were kindly placed at my disposal by General Gregg, at that time commanding the district of New Mexico.

A section carried across from Algodones on the Rio Grande to the Sandia Mountains, through the village and creek of Placita, gave the following results: The road winds among and ascends for several miles, mesas of coarse Tertiary gravel and cobble-stones until it reaches a wide plateau, from which the mountains rise on the east. This tract is traversed by

Placita Creek and its tributary arroyos, which furnish interesting sections. From these it appears that the greater part of the plateau consists of the yellow, muddy shales and sandstones of Cretaceous No. 3. They form the bottoms, and sometimes the walls of the arroyos, and rise in low monoclinal hills at various points on the plateau. The beds dip N.W. 20° to 40°. In the intervals between the hills, there is a deposit of indurated clay of 40 feet in thickness, of Postpliocene age. I obtained teeth and other bones of *Elephas primigenius* subspecies *columbi* from this bed, and found bones of Elephants in place in the banks of the arroyo. Shells of *Planorbis*, *Physa*, &c., indicate the lacustrine character of the deposit, which I have called the Placita marl.*

The descriptions and determinations of the species of the Santa Fé and Placita marls were published in the following essays:

1874.—Proceedings of the Philadelphia Academy, p. 147, Notes on the Santa Fé marls, and some of the contained fossils, by E. D. Cope.

1874, November 28.—Report upon Vertebrate fossils discovered in New Mexico, with descriptions of new species, by E. D. Cope, p. 15. Annual Report Chief of Engineers, pt. 2, p. 603.

1874.—Annual Report of Chief of Engineers, ii, p. 603.

1874.—Proceedings Academy Philadelphia, 221, On a new *Mastodon* and Rodent.

1875.—Proceedings Academy Philadelphia, p. 255, On fossil Lemurs and Dogs.

1875.—Proceedings Academy Philadelphia, 257, On the Antelope-deer of the Santa Fé marls, and the age of the formation.

1875.—Proceedings Academy Philadelphia, p. 258, On some new fossil *Ungulata*.

1875.—Proceedings Academy Philadelphia, p. 261, The phylogeny of the Camels.

1875.—Proceedings Academy Philadelphia, p. 271, On an extinct Vulturine Bird.

1875.—Annual Report of Chief of Engineers, ii, p. 988, On the Vertebrate paleontology of the Santa Fé marls; *l. c.* 986, On *Mastodon* from Taos; *l. c.* 997, On *Elephas* from Placita.

1876.—Proceedings Philadelphia Academy, July, on *Canis wheelerianus* and the evolution of the camels.

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*Annual Report of Chief of Engineers, 1875, p. 997.

4.—DESCRIPTIONS OF MESOZOIC VERTEBRATA.

PISCES.

?PERCESOCES.

SYLLÆMUS, Cope.

Report U. S. Geol. Surv. Terrs., ii, p. 180.

Allied to the *Mugilidæ*. A short, spinous dorsal fin; ventral fins abdominal, posterior to the spinous dorsal. Pectoral fins subinferior in position. Coracoid bones forming a compressed, keeled body. Scales large, cycloid; lateral line present, extending along the middle of the sides. Parietal bones less than epiotics, entirely separated by the supraoccipital. Frontal bones large, wide, their common suture distinct.

The opercular apparatus extends obliquely backward, while the mandible is produced forward. Hence the inferior part of the hyomandibular and the symplectic are directed obliquely forward. The end of the muzzle is broken off, but the posterior part of the dentary bone does not exhibit any teeth. The opercular bones are thin, and their inferior borders reach the median line of the inferior side of the head.

The only species of this genus which has fallen under my observation is represented by a specimen in which the body posterior to the femoral bones is wanting. The surface is covered with scales, so that only the outlines of those bones can be distinctly seen. They are thickened, and curved outward; those of opposite sides are well separated from each other. The scales exhibit a very delicate concentric line-sculpture.

The very posterior position of the ventral fins distinguishes this genus from *Mugil*, while the inferior position of the pectoral fins is not seen in *Atherina*. The lateral line does not occupy the inferior position seen in the *Scombresocidæ*. As compared with *Apsopelix*, Cope, from the Benton group of Kansas, *Syllæmus* differs in the absence of dorsal radii or interneural spines anterior to the ventral fins. There is doubtless some affinity between the two genera, as the other characters are quite similar. I was unable to detect a lateral line in *Apsopelix*. It is possible that a catalogue-name of Agassiz, viz, *Calamopleurus* (Poiss. Foss., v, p. 122), refers to this or some allied genus; but I am unable to discover that it has ever been described.

Syllæmus latifrons, Cope.

Report U. S. Geol. Surv. Terrs., ii, p. 181.

Represented by the entire head and body of a fish as far as the basis of the ventral fins, excepting the end of the muzzle. The scales are completely preserved, while only the bases of the fins remain.

The body is subcylindric, while the head is broad and flat above. The inferior side of the head is contracted; the coracoids forming a keel, and the lower borders of the dentary bones being in contact. The angular portion of the dentary is strongly grooved on its inferior surface, and the proximal or anterior parts of the operculum display a radiate sculpture. The top of the head is smooth, excepting a slight radiate sculpture of the parietals. The outline of the parietals is subround, and a little more extended than that of the supraoccipital, which is a short longitudinal oval.

There are twenty-six or twenty-seven longitudinal rows of scales, or thirteen on each half; those of the abdomen not differing from those of the sides. The lateral line runs along the eighth below the dorsal fin, originating just above the base of the pectoral fin. There are nine rows of scales between the occiput and the first dorsal ray. I count the bases of fifteen dorsal radii, which are all fissured anteriorly, excepting the first, which is rudimental. The anterior rays are stouter than the posterior, and they embrace the posterior part of the ray in front of them by the basal fissure. The posterior rays are much narrowed, and embrace but little. The pectoral rays are numerous. The physiognomy of this fish is rendered peculiar by the depressed form of the snout, with the narrow under jaw. It is impossible to be sure whether the muzzle was elongate or not.

Measurements.

	M.
Length of the specimen to the base of the ventral fin	0.205
Length of the specimen to the base of the dorsal	0.090
Length of the specimen to the base of the pectoral	0.075
Length of the specimen to the edge of the operculum	0.071
Length of the specimen to the edge of the preoperculum	0.055
Length of the specimen to the condyle of the mesopterygoid	0.029
Length of the specimen to the orbit	0.017
Diameter of the front between the orbits	0.020
Diameter of the body at the middle of the dorsal fin	0.045
Depth of the body at the middle of the dorsal fin	0.050

The specimen was originally stated to me to have been found "near the summit of Pike's Peak," Colorado. I remarked on this, that "the specimen has the appearance of having been derived from the Cretaceous beds, probably of the Niobrara epoch (No. 3), which are extensively exposed along the eastern base of that mountain." More full information leads to the belief that it was obtained from some point in New Mexico.

REPTILIA.

CROCODILIA.

The only Mesozoic *Reptilia* discovered by the expedition of 1874 were obtained from the so-called Triassic red beds of the western side of the Sierra Madre, on the Gallinas Creek, as already stated in the geological description. They are in a fragmentary condition, but of great interest, as being the first fossils discovered in that formation in the Rocky Mountains. With the Reptilian remains are the rhomboganoid scales of small Fishes, which are abundant in the coprolites of the Crocodiles. The Reptiles represent three orders of *Crocodiles*, *Dinosauria*, and apparently of *Sauropterygia*. The Dinosaurian order is represented by a part of the crown of a tooth of a species of large size, of the general character of *Lœlaps*. Both faces are convex, the one more so than the other, and the long axis of the crown is curved toward the less convex side. Both cutting-edges are sharply and closely crenate-denticulate, as in *Lœlaps*, *Megalosaurus*, &c.; otherwise, the enamel is perfectly smooth. There was not enough of this animal discovered to enable me to identify it. The suspected Sauropterygian species is represented by a single vertebra, with the centrum slightly depressed, with circular section, and about as long as wide. The neurapophysis appears to have been united by suture, although this point is not so clear as desirable, and the bases of the diapophyses are very stout, extending the entire length of the upper half of the lateral surface of the centrum. Of the articular faces, one is much more concave than the other. Length of centrum, $0^{m}.05$; width, $0^{m}.057$; depth, $0^{m}.055$. The Crocodilian remains consist of a portion of a jaw-bone with alveoli for four teeth, of a broken vertebra, and a number of dermal scuta and fragments of other bones. At another locality, not far distant, were found numerous remains of Saurian bones, embracing dermal and cranial pieces, coprolites, a fragmentary tooth, &c., which may have some affinity to these. The species indicated by the former has been described and named as follows:

TYPOTHORAX, Cope.

Proc. Acad. Phila., 1875, p. 265; Ann. Report Chief of Engineers, 1875, p. 1004.

The fragment of jaw belonging to this genus is probably maxillary in position, for the following reasons: The interior face of the bone is sutural, and for the most part solid. This would refer it to the position of the symphyseal portion of the dentary bone of a gavial-like form, but for other considerations. Supposing the piece to be dentary, and the suture therefore vertical, the incongruity follows that the alveolar face becomes very steep, so much so as to prevent the interlocking of the teeth, which become lateral in position. If, however, the jaw fragment be reversed in position, and the alveolar face placed in a horizontal position, the suture of the inner side forms a sharp angle with the vertical plane, as it should on the supposition of its being the maxillary bone. The wedge-shaped section necessary to fill the space between it and the median plane will then be that of the prolonged posterior spine of the premaxillary bone. The solidity of this portion of the muzzle is inconsistent with the gavial genera of the Jura and later times, but not with the structure of the Triassic Belodons. The posterior part of the inner face is, however, strongly excavated, and the sutural margin exhibits an outward deflection, which is either the boundary of the nostril or the suture for the apex of the prefrontal or nasal bone. In either case, the nasal cavity and the nostril are posterior in position in conformity with the structure of the "Thecodont" *Crocodilia.* The alveoli are large and arranged in a curved line, one of them somewhat exterior in position and isolated by a short diastema like a canine. Surface of the bone pitted. The dermal scuta found close to the jaw fragment have a flat upper surface marked with shallow pits rather closely placed, having resemblance to an obsolete Trionyx sculpture. Near one of the margins of the bone, the pits run out in shallow grooves. A portion of a vertebral centrum found with the jaw exhibits one articular face; this is shallow, concave, of the type of the Amphicœlian division of *Crocodilia.* The body of the centrum is much compressed.

The other remains include a portion of a dermal bone like those described, and the crown of a tooth, among other fragments. This crown, which has lost most of its enamel, is triangular in section, and somewhat curved in its long axis. A convex face is directed forward and outward (on the supposition that the tooth is superior), and a nearly plane face posteriorly. The inner face is worn flat by the attrition of an opposing tooth. The pulp-cavity is minute or wanting.

Typothorax coccinarum, Cope.

Plate xxii, figs. 1-9.

Proc. Academy Phila., 1875, 266; Ann. Report Chief of Engineers, 1875, p. 1004.

The pitting of the maxillary bone is not linear, and is sometimes round; it is rather remote. The outside of the bone is steep, indicating that the muzzle is not depressed. Its face is swollen opposite the supposed canine tooth. The alveolæ are round and longitudinally oval. The alveolar face is decurved near the end of the muzzle. The superficial layer of the cranial and dermal bones is dense and fine-grained. The second series of specimens, whose reference is by no means certain, but which contains a dermal bone like that of the type, includes fragments apparently of the upper surface of the cranium. This is marked with irregular tuberosities and excavations resembling that seen in the Belodonts of the Carolinian and Würtembergian Trias. A section of a narrow dermal bone displays an elevated, obtuse, median keel, the only bone which displays this form in the collection, the usual form being either flat or slightly concave. Accompanying the same, are numerous coprolites, which are apparently too small for an animal of the dimensions of the type-specimen. They are slender, and display rectal folds, which do not exhibit a continuous spiral. They are found, wherever fractured, to be filled with the rhomboganoid scales of some small fish.

Measurements.

	M.
Length of fragment of maxillary	0.095
Depth (oblique) at ? nostril	0.050
Depth (vertical) at ? nostril	0.045

Width (median) at ?nostril		0.025
Width at front alveolus		0.035
Diameter of canine alveolus		0.015
Diameter of another alveolus		0.011
Diameter of centrum of (?caudal) vertebra	transverse	0.024
	vertical	0.022
Thickness of dermal shield		0.008
Measurement across four fossæ of same		0.020
Diameter of crown of tooth No. 2		0.018
Length of coprolite of No. 2		0.045
Diameter of coprolite of No. 2		0.011

The flat and regularly-pitted dermal bones distinguish this genus from *Belodon.* The species was of large size, the cranial fragments equaling corresponding portions of the Gangetic gavial.

CLASS?

DYSTROPHÆUS, Cope.

This genus reposes on scanty remains, but which are in good preservation, and which present marked characters. The bones consist of the humerus, three metapodials, some ?carpals, and the distal end of an ?ulna, with a probable sternum and an inferior element of either the scapular or pelvic arch, probably the latter. There is also a number of fragments, which are not easily identified. The specimens were discovered by Prof. J. S. Newberry in Southeastern Utah, while acting as geologist to the Engineer Exploring Expedition under the command of Capt. J. N. Macomb, United States Army. He excavated them from the red and green rocks usually referred to the Trias, hence from the same formation which yielded the *Typothorax* already described. Professor Newberry made sketches of the bones as he exposed them. They were all, he states, found in close proximity, the bones of the limb in nearly normal relation. It is altogether probable, according to Professor Newberry, that they belong to a single animal. I find nothing to forbid this supposition and much to confirm it.

One of the most remarkable bones is a broad, flat element, one of whose borders is digitate, the processes being long, and separated by deeply entrant sinuses. Two sides of the bone are broken away, but the others give origin to five digitiform processes. Two of these are larger and longer than the others, and externally on the right side is a shorter one. Outside of this is a larger process, whose extremity is recurved so as to be subparallel with the longer processes, and which was connected with another bone by an articular surface. This information is derived from Professor Newberry's notes made in the field. It is probable that this bone is the sternum, and that the articulation mentioned is costal. It is not certain whether the longitudinal median line passes through a sinus or a digitation; but a projection of the surface of the plate, which is probably median, is opposite one of the latter. Supposing, then, that the sternum is produced into a median posterior process, we find a resemblance to the corresponding element in many birds not heretofore known among reptiles. There are in that case three postero-externally directed processes on each side, of which the two posterior are free. Another interpretation might be that it is a coracoid with anterior digitations. In this case, the articulation above mentioned would be anomalous. The number of digitations is too great for this element, and the space remaining for contact with the sternum is too small.

Another large flat bone approximates a right-angled triangle in form, the length greatly exceeding the width. The right angle is massive and produced, and is evidently the point of connection with the other parts of the skeleton. The bone is flat on one side and convex on the other, and can only be identified with probability with the scapula of a Dinosaurian reptile.

The large size of the anterior limb, which might be inferred from this scapula, is justified by the humerus, which is preserved in almost perfect condition. This humerus is one of the longest, and is distally the most contracted known in the *Dinosauria*. The proximal extremity is of the form usual in that order. A short distance below the head, the section is T-shaped, with one end of the transverse limb shorter than the other. The ridge of which this limb is a section is almost wanting at the head, which is thus Γ-shaped. The limb representing the stem of the T, is stouter than the others, and forms the summit of a massive column, which soon sinks into the shaft. Its free extremity is obtuse and rounded, and, though representing the head, does not rise above the level of the other crests or tuberosities. The distal extremity of the humerus looks much like that of a tibia. It is truncate, and its long axis is in the plane of the tuberosities of the head. Its outline is oval, one end narrowed to an angle and the other broadly rounded. The surface is roughened with coarse pits.

The distal extremity of another long bone, most probably the ulna, is more robust than that of the humerus. The shaft is a flattened oval, and the articular extremity is a wide and somewhat irregular oval, the greatest transverse diameter being nearer one end. The articular surface is roughened with coarse pits.

Three metapodials were found in immediate proximity to each other, two in nearly their normal relations and one slipped forward. They are neither remarkable for length nor abbreviation. The proximal ends are truncate and the distal ones convex, but without distinct median grooves or lateral angles. Both extremities are moderately expanded, and the shafts are contracted at the middle. The external bone is a little shorter than the two others, and is more flattened. It has a slightly defined convex head, with an adjacent prominent but ill-defined lateral crest. The larger of the longer bones has a crest at one angle, like that of an olecranon process. The proximal end of the same bone is massive, and is trapezoidal in outline. The outline of the corresponding head of the adjacent bone is triangular. A marked character of these bones is the rough or pitted surface of their articular extremities, except the distal end of the shorter bone. The shafts are solid, and filled with nearly equal coarse cancelli.

The bones above described are evidently those of a Dinosaurian reptile, and they present characters which have not been previously observed in any other genus of the order. The form of the articular extremities of the humerus distinguishes it from the other known genera, especially from those of the European Trias.

The rugose articular surfaces are also peculiar, indicating less than the usual mutual movement of the bones upon each other. A cartilaginous cap is indicated, which was probably the element from which the mammalian epiphysis was derived. The sculpture of the surfaces is coarser than that to which epiphyses are attached in the *Mammalia*. The name of the genus expresses this character.

It is altogether probable that this genus embraced terrestrial animals, with powerful fore and hind limbs subequally developed. The typical species is of gigantic proportions.

Dystrophæus viæmalæ, Cope.

In the supposed sternum of this animal (which I have not seen, but which was sketched by Professor Newberry), a rather small, slender, and compressed process projects from near the middle of one of the sides at right angles to it. Only two of the lateral processes are represented as complete. The longer is subspatulate; the shorter subacuminate. The scapula presents three complete borders,—the proximal and two lateral; but the distal is not known. Without it, the length is two and one-half times the breadth. The point of junction of the longer (and perfect) short border with one of the long borders is much thickened, terminating in a mass of bone which is unfortunately broken, but whose section in the line of the end border is a wide oval. From this point, the plate thins away to the various borders. The greatest thickness is nearer the border which terminates in the enlargement described. This surface is then gently convex in transverse section, while the opposite one is concave to a less degree. It is thicker at the middle than at the anterior border in a longitudinal direction.

The proximal extremity of the humerus is much expanded. The greater tuberosity is a huge crest, as prominent as the head, and separated from it by a marked concavity, which constricts the mass connecting it with the head, thus forming a neck. This concavity extends about one-third the length of the shaft. On the opposite side of the head, a similar concavity excavates the shaft, separating the internal from the interior ridge. The latter is in its middle portion as prominent as the external ridge, and extends as far downward. The extensive external face of this part of the bone is nearly flat.

The internal ridge, descending from the head, continues into the posterior border of the interior face of the shaft. The great tuberosity continues into the single external ridge of the shaft, which is thus near the middle triangular in section, the base of the triangle internal. The external extremity of the distal end is therefore an angle, and the internal a convex side, shorter than the anterior and posterior sides. A ligamentous groove marks the posterior border of the extremity at a point measuring one-third of its length from the external angle. The expanse of the distal extremity is not more than three-fourths that of the proximal. The entire bone so resembles a tibia as to have induced me to refer it at first to that element. The characters of the proximal end are such as to render such identification highly improbable. Such reference would also require that the distal extremity should have a fore and aft direction, an arrangement incompatible with the tibia.

The displaced metapodial is flattened, and expanded at the extremities. One side is nearly flat, but slightly concave in the longitudinal direction; the other side is convex and nearly level in the longitudinal direction. The lateral borders of the shaft are thus narrowed. The distal end displays a convex condyle, and a flat, prominent ala, which is in the general plane. The ala is separated from the condyle by a deep groove on the convex side. The condyle is a half-hemisphere only, presenting only with the convex side of the shaft, from which it is not separated by a constriction. It is bounded at its distal edge by an angle, which is a continuation of the proximal edge of the ala. The proximal extremity is injured at one angle, but, with this complete, would be nearly a regular rhomboid with parallel longer and shorter outlines; the acute angle of the latter being the continuation of the lateral border of the shaft. The extremity is subtruncate, and part of the surface is irregularly excavated by pits and grooves. The transverse extent of the proximal end, when perfect, was probably a little greater than that of the distal.

The two adjacent metapodials are subequal in length, and longer than the displaced one by one-fourth the length of the latter. One of these bones is throughout rather thicker than the other, although the transverse diameter of the shafts is equal; but the stouter bone is considerably more dilated at the extremities. The distal end of the stouter bone is thickened in the direction at right angles to the plane of the limb; but the chief expansion is in that plane. The angle next to the other bone is protuberant, while the other angle is expanded into a sharp, convex crest, or ala. A section of this extremity is diamond-shaped, with one of the lateral planes produced into this crest, while the corresponding border of the opposite side drops down, being represented by a mere convexity of the surface, which continues to the crest. The surface of the extremity is irregular. The section of the shaft is a broad oval, becoming subcircular near the proximal extremity. The latter is enlarged in both directions. It is a rectangle in outline, a little extended in the plane of the limb, with one of the angles cut off from the corresponding angle to the middle of one side. The long side thus left is slightly convex, and ends in an angle. The side subtended by this angle is slightly concave, and is approximated to the other bone. The opposite side is slightly emarginate near the middle. Its surface is very slightly convex, and is irregularly grooved and pitted.

The more slender of the two bones is but little and about equally expanded at the opposite extremities. The distal end would have an ovoid section, but for the fact that it is obliquely truncate at the extremity next to the other bone. It is convex in the antero-posterior direction and plane in the transverse; its surface is grooved and pitted. The side next to the other bone is flat or slightly concave at the distal end, and, though thicker than the external border, becomes rounded at the middle of the shaft, and is again flattened at the proximal extremity. The external border is distally produced into an obtuse angle; lower down, the shaft has a thin, angular border. The proximal end has less antero-posterior diameter than the distal, and is subtriangular in outline; the apex being acute and external. The surface is flat, and is strongly marked with deep grooves. The other surfaces of the limb-bones are smooth, except a few weak ridges near the distal ends of the two distal bones.

Measurements.

		M.
Length of the part of the scapula preserved		0.680
Width at the middle		0.270
Thickness at the middle		0.048
Thickness at the proximal angle		0.117
Total length of humerus		0.765
Diameter of the proximal end	at the head	0.080
	at the tuberosities	0.225

Diameter of the shaft	antero-posterior	0.080
	transverse	0.078
Diameter of the distal end	antero-posterior	0.085
	transverse	0.145
Transverse diameter of the head of the humerus		0.160
Diameter of the extremity of the ?ulna	antero-posterior	0.110
	transverse	0.150
Length of the external metacarpal		0.210
Proximal diameter	antero-posterior	0.045
	transverse	0.100
Diameter of the shaft	antero-posterior	0.033
	transverse	0.067
Diameter distally	antero-posterior	0.050
	transverse	0.115
Length of the median metacarpal (stouter)		0.245
Diameter proximally	antero-posterior	0.057
	transverse	0.115
Diameter of the shaft (transverse)		0.055
Diameter distally	antero-posterior	0.074
	transverse	0.083
Length of the median metacarpal (slender)		0.240
Diameter of the proximal end	antero-posterior	0.057
	transverse	0.089
Diameter of the shaft (transverse)		0.049
Diameter distally	antero-posterior	0.041
	transverse	0.083

More than usual interest attaches to this fossil. It is the first one found in the Triassic beds of the Rocky Mountain region, and was derived from an inhospitable region rarely traversed by white men. The locality is in the Painted Cañon, not far from the Sierra Abajo, in Southeastern Utah, near the Colorado boundary; latitude 38° 15′, longitude 110°. This cañon is one of those tributary to the Great Colorado River, and is without water. The rock is described by Professor Newberry as the same as that which I have identified in New Mexico as the Trias, and is of the usual red color. The occurrence of a terrestrial Dinosaurian at that locality tends to confirm the conclusion to which I have already attained, that this immensely extended deposit is of lacustrine character.

Professor Newberry gives an interesting account, in his report to Captain Macomb,* of the locality in which the bones of this reptile were found.

*Exploring Expedition from Santa Fé to the Junction of Grand and Green Rivers, 1859, p. 91 (1876).

He regarded them as belonging to a Saurian, and adds that he found in the same stratum the only fossil shells he had ever seen from that formation in New Mexico. These have the form of *Natica*, "but are probably not susceptible of accurate classification".

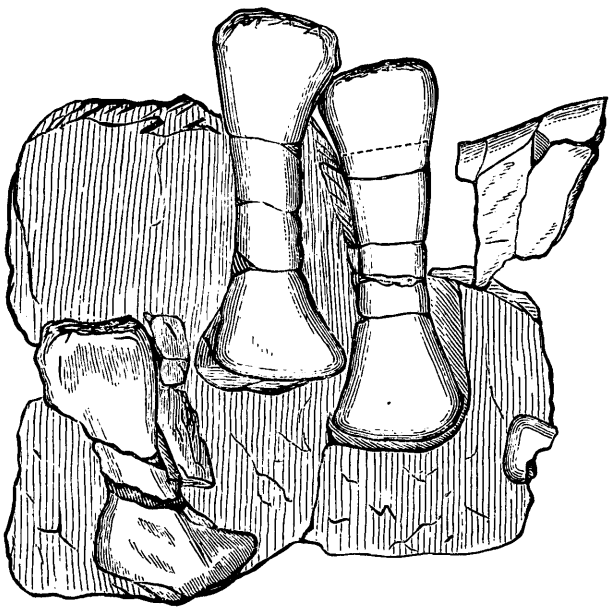

FIG. 3.—Metapodials of *Dystrophæus viæmalæ*.

CHAPTER XII.

THE FOSSILS OF THE EOCENE PERIOD.

PISCES.

The remains of fishes are abundant in the Wahsatch formation in Northwestern New Mexico. The families and orders represented are few, and present striking differences from, as well as resemblances to, those of the Bridger formation. The predominant family in New Mexico is the *Lepidosteidæ*, or Bony Gars, which are also abundant in the Bridger beds; but, in the latter, they are associated with equally numerous *Amiidæ* and *Siluridæ*, of which no trace has been discovered in New Mexico. Further, the teeth of Sharks occur sparingly in the latter region in the same beds with the Gars, while, in the Bridger beds of Wyoming, this group of animals is entirely wanting.

The remains of *Lepidosteidæ* are found everywhere, and in place. The teeth of the sharks are always more or less worn or rolled, and are most common in a bed of coarse sandstone which lies near the middle of the series. This bed also contains the teeth of Mammals, *e. g.*, *Hyracotherium*, *Phenacodus*, &c., in a similarly worn condition. Fragments of oyster-shells also occur in the same neighborhood; those that I procured not being in place as were the teeth. As the Eocene lake is supposed to have been fresh, and as the *Lepidostei* are not marine fishes, it becomes questionable whether the Oysters and Sharks are not intrusive fossils, derived from the adjacent Cretaceous strata which formed the shore of the ancient lake. In support of this view, I may state that I obtained one species, the *Galeocerdo pristodontus*, Agassiz, from both Eocene and Cretaceous formations, the latter in an unworn condition. In opposition to it, I may add that the Mammalian teeth accompanying those of the Sharks are not transported from another formation, and there is nothing to show that the origin of the two was different. A similar state of things exists in the siderolitic Eocene beds of the canton Vaud, Switzerland, where Mammalian bones are mingled with Sharks' teeth. M. La Harpe remarks respecting these, that there is nothing to show that these teeth are not in place in the Eocene beds, and no evidence that they have been transported. The genera of Sharks observed by me in New Mexico are still existing (*Lamna*, *Galeocerdo*, &c.), and are strictly marine. The cause of their occurrence in beds usually supposed to be lacustrine cannot be stated; but, as *Mollusca* are almost wanting from the latter, there is no evidence to disprove the supposition that the ancient lake had open communication with the ocean, and that its waters were, at one time at least, more or less salt.

The species, so far as determinable from the injured state of the specimens, are known Cretaceous and Tertiary forms. They are *Lamna texana*, Roemer, and an undetermined *Lamna;* an *Oxyrhina* or *Otodus*, undetermined; *Galeocerdo pristodontus* and *G. ? aduncus;* and a fragment of a large tooth, with straight denticulate edge. These teeth are figured on pl. xxii, figs. 18–19. The remains of *Lepidosteidæ* come next in order.

GINGLYMODI.

Two genera of this order are known from the Tertiary formations of North America; *Clastes*, from the Eocene, and *Pneumatosteus*, Cope, from tho Miocene beds. The former has only been found in the Rocky Mountain region, the latter in the East, in North Carolina. The existing species are confined to North and Central America, and belong to two genera, *Lepidosteus* and *Atractosteus*.

CLASTES, Cope.

Annual Report U. S. Geol. Survey. Terrs., 1872, p. 633.

Clastes aganus, Cope.

Plate xxiii, figs. 10–29.

This Garfish is represented by a number of fragments of the cranium, several vertebræ, and numerous scales, belonging to one individual. Less numerous portions of many other individuals were found, which do not present specific differences.

The cranial bones of the superior walls are rather thick. Their superior surface is thrown into obtuse folds, or ridges, which inosculate extensively, leaving interspaces of about their own width. The summits of these ridges are not ornamented with small plates, or bands, of enamel, as is usual in many Eocene species, except in some small dots near the borders of one of the thinnest cranial bones. It has occurred to me that this lack might be due to attrition; but the character is uniform in several specimens otherwise unworn, and with the enamel of their scales in good preservation, so that I cannot attribute it to this cause, and have given the species a name in allusion to it. About an inch of the basi-occipital bone is preserved. It displays the typical characters of *Lepidosteus* in its projection posterior to the exoccipitals and its strong inferior longitudinal groove. It is deeply excavated for the spinal cord.

The vertebræ are all dorsals, beginning with the one succeeding the basi-occipital. The first is smooth and slightly excavated on the middle line below, and strongly excavated for the neural canal. The diapophysis is small and subcylindric, and there are two small pits at the base of the neurapophysis. The second dorsal has a flattened face below, which is marked with several shallow longitudinal grooves. Two stronger ones appear below the cylindric diapophysis, and a profound one at the base of the neural arch. The dorsals, which follow after a short interruption, begin to be a little longer, and have the characteristic deep longitudinal pit on the lower part of the side of the centrum. These leave the inferior face as a rather wide rib, which widens slightly in the posterior direction. Its surface is interrupted by a median and one or two lateral grooves. There is a deep longitudinal pit at the base of the neurapophysis, and a depressed smaller one at the superior posterior base of the diapophysis, and another like it at the inferior anterior base. Posterior to these vertebræ, the centra become a little longer, and narrower at the articular extremities. The median groove of the narrow inferior plane alone remains. The superior border of the articular cup is, in all the vertebræ preserved, excavated by the neural canal; the excavation of the ball is less marked or wanting. In the anterior vertebræ, both articular extremities are excavated on each side below the middle in correspondence with the lateral fossæ, so as to produce a short T-shape. This excavation becomes less, and disappears on the posterior vertebræ.

The scales are acute, and the ganoïne is entirely smooth. The two basal processes are of moderate length. The tube of the lateral line enters the posterior border, and issues on the inferior side of the scale at a point from two-fifths to one-third the length from the apex.

In size, this species was similar to that of the *Atractosteus ferox* of the Mississippi.

Four species of this genus have been described, and an additional one (*Lepidosteus simplex*, Leidy) figured. The former are the *C. anax*, Cope, *C. cycliferus*, Cope, in the Annual Report of the United States Geological Survey of the Territories of 1872, and *C. atrox* (*Lepidosteus*, Leidy) and *C. notabilis* (*Lepidosteus*, Leidy) in the Report of the United States Geological Survey of the Territories, I, p. 189. The *C. aganus* differs from these in the following particulars: Its "posttemporal" bone is but one-fourth the size of that of *C. anax*, and is less profoundly sculptured; it has not the ganoid cranial ornamentation and rounded scales of the *C. cycliferus*. The articular faces of the vertebræ are more depressed than in the *C. atrox*, and are excavated on their inferior borders in a way not seen in that species. In an anterior dorsal of *C. notabilis*, the floor of the neural canal is convex at the border of the centrum, a character which does not belong to any of the vertebræ of the *C. aganus*.

Measurements.

			M.
Thickness of a superior cranial bone			0.005
Diameter of basioccipital cotylus	vertical	lateral	0.015
		median	0.010
	transverse		0.023
Width of inferior basioccipital groove			0.007
Diameter of second dorsal	vertical (median)		0.011
	transverse		0.018
	longitudinal		0.010
Diameter of anterior dorsal	vertical		0.0135
	transverse		0.0155
	longitudinal		0.014

Width of inferior rib of do. at middle		0.006
Diameter of more posterior dorsal	vertical	0.012
	transverse	0.015
	longitudinal	0.010
Depth of ganoid area of a scale		0.014
Length of ganoid area of a scale		0.020
Thickness of the same at the middle		0.0045
Width between posterior bases of exoccipitals		0.0085

Clastes integer, Cope.

Plate xxiv, figs. 1-16.

Gar, Cope, Ann. Report Chief Engineers, 1874, p. 592.

This species of Fish is represented by remains similar to those of the last, *i. e.*, by cranial bones, vertebræ, and scales. The characters of the surfaces of the first and last-named parts do not differ from those of *C. aganus*, but the vertebræ present peculiar features. The inferior face of the first vertebra is more deeply excavated than in that species. The inferior face of the centrum is not marked with the deep median groove so characteristic of the corresponding, and indeed of all the dorsal vertebræ of *C. aganus*, being smooth and entire. The lower part of the margin of the concave and convex articular faces of the centrum of the same vertebra is not excavated on each side, and these borders are nearly straight. In a second and smaller specimen, the inferiòr face is also entire, and the articular faces are subcordiform and regularly contracted below. The grooves of the inferior surface continue throughout the length of the column in the existing *Lepidosteus* of the Ohio.

The caudal vertebræ of the *C. integer* present the usual characters of the recent species. They have a narrow lateral rib and broad decurved parapophyses; the inferior surface has two narrow approximated ridges, inclosing a longitudinal pit with the parapophysis.

The scales are generally smooth, but a few near the ?scapular arch are marked with longitudinal linear interruptions of the ganoïne.

Measurements.

	M.
Length of first dorsal	0.008
Depth at middle	0.011
Width of centrum	0.026
Length of a median dorsal	0.015

Depth of centrum of same	0.012
Length of anterior caudal	0.019
Width of centrum do. (depressed)	0.013
Length of a median caudal	0.018
Depth of same in front	0.011
Width of same in front	0.012
Length of ganoid surface of a scale	0.019
Depth of ganoid surface of a scale	0.015

The points in which the *C. aganus* differs from the species heretofore described are shared by the *C. integer*, excepting those in which it differs from the *C. atrox*. The entire smoothness of the inferior face of the vertebral centrum distinguishes the *C. integer* from that species.

REPTILIA.

As is the case with the corresponding Eocene formations elsewhere, the most numerously represented class of *Vertebrata* is, after the Mammals, the *Reptilia*. But three orders are represented, which are all still existing, viz, the *Lacertilia*, the *Testudinata*, and *Crocodilia;* the *Ophidia* have not yet been found in the Wahsatch beds. The Tortoises are extremely numerous in individuals and species, and the Crocodiles only a little less so; remains of Lizards are comparatively rare.

LACERTILIA.

On several occasions, osseous cranial and dermal scuta of Lizards were obtained, but always in such a state of dislocation as to forbid the proper identification of the genera and species. They are ornamented on their superior surfaces by regularly-arranged tubercles, of a shining substance, resembling ganoïne, or enamel. The dermal scuta are rectangular, and display a fine suture on their borders.

The species probably belong to the *Placosauridæ* of Gervais, whose remains have been found in the Eocene of Europe. I give figures of some of the fragments on pl. xxxii, figs. 26–36.

TESTUDINATA.

The genera of Tortoises obtained number six. Of these, *Trionyx*, *Dermatemys*, and *Emys* still exist, while *Plastomenus*, *Baëna*, and *Hadrianus* are extinct, and, so far as known, characteristic of the Eocene period alone. The entire number has been found in the Bridger beds of Wyoming. Besides the descriptions from the carapace and plastron given below, mention may be made of some vertebræ whose correct reference cannot now be made. These are opisthocœlian, with well-developed zygapophyses, and a solid mass of a depressed-oval form for neural spine. The centra are compressed and elongate, and indicate a long tail, as in the genus *Chelydra*. The diapophyses are well developed, and the chevron-facets are excavated and continuous with the posterior cup.

TRIONYX, Geoffr.

Turtles of this genus were exceedingly abundant during the Eocene period in New Mexico. Over considerable tracts, where other fossils are rare, these are commonly found. They present considerable uniformity of sculpture, and mostly have the coarse character of the Cretaceous species rather than the delicate patterns of surface of the existing and many of the Miocene species. The only species which appears to be identical with those of the Bridger formation is the *T. guttatus*, Leidy.

All of the species are of considerable size, and the bones of the carapace and plastron are rather thick. The sculpture of the median portion of the carapace is in all a coarse, uninterrupted honeycomb; that of the plastron is of finer character. To *T. leptomitus*, Cope, I refer five individuals; to *T. ventricosus*, two individuals; to *T. cariosus*, Cope, five individuals; to *T radulus*, Cope, three; and to *T. guttatus*, three. Many other specimens are not finally classified, owing to the absence of the essential parts of the carapace, &c.

The characters are as follows:

I. Costal bones with transverse ribs at their distal ends:

A. The dermal ossification extending beyond the bases of the free rib-ends.

Trionyx leptomitus, Cope.

Plate xxvi, figs. 1-4.

Catalogue of Eocene Vertebrata, U. S. Geog. Survs. W. of 100th M., 1875, p. 35.

The costal ridges numerous, close together, and parallel; the hyposternal bones pitted, the pits separated by thick ridges or intervals.

In the typical specimen, the distal end of a costal bone is crossed by numerous parallel ribs separated by intervals very little wider than themselves, and which inosculate but little. Eleven of these ridges may be counted between the broken extremity and the free border. Associated with this specimen is a hyposternal bone, which is especially massive, and is convex on the inferior face. The twin gomphosial processes are remarkably short and stout. A smaller hyposternal bone, collected by A. R. Conkling, of the expedition of 1875, exhibits the same characters. It is unfortunately not accompanied by carapace.

A third specimen includes a number of portions of the carapace. The middle portions of the costal bones present the usual reticulate pattern, of smaller size than in the *T. radulus*, &c., and their distal portions are marked with closely-placed parallel ridges, which are frequently connected by cross-ribs. The superior layer of the costal bone projects like a roof over the base of the free portion of the rib.

Measurements.

	M.
Thickness of costal of No. 1	0.010
Length of fragment of the same	0.032
Width of base of twin processes of hyposternal of the same	0.024
Thickness of hyposternal of the same	0.008

Trionyx cariosus, Cope.

Plate xxvi, fig. 5-10.

Systematic Catal. Vert. Eocene, U. S. Geog. Survs. W. of 100th M., 1875, p. 35.

This is an abundant species in the New Mexican Eocene. While the proximal portions of the costal bones exhibit the usual honeycombed sculpture, the distal portions, for a considerable length, possess the longitudinal ridges only, or with only occasional connections between them. The difference between this species and the *T. leptomitus* consists in the relative remoteness of the ridges, which are separated by intervals of two and three times their width. The superior layer of the costal bones is produced far beyond the inferior or costal portion, causing a deep longitudinal grooving of the free border of the carapace. At the sutures, the pits are lengthened so as to continue across them, there resulting an unreticulated band extending on each side of each suture.

In a large specimen represented by many fragments, the postabdominal bone is thicker than any of the costals, and presents a rather short free margin round its lateral extremities. Its surface is simply honeycombed.

The hyposternal of the first specimen is flat, and presents a rather irregular reticulate sculpture medially.

Measurements.

	M.
Thickness of distal end of first costal, No. 1	0.011
Length of overhanging free edge of first costal, No. 1	0.012
Thickness of postabdominal bone, No. 2	0.015
Antero-posterior width of postabdominal bone, No. 2	0.046
Thickness of a costal bone medially	0.012
Thickness of another costal bone proximally	0.007
Width of another costal bone proximally	0.042

AA.—The superficial part of the costal bones not overhanging, but obliquely continuous with the free rib-extremity:

Trionyx radulus, Cope.

Plate xxvi, figs. 11-16.

Loc. cit., p. 35.

This turtle is nearly allied to the *T. cariosus*. As in it, the proximal portions of the costal bones and the vertebral bones are honeycombed, while the distal parts of the former are parallel-ribbed. Five to nine of these ribs can be counted from the free end. They are not closely placed, being narrower than their intervals. The size of the species is the same as that of *T. cariosus*, but the costal bones are more uniformly thinner.

Measurements.

	M.
Width of a costal bone, No. 1	0.044
Thickness of a costal bone, No. 1	0.006
Width of a vertebral bone, No. 1	0.029

Trionyx ventricosus, Cope.

Plate xxvi, figs. 17-23.

Represented by portions of three individuals from the collections of

1874 and 1875 respectively. The sculpture of the carapace of these differs from that of the other species in consisting everywhere of close and rather fine vermiform ridges, which are frequently interrupted, and as frequently inosculate. Some of the associated fragments have a tubercular appearance, while others are reticulate in a small pattern. The accompanying hyposternal bone is characterized by its downward convexity and the thickness of its external free border. The twin gomphosial processes are short and stout. The sculpture is in parallel wrinkles, which inosculate sometimes, and are sometimes interrupted.

While this species approaches slightly the *Trionyx leptomitus* in the sculpture of the distal part of the costal bones, and the form of the hyposternals, it may readily be distinguished by the totally different sculpture of the latter, and of the proximal part of the costals, and by the beveled edge of the superficial layer of the carapace, which does not overhang the free end of the rib.

Measurements.

	M.
Width of a costal bone proximally	0.025
Thickness of a costal bone	0.007
Thickness of a costal bone distally	0.008
Thickness of a hyposternal bone distally	0.008

This species is smaller than the others, but very stout.

II.—The pitted sculpture of the costal bones extending to their ends:

Trionyx guttatus, Leidy.

Trionyx guttatus, Leidy, Report U. S. Geol. Surv. Terrs. (4to), p. 176, pl. ix, fig. 1.
T. uintaënsis, Leidy, Cope, Syst. Catal. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., p. 35 (not of Leidy).

The distinguishing character of this species is expressed in the above definition of section II. To it must be added that the distal ends of the costal bones are beveled regularly to the free rib-extremity.

Almost the entire carapace of one of the individuals of this species was obtained by myself. The pitting is uniform and without interruption, extending even to the sutural edges of costal bones. It is strong on the vertebral bones, but, near the distal ends of the costals, becomes obscure; the border itself being smooth. The ribs separating the pits are coarse, but not so wide as the pits. From the suture of the first costal, it is evident that the nuchal was large and thick, and that it underran the costal, forming a beveled suture. Costal capitula wide. The costal bones are scarcely thicker distally than proximally, *i. e.*, from 7 to 9 millimeters.

I originally referred these turtles to the *T. uintaënsis* of Leidy, but now believe that they present rather the characters of the nearly-allied *T. guttatus* of the same author. Both have been found in the Bridger beds with the *T. heteroglyptus* and *T. concentricus* of the writer.

PLASTOMENUS, Cope.

U. S. Geological Survey of the Territories, 1872, p. 617.

The structure of the skeleton in this genus remains incompletely known in spite of the abundance of specimens which I procured in the Eocene beds of New Mexico. As already stated, it is allied to the genus *Trionyx*, but differs in some important points in the bones of the plastron. The hyosternal bones which I have seen in *P. multifoveatus* and *P. trionychoides* are generally like those of *Trionyx*, while the hyposternals, if I have correctly identified them, differ materially. These elements are preserved in the two species named and in *P. corrugatus*, and here they display a transverse width behind the inguinal region more like an Emydoid than a Trionychoid genus. The inguinal border is thickened, and at the bridge somewhat recurved. In *P. corrugatus*, there is a fontanelle at the supposed postabdominal suture, as in *Trionyx*, while there is no indication of one in the *P. trionychoides*. The hyosternals also display a more completed ossification than in *Trionyx*, in the fullness of the borders between the internal and external digitations. Thus, in *P. multifoveatus*, the internal border is regularly convex, and the processes for the episternal bone scarcely project beyond it. The external digital process projects more extensively, while the free ends of the ribs extend little or not at all beyond the border of the carapace. Among the various remains from Wyoming and New Mexico, no marginal bones have been found.

Portions of the skeletons of the species of this genus are very abundant in the Eocene of New Mexico. Though one seldom obtains an entire carapace or plastron, the form, size, and sculpture indicate that the remains belong to several species. The figures, composed of ridges, pits, etc., variously distributed, are often quite elegant. The species do not attain the average size of the Trionyches of the same era; but the *P. communis*, *P. lachrymalis*, and *P. multifoveatus* exceed in dimensions the living species of North American waters.

The species above named, in which the sternal characters are evident, are the only ones which can certainly be referred to the genus; but several others from the Eocene beds can with much probability be referred here also, the whole number being eight. Four species from the Fort Union Cretaceous beds have been referred to *Plastomenus*, but, as already remarked, as a provisional arrangement until their structure is better known. The *P. thomasii* is also of uncertain reference to this genus.

I. Surface without welts, or with the sculpture thrown into ridges:
 a. No ridge-lines:
  Surface with sharp, fine wrinkles .... *P. corrugatus.*
  Surface with more remote wrinkles, little inosculating .... *P. trionychoides.*
  Surface honeycombed with thick, inosculating ridges .... *P. multifoveatus*
 aa. Sculpture thrown into ridges:
  Surface coarsely honeycombed with fine ridges .... *P. fractus.*
II. Sculpture interrupted with solid welts; pits small or reduced to punctæ:
  Surface with transverse ribs separated by one or two rows of pits .. *P. serialis.*
  Welts few, oblique, separated by numerous pits .... *P. communis.*
  Welts broken up into short ridges behind; intervening surface punctate .... *P. lachrymalis.*
  Welts represented posteriorly by tubercles separated by smooth surface; anteriorly unbroken, the surface punctate .... *P. œdemius.*

Of these species, *P. corrugatus*, *P. multifoveatus*, *P. fractus*, *P. serialis*, *P. communis*, and *P. lachrymalis* have been found in the Wahsatch beds of New Mexico; and the *P. trionychoides*, *P. multifoveatus*, and *P. œdemius* in the Bridger beds of Wyoming.

I.—*Carapace with ridges which inosculate less or more:*

Plastomenus corrugatus, Cope.

Plate xxv, figs. 20–26.

Catal. of Eocene Vert. of New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 35.

Ridges fine, inosculating less; no welts.

Remains of six individuals are provisionally referred to this species;

but they present such variations in size and sculpture as to render further investigation necessary. The degree of inosculation of the ridges evidently differs much in different parts of the same carapace, but no portion of it presents the open honeycomb pattern of the *P. fractus.* The typical individual is, however, represented only by a hyposternal bone, and portions of carapace are only provisionally associated with it. This bone is ornamented with sharp, raised, narrow ridges, which are straight or vermiculate, and which inosculate but little. The broken base of the bridge is particularly stout, and the thickening continues within the inguinal border to the postabdominal extremity. The inguinal edge is thinner, and is incurved at the postabdominal gomphosis.

Measurements.

	M.
Thickness of hyposternal at middle	0.007
Thickness of hyposternal at bridge	0.009
Seven ridges measure	0.010

Plastomenus multifoveatus, Cope.

Plate xxv, fig. 11.

Plastomenus multifoveatus, Cope, Ann. Report U. S. Geol. Surv. Terrs., 1872, p. 619.
? *Plastomenus catenatus*, Cope, System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 35.

In this species, the pits of the sculpture are smaller on account of the increased thickness of the separating ridges. These inosculate more or less, according to the portion of the carapace. There are no welts. Thickness of a costal bone (type of *P. catenatus*), $0^{m}.004$.

Portions of this species from Wyoming were originally referred to the *P. thomasii;* but the individual to which they belong has much wider hyposternal bones in the antero-posterior direction, while the hyposternal of *P. thomasii* is more like that of a *Trionyx.* The New Mexican specimen presents some differences, but it is uncertain whether they are specific.

Plastomenus fractus, Cope.

Plate xxv, figs. 1–219.

System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 35.

Five individuals in a fragmentary condition represent this Turtle, and present greater uniformity of character than some of the others. The sculpture is a honeycomb, where the fossæ are wider than the separating ridges, which is traversed at intervals of two or three fossæ by elevated lines, which are transverse or oblique to the long axis of the costal bones as they are situated in the carapace. These lines are elevated portions of those separating the fossæ, and hence differ entirely from the smooth, thick welts of the species of the genus which follow. They are usually zigzag in their course, as defining the pits, and sometimes inclose small pits. The vertebral bones are strongly pitted. None of the specimens indicate large size.

Measurements.

	M.
Width of a vertebral bone	0.012
Width of a costal bone	0.022
Thickness of the same	0.005
Interval between two raised lines	0.007

II.—*Sculpture coarsely or finely punctate:*

Plastomenus communis, Cope.

Plate xxv, figs. 1–6.

System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. 100th M., 1875, p. 35.

Carapace coarsely pitted in transverse lines, the surface crossed transversely, obliquely, or longitudinally by uninterrupted welts.

The typical specimen of this species is of considerable size, and embraces the greater part of the carapace in a fragmentary condition. There are portions of three other individuals of similar proportions, and parts of four other smaller ones. Of the latter, two, which I refer to as var. II, are disproportionately thin, so as to occasion question of their proper reference here; while two others, still smaller, are relatively stouter, so as to render it probable that they are young animals of the *P. communis.*

The typical specimen, as well as the stouter ones referred to it, is characterized by an increase of thickness to the free border of the carapace, which is unusually obtuse and heavy. No rib-extremities project beyond it.

Measurements.

	M.
Width of a costal bone	0.044
Thickness at the border of the same	0.012
Five pits in	0.010

	M.
Width of a costal bone of a small turtle	0.020
Thickness of the same	0.005
Five pits in	0.010
Width of a costal bone of the thin form	0.025
Thickness of the same	0.005
Five pits in	0.010

Plastomenus serialis, Cope.

Plate xxv, figs. 8-10.

Costal bones having the sculpture regarded as definitive of this species were found in five different localities; but, as they were found isolated, the other portions of the skeleton cannot be satisfactorily determined.

The species is readily distinguished by the closely-placed, subparallel ridges which cross the ribs parallel to the axis of the body, which are separated by one or two rows of impressed dots, or small fossæ. In some specimens, the latter are obsolete.

Measurements.

	M.
Width of a costal bone, No. 1	0.027
Thickness of the same	0.005
Four and a half cross-ribs in	0.015
Width of a costal bone, No. 2	0.018
Thickness of the same	0.003
Three and a half cross-ribs in	0.009

This is the species which I described in the Systematic Catalogue of the Vertebrata of the Eocene of New Mexico under the name of *P. ? thomasii*, a provisional identification not justified by further examination.

Plastomenus lachrymalis, Cope.

Plate xxv, fig. 7.

Report on Vertebrata of New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 15.

Costals with finer pits, the welts broken into tubercles posteriorly.

The largest species of the genus represented in the Eocene of New Mexico. The costal bones are rather finely punctate, the posterior as well as the anterior. The anterior costal bones are crossed by numerous ridges from side to side obliquely; the obliquity increasing posteriorly. On the posterior bones, they are broken into vertical bars, separated by considerable intervals, and of linear form. The posterior costals reach a thickness of 0m.006 and a width of 0m.025.

The pitting of the posterior part of the carapace distinguishes this species from the *P. œdemius*.

But one specimen obtained.

BAËNA, Leidy.

Baëna arenosa, Leidy.

Plate xxiv, fig. 32.

Report U. S. Geol. Surv. Terrs., i, p. 161.

One specimen obtained, which consists of the middle transverse portion of a chelonite, the only one procured by me in New Mexico. It exhibits the characters of specimens from the Bridger beds of Wyoming in the longitudinal and oblique ridges of the vertebral region and flared postero-lateral border of the carapace.

Measurements.

	M.
Total width	0.245
Depth at middle	0.110

DERMATEMYS, Gray.

Baptemys, Leidy, Report U. S. Geol. Surv. Terrs., 1873, p. 154.

Dermatemys costilatus, Cope.

Plate xxiv, fig. 32.

System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 36.

Six individuals contribute fragments to our knowledge of this species, but without the completeness desirable. The species is essentially characterized by the presence of an elevated but obtuse rib, which crosses the costal bones at right angles to their length. As costals with all degrees of definition of the rib are preserved, I suppose that it disappeared at the middle of the carapace, or only existed on the posterior portion. Associated with the costals are vertebral bones, with a similar but more pronounced rib on the median line; this, also, is faint or wanting on associated vertebrals. I therefore suppose that this keel, also, is confined, as in the *D. vyomingensis*, to the posterior extremity of the carapace. Other portions of the skeleton are of uncertain reference; but there are associated, in four of the specimens, portions of plastron with the free borders marked by a broad, smooth band, which thickens inward to an abrupt, descending margin. The surface of this border is regularly marked with parallel, obtuse ribs. The vertebral bones on which the median rib is obsolete have their lower surface produced in a projecting point on each side of the rather narrow excavation for the extremity of the vertebra which precedes each. The size is about that of the *Dermatemys vyomingensis*, and the robustness of the bones similar.

The reference of this species to the genus *Dermatemys* is provisional only, and is based on specific resemblances to the *D. vyomingensis*, Leidy.

EMYS, Brongniart.

Tortoises having the carapace and plastron of this genus were abundant in New Mexico during the Wahsatch epoch. Fragments of these portions of the skeleton are very commonly found, and not unfrequently the geologist meets with them in a nearly entire condition. Materials for the determination of two species were obtained by myself in 1874.

Emys lativertebralis, Cope.

Plate xxvii, figs. 1-3; Plate xxviii, figs. 1-2.

Emys latilabiatus.—System. Cat. Vert. Eocene, New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 36, not of Paleontological Bulletin, No. 3, p. 3, and U. S. Geol. Survey of the Terrs., 1872, p. 626.

I found the larger portion of the carapace and plastron of a specimen of this species piled together and free from the matrix, and considerable, though less numerous, portions of four other individuals of the same, in a similar condition.

The characters which distinguish this species from the *Emys vyomingensis*, to which it is allied, are the following: The vertebral bones are, excepting the first, wider than, or as wide as, long; the mesosternal bone is truncate behind, and is not crossed by the common suture of the pectoral and humeral dermal scuta; the postabdominal bones are divided by a deep semicircular excavation behind, which separates widely their posterior apices. In the *E. vyomingensis*, the vertebral bones, except a few of the posterior, are longer than wide; the mesosternal bone is angulate behind, so as to be crossed by the pectoro-humeral suture, and the postabdominal bones are much less deeply excavated and furcate. The vertebral bones, I have in three New Mexican specimens of the *E. lativertebralis*, the mesosternal and episternal in five, and the postabdominals in three. The characters of the *E. vyomingensis*, I have verified on numerous specimens obtained by myself in Wyoming, and in the figures and descriptions of Dr. Leidy.* In one of my examples of *E. lativertebralis*, the pectoro-humeral suture creeps over the posterior margin of the mesosternal bone, keeping close to the edge, which observes its normal transverse direction.

The following description is that of the most complete specimen. Eight vertebral and a nuchal bones are preserved, which, when placed in relation, present a vacancy for the third vertebral. The pygal is wanting, while the caudal marginal is present. The first vertebral bone is wanting, but the outline of its posterior portion is indicated by the bones which bound it. Its lateral borders are gently convex, and do not diverge much from the similarly convex posterior border. Its length exceeds its width. The posterior sutures of all the vertebral bones from the second to the fifth inclusive are regularly shallowly concave, the posterior sutures correspondingly convex; in the posterior vertebræ, they are bracket-shaped or transverse. The antero-lateral angles of all from the second to the eighth inclusive are obliquely truncate. The second and third are as wide as long; the remainder are wider than long. The sixth is twice, the seventh more than twice, as wide as long. The eighth is wider before than behind and urceolate, with anterior lateral angles broadly truncated; it is half its width wider than long. All of the vertebrals are flat, excepting the pygal, which is convex on its median line. The costal bones are of moderate thickness, and without sculpture; their capitula are well developed. The nuchal bone is thickened, and its marginal portion is not very wide, and is openly notched at the middle. The caudal is smaller than the other marginals, subquadrate, moderately recurved, and roof-shaped in section at the posterior border. The costal buttress for the ascending process of the bridge is not prominent. On the first costal, it is a slightly-raised sutural face near the distal end, and 0.75 of an inch anterior to the posterior suture.

*Report U. S. Geol. Survey Terrs., by Hayden, i, p. 140.

The posterior surface is on the fifth and sixth costals, chiefly on the former, where it terminates two-fifths the length from the distal end. The iliac sutural surface is rather small, and is situated near the proximal extremity of the eighth costal bone, half-way between its borders. It is a subtriangular tuberosity, with a projecting narrow capitulum directed toward the proximal apex of the costal bone.

The free marginal bones are large, thin, and but little recurved; the second and eleventh being the most so. The anterior marginals are very little smaller than the posterior. They are all crossed proximally by the costo-marginal suture, excepting the caudal marginal. The bridge-marginals are thin, not angulate, and but little convex, indicating that the body-cavity is not depressed. The angle of the marginals adjoining the bridge is somewhat recurved.

The bones of the plastron are not thick, and are united by rather fine suture. The anterior lip is not very prominent, is truncate, and is notched just within its external angles. The mesosternal bone is produced anteriorly, while the posterior border is transverse, and the extero-posterior angles obliquely truncate. The common hyosternal suture is a little longer than the common hyposternal. The posterior lobe contracts distally, and terminates in two points, which are separated by a semicircular emargination. The superior margin of the plastron is thickened at the extremity of the anterior lobe in front of a definite line, which extends between the extero-posterior angles of the episternal bones. Of this thickening, two parallel ribs, which extend to the lateral angles of the lip, are most prominent. Behind the episternal bones, the thickening is little marked. The superior border of the entire posterior lobe exhibits a wide thickening, with sharply-defined inner border, which is most elevated opposite the posterior angles.

The dermal scuta are well marked. The first vertebral is longer than wide, the second as long as wide, the third a little wider than long, and the fourth still wider. The nuchal scutum is distinct, and is notched behind. The gular scuta are longer than their combined width, and they extend well on the mesosternal. The humero-pectoral suture is nearly transverse, and passes behind the mesosternal bone. The abdominal scuta are longer than the pectoral, but not much; the length of the femoral on the middle line is intermediate between the two, while the middle line of the anal is the shortest of all.

Measurements.

	M.
Length of carapace restored	0.350
Length of a costal bone, on curve	0.108
Width of the same medially	0.024
Thickness of the same medially	0.005
Width of a marginal next the bridge	0.041
Width of a marginal of the bridge, on curve	0.030
Length of the same	0.035
Length of an anterior free marginal	0.045
Width of the same	0.048
Length of the caudal marginal	0.030
Width of the same	0.035
Axial length of the third vertebral bone	0.030
Width of the same	0.034
Axial length of the seventh vertebral bone	0.014
Width of the same	0.040
Length of the eighth vertebral bone	0.022
Width of the same	0.037
Length of the first pygal vertebral bone	0.035
Width of the same	0.029
Length of the plastron	0.290
Length of the posterior lobe	0.110
Width of the same at the base	0.135
Width of the same between the apices	0.045
Length of the anterior lobe	0.095
Width of the same at the base	0.146
Width of the anterior lip	0.050
Length of the thickening of the anterior lip	0.035
Length of the mesosternum	0.040
Width of the mesosternum	0.059
Length of the hyosternal on the middle line	0.060
Length of the hyposternal on the middle line	0.080
Length of the postabdominal on the middle line	0.058

Two of the specimens of this species are a little larger than the one described. A third is much smaller, and some of its vertebral bones display a faint trace of carination. There is in some of the marginal bones of the small, and probably in the large, specimens, a small pit for a gomphosis.

This species differs from the *Emys gravis*, Cope, from the Wahsatch beds of Wyoming, in its general light and thin construction.

Emys cibollensis, Cope.

Plate xxvii, fig. 4; Plate xxviii, figs. 3-6.

Emys ? Stevensonianus, "Leidy," Cope, System. Cat. Vertebrata Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 36.

This species is represented by the imperfect carapace and plastron of a single individual, in which some of all the characteristic elements are present, excepting the vertebral bones. The general relationships of the species are to the *Emys latívertebralis*, that is, the anterior lobe of the plastron has a distinct truncate lip, and the posterior lobe is deeply excavated on the middle line; the superior borders of both lobes have a thickened band, which is best developed posteriorly; and the costal and marginal bones are without especial sculpture.

The specimen is below the average size of those of the *E. lativertebralis*, but not sufficiently so to account for the much smaller size of the marginal bones, which are also relatively thicker. The lobes of the plastron are differently proportioned. Thus, in *E. lativertebralis*, the posterior lobe, measured along the median line, is as long as the anterior to the posterior suture of the mesosternal bone; in the *E. cibollensis*, the former measurement considerably exceeds the latter. This shortening of the anterior lobe of the plastron is accompanied by other peculiarities. The mesosternum is transverse diamond-shaped, the posterior border being nearly as angular as the anterior. The dermal scuta have an anterior position. The gulars are very short, each one being wider than long, and their posterior angle not reaching the mesosternum. The humero-pectoral scutal suture, on the other hand, crosses the mesosternum a little behind the middle, instead of passing behind it, as in *E. lativertebralis*. The thickening of the margins of the plastron has some low ribs parallel to the border. The osseous sutures are not very coarse; the dermal sutures well marked. The marginal bones are not, or but little, recurved. The lip of the plastron has a slight notch on one side.

Measurements.

	M.
Anteroposterior width of a costal bone	0.022
Thickness of the same	0.006
Length of a posterior free marginal	0.030
Thickness of the same	0.009

Length of the posterior lobe of the plastron	0.095
Length of the anterior lobe, including the mesosternum	0.065
Greatest length of the episternal	0.049
Greatest width of the episternal	0.052
Length of the mesosternal	0.036
Width of the mesosternal	0.055
Length of the gular scute	0.025
Width of the lip	0.046

Emys euthnetus and *E. testudineus*,* Cope, resemble this species in some respects, but neither has the transverse mesosternum; and, in the former, the marginal thickening of the plastron is much narrower.

HADRIANUS, Cope.

Proceedings Amer. Philosoph. Society, 1872, p. 468.—Ann. Report U. S. Geol. Survey Terrs., 1872 (1873), 630.

This genus represents the *Testudinidæ* in the Eocence Fauna of North America, and, as such, is characterized by structure adapted for terrestrial life exclusively. Three species have been discovered in the Bridger beds of Wyoming, which resemble each other in the massive marginal bones of the carapace and plastron, and their large size. They were abundant during that period. The Wahsatch beds of New Mexico contain no less numerous remains of this genus, but which are found in such a fragmentary condition as to render the identification of the species less exact than is desirable. The insufficient remains at my disposal do not enable me to characterize more than one species, and do not distinguish this one from one of the species of the Bridger beds. Fragments indicate a second species of smaller size and more massive proportions than the former.

Hadrianus corsonii, Leidy.

Plate xxiv, figs. 36–7.

Testudo corsonii, Leidy, U. S. Geological Survey Montana, 1871, p. 366; Report U. S. Geol. Survey Terrs, i, p. 132.

Although fragments of this species are abundant, no considerable portion of any one individual was found. Since the sternal lobes furnish in this genus the most striking of the specific characters, I have to rely for description on portions of the episternal and postabdominal bones.

*Ann. Report U. S. Geol. Surv. Terrs., 1872, pp. 627–628.

The shovel-shaped angle of the left postabdominal, found in connection with numerous small fragments, resembles that of *H. corsonii* in its posterior production. It is thinned on the edges, and the extent of that of the inner side shows the median notch to have been deep. The roof-like ridge of the upper surface is nearer the inner than the external margin, and rises into the thickening which bounds the internal abdominal concavity of the plastron in this genus. The inferior surface is uninterrupted, and slightly recurved.

Measurements.

	M.
Length from the internal marginal thickening	0.105
Thickness at the internal marginal thickening	0.021
Width at the fundus of the median notch	0.098

A second and much smaller specimen may belong to a younger animal, or to another species. The posterior border of the postabdominal bone is less produced, and the prominent angle is nearer the notch than the line of the external border.

Measurements.

	M.
Length from the thickening	0.030
Depth at the same	0.015

The episternal lip of another specimen is of very large size. The greater part of the median sutural border is preserved; but the fracture reaches the free border near the base of the lip, so as to leave its extent uncertain. It evidently projected decidedly, though not so much as in the typical *H. corsonii.* Its lateral border is not at right angles with the anterior, but passes into it by a bold curve. The inferior face of this portion of the bone is convex in both directions.

Measurements.

	M.
Length of the median suture preserved	0.090
Thickness at the same	0.025
Width at the base of the lip	0.085
Length to the concavity of the external margin (axial)	0.035
Thickness of the border of the plastron near the bridge	0.037

The supposed second species is represented by the angular projection of the postabdominal of the left side, broken away from the remainder of the bone. It presents the external portion of the femoro-anal scutal suture. This fragment is characterized by its great thickness and the straight and abrupt descent of the superior surface to the margins. The latter are acute and not produced nor recurved. This evidently pertained to an animal much more robust than the others, and of smaller size.

Measurements.

	M.
Length of the postabdominal from the transverse line of the end of the dermal suture	0.060
Thickness at the middle	0.027

CROCODILIA.

DIPLOCYNODUS, Pomel.

This genus, which is abundantly represented in the Tertiaries of France, was first detected by me in the Bridger basin of Wyoming, where a single species, the *D. subulatus*, occurs. A second species was found in New Mexico by the writer, which presents typical characters in the paired canine teeth and broad, overhanging muzzle, in which the nasal bones do not divide the external nares. In one of the specimens, numerous dermal bones are preserved, and they are without keels.

Diplocynodus sphenops, Cope.

Plate xxix.

System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 31.

Indicated by a fragmentary skeleton, in which occur numerous portions of the cranium and vertebræ; a second specimen includes corresponding parts, with more numerous vertebræ. In both, the distal part of the mandibular ramus is preserved, and shows two enlarged teeth inserted close together, the posterior opposite to the posterior border of the symphysis. In front of these, there is an edentulous space; behind them is a series of quite small teeth. The dentary bone is quite narrow at this point, indicating an acuminate symphysis and muzzle.

The type-specimen includes the frontal and parietal bones. The former united are not expanded, but are about as wide as in *Crocodilus elliottii*, Leidy. The interparietal face is a plane, is narrow, its sharply defined, lateral borders including two rows of deep pits. The front is rough, with deep pits, which have a transverse direction opposite the postfrontal bones;

anteriorly, they are smaller and less pronounced. The lateral olfactory ridges of the inferior surface are not strongly defined. The sculpture of the lower jaw consists of rather distant, impressed, punctiform pits in shallow depressions. A larger mandibular tooth is smooth, and not sulcate at the base.

A cervical vertebra has a short, simple, obtuse hypapophysis, not connected with the parapophyses. Its cup is a little deeper than wide. Surface near articulations smooth. A dorsal, with hypapophysis and lateral capitulum, has a depressed centrum. The centrum of a sacral vertebra is, on the other hand, compressed, and, though this is partly due to pressure, the form is normally much less depressed than usual. Fragments of the jaws are coarsely pitted-rugose.

The second specimen is of a larger Crocodile, and presents similar characters. The third and fourth cervicals show the hypapophyses and parapophyses fused together into a crescentoid mass below the articular cup, as in *D. subulatus*, Cope. In such centra, the cup is a little deeper than wide. In a lumbar, the surface next to the posterior shoulder is sculptured with longitudinal grooves, a character not seen in the dorsals.

The broken, terminal part of the snout of this specimen is flat. The premaxillaries are wide, and extend an inch and a half posterior to the nares. The latter are narrowed at the region preserved, and their posterior border is notched by the projecting ends of the nasals. The surface is deeply, coarsely corrugated at the middle, and becomes smoother toward the edges of the maxillary bones. The surface between the anterior angles of the orbits is moderately rugose, like the maxillary borders, while the superior arches of the cranium are deeply pitted. The posterior part of the dentary bone is more strongly pitted than the anterior, and its depth, with that of the adjacent part of the angular bone, shows that the external foramen is small.

The greater part of two successional teeth are preserved, in one instance in the alveolus of the large maxillary pair. They are neither of the short and obtuse, nor of the slender and acuminate type. They are but little compressed, and have opposite, low cutting-edges. The surface is roughened with rather coarse, undulating ridges. One, at least, of the large teeth of the lower jaw is received into a narrow excavation of the border of the upper jaw.

The dermal bones are coarsely pitted, and no one of the seven preserved is carinate.

Measurements.

No. 1.

		M.
Width of the parietal bone		0.013
Width of the frontal at the orbits		0.043
Depth of the ramus at two canines		0.037
Depth of the ramus just behind the same		0.030
Width of the ramus at the symphysis, posteriorly		0.020
Length of a cervical vertebra		0.043
Diameter of the cup	vertical	0.022
	transverse	0.021

No. 2.

	M.
Width of the muzzle at the canine notches	0.074
Width of the nares near the posterior border	0.030
Depth of the mandibular ramus at the canines	0.044
Length of the alveoli of the inferior canines together	0.020
Width of the ramus at the posterior end of the symphysis	0.031
Depth of a cervical centrum in front	0.029
Width of the same	0.027
Length of the same	0.041
Length of a lumbar centrum	0.045
Width of a dermal shield	0.045

The size of the *Alligator mississippiensis.*

CROCODILUS, Linn.

Remains of species of this genus are exceedingly abundant, chiefly in the upper beds of the formation, associated with Garfishes. The lower beds contain the greater number of Mammalian remains, with a smaller percentage of Crocodiles. The latter do not include any Gavials, and resemble in some degree those of the Bridger group; some of the species being probably identical.

The New Mexican species are naturally divided into those with flat frontal bone, with the inferior ridges little developed, and those in which the interorbital region is bounded below by strong orbital or olfactory crests. In the latter, the superior plate is narrower and thicker.

Crocodilus grypus, Cope.

Plate xxx.

System. Cat. Vertebrata Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 32.

Established on remains of two individuals, which are in a fragmentary state, including portions from all parts of the skeleton. The teeth are of unequal sizes, and are round in section in the anterior half of the jaws; are conic and compressed at apex, curved, and with delicate opposed cutting-edges, which extend to the base of the crown. The middle of the length of the crown is delicately rugose-striate in young teeth. A large tooth occupies a position a little anterior to the lateral notch. In the lower jaw, a very large tooth occupies a position opposite the posterior extremity of the symphysis; the latter marking the middle of the alveolus. Three teeth of much smaller size follow posteriorly in close succession, and are followed by a fossa to receive the apex of a superior tooth. The ramus is wide at the symphysis. The extremity of the lower jaw supports a large tooth close to the symphysis, which is followed by one of half its diameter. A part of the posterior outer side of the ramus is deeply pitted.

In the second specimen, a part of the frontal bone shows that part of the cranium to be deeply and rather irregularly pitted. The orbital border is wide and shallow, and the lateral olfactory ridges not prominent. The inferior ridge of the frontal which bounds the face of contact of the alisphenoid has a somewhat different position from that which it holds in *C. grypus* and *D. sphenops*. Here it extends anteriorly to a point in advance of the post-frontal bone; there it only reaches to opposite the anterior part of the same. Here it is stronger, and the excavation of the surface on the side next the postfrontal is deeper. There are three larger teeth on the median posterior part of the mandibular ramus, which is there rather slender, and but little rugose. The premaxillary bone and tooth are as in the first specimen.

Another series of fragments perhaps belonging to the same individual as the last, includes numerous vertebræ and other skeletal elements. A cervical vertebra has a prominent hypapophysis with long base, which is free from the parapophyses. There are rugose lines between the latter and the edge of the cup. The dorsals have a hypapophysis with short base, and have a prominent shoulder with smooth surface-bone. In the articular cups, the transverse slightly exceeds the vertical diameter. The caudals are of moderate length. The condyles of the femur are of unequal size, and the head not expanded.

Measurements.

No. 1.	M.
Width of the ramus at the symphysis	0.030
Diameter of the large alveolus at the symphysis	0.015
Length of the bases of the four teeth following	0.029
Diameter of the large premaxillary tooth	0.010
Diameter of the anterior lower incisor	0.013
Width of the ramus at the second incisor	0.031
No. 2.	
Width of the frontal bone above the orbit to the inferior groove	0.020
Depth of the ramus behind middle	0.032
Length of the cervical vertebra	0.038
Width at the articular ball	0.025
Length of a dorsal	0.037
Width at the articular cup	0.025
Length of a caudal	0.043

In comparison with a common large species of the Bridger formation from Wyoming, which agrees with such characters as can be found in the description of *C. affinis*, Marsh, I find the position of the large mandibular tooth is quite different, it being considerably anterior in the Wyoming species. The first incisor tooth is also less enlarged in the latter.

Crocodilus wheelerii, Cope.

Plate xxxi, figs. 1–5.

Syst. Cat. Vertebrata Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 33.

This Crocodile is known from remains in the same fragmentary condition as those already described. There are numerous portions of the cranium with vertebræ.

This species is at once distinguished by the relative width of the interorbital portion of the frontal bone, and the slight development of the lateral inferior ridges. The pitting is relatively smaller than in any of the other species, numbering five or six rows on the parietal region. There is a smooth border of the superciliary edge. The frontal has a narrow anterior prolongation between the prefrontals, longer than in "*C. affinis*," and without the transverse impression preceded by a smooth space seen in that species. The pitting is, on the other hand, gradually reduced toward the nasal region. Other cranial bones are strongly sculptured. A portion of the maxillary contains teeth. These are robust, with slightly compressed, obtusely conic crowns, with rugulose enamel.

A cervical vertebra is elongate, with the short hypapophysis free from the parapophyses; its ball is subcircular.

Measurements.

	M.
Length of the frontal bone (10 millimeters supplied)	0.130
Length of the anterior production of the same	0.053
Width of the same at front of the orbits	0.037
Width of the same posteriorly to the inferior groove	0.030
Depth of the mandible at the cotylus	0.053
Length of a cervical vertebra	0.043
Width and depth of the ball of the same	0.025
Length of a lumbar	0.042

The size of this species was equal to that of the fully-grown Louisiana Alligator.

This Crocodile is named in respectful recognition of the services to this department of natural science of Lieut. George M. Wheeler, directing the U. S. Geographical Explorations and Surveys west of the One hundredth Meridian.

Crocodilus ? elliottii, Leidy.

Plate xxxi, figs. 6–17.

Report U. S. Geol. Survey Terrs., i, p. 125, pl. viii, figs. 4, 6.

With this species, we enter the second group of the genus above noted, where the frontal bone is stout, and furnished with prominent inferior ridges. The specimens referred provisionally to the *C. elliottii* embrace cranial bones and teeth, but I do not consider the reference final.

The frontal bone is wide between the orbits, where six round pits can be counted in a somewhat irregular transverse line. The prefrontals extend backwards, and contract the frontal, so that between them only two pits can be counted. A fragment of the left premaxillary shows the muzzle to be flat, rather narrow, and strongly pitted. A tooth in a fragment of the jaw presents a short, obtuse, compressed crown, with finely striate enamel.

Measurements.

	M.
Length of the frontal between prefrontal and parietal sutures	0.041
Width of the same between the orbits	0.032
Width of the same between the postfrontals	0.037
Thickness of the same between the prefrontals	0.012
Thickness of the same between the postfrontals	0.011
Elevation of the crown of the tooth	0.010
Long diameter of the crown of the tooth	0.010

Numerous bones of the skeleton of another smaller specimen were obtained, the proper reference of which is uncertain, as it does not contain the portions which define the species as above described. Thus the superior cranial bones and the terminal portions of the jaws are wanting. The posterior parts of the jaws show that at least four of the mandibular teeth possess the very short and oval crowns seen in the *Alligator mississippiensis* and *Crocodilus heterodon*. As in these, they are divided by a low, longitudinal edge, from which fine grooves diverge on each side. The crowns become more acute anteriorly. One of the large teeth has the short obtuse crown characteristic of *C. elliottii*, and quite different from those of *C. grypus*. The quadrate bone has a characteristic form. It is not so thin as in the *C. wheelerii*, and lacks the ala of the inner side seen in *C. chamensis*. It differs from that of the species here referred to *C. ?liodon* in having the condyle all in one line, and not presenting an upward direction of the inner extremity. The pneumatic foramen is distinct. The centra of the dorsal vertebræ preserved are moderately depressed.

Measurements.

	M.
Extent included by last four mandibular teeth	0.040
Length of the crown of the penultimate of the same	0.009
Height of the crown of the penultimate of the same	0.005
Length of the condyle of the quadrate bone	0.040
Depth of the quadrate bone at the middle of the condyle	0.012
Length of a cervical vertebra	0.035
Length of a dorsal vertebra	0.030
Depth of the cup of the same	0.017
Width of the cup of the same	0.018
Width of the centrum, including diapophyses	0.034

The dermal scuta are articulated, and with coarse pits. Several of them have a median thickening which represents a keel.

Crocodilus ? liodon, Marsh.

Plate xxxi, figs. 18–23.

Amer. Journ. Sci. Arts, 1871, p. 454.

Two individuals which agree with the description cited in the depressed form of the centra of the dorsal vertebræ, the articulated dermal scuta, and general proportions, are not accompanied by cranial bones, excepting a portion of the parietal. This displays three larger or four smaller pits between the temporal fossæ. The odontoid bone is elongate. The centrum of the axis is much compressed, and is strongly keeled on the median line below, being without lateral longitudinal angles. In an anterior cervical vertebra, the hypapophysis is connected by a lateral thickening with the parapophysis, while in a posterior cervical this connection is wanting. The centra of the lumbars are not compressed; sacral centra depressed.

The specimens are of rather small size, and one of them is adult.

Measurements.

	M.
Parietal width	0.015
Parietal thickness	0.010
Width of end of quadrate condyle	0.025
Thickness of the same	0.010
Length of the axis, with odontoid	0.040
Length of dorsal	0.029
Width of dorsal cup	0.017

Crocodilus chamensis, Cope.

Plate xxxii, figs. 1–22.

Report on vertebrate fossils of New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 15 (*Alligator*).

Represented by portions of the mandibular arch of a small Crocodilian, resembling in some respects the *A. heterodon* of the Wyoming beds. The posterior teeth have the same short, expanded, sessile, bean-shaped crowns, with a median longitudinal ridge, and more delicate lines radiating close together from it to the border of the crown. The anterior teeth differ in being cylindric instead of compressed. There is a large canine, preceded and followed by teeth of much smaller size.

Measurements.

	M.
Length of the symphysis	0.019
Length of the alveoli of six teeth from the symphysis	0.022
Width of the ramus just behind the symphysis	0.010
Long diameter of the posterior tooth	0.005

The specimen selected as type is one of the smallest. The surface of the bones is roughened with pits.

Besides the type-specimen, I obtained a fragmentary cranium and numerous dermal scuta of another individual. The muzzle is wide and flat, and is emarginate at the sides for the accommodation of the large mandibular tooth. This species must, therefore, be referred to the genus *Crocodilus*. The cranium is very rugose above, especially on the muzzle. The interorbital part of the frontal bone is narrow and thick, and with strong inferior crests. The superior surface is covered with numerous closely-placed round pits, of which five and six may be counted between the orbital borders. The extremity of the quadrate bone is concave transversely, and the exterior end of the condyle is not, or but little, wider than the interior. A prominent ridge extends from the former as an external inferior alate border of the quadrate. Inferior face of the quadrate concave. The dermal scuta are very few of them keeled, and they are mostly united by suture. Their surface is covered with rather small, sharply-defined pits.

Another adult specimen is represented by nineteen vertebræ, part of the frontal bone, part of the femur, and numerous dermal bones. The frontal bone is thick, and with well-developed lateral olfactory ridges. Its superior surface is marked with closely-placed pits. The inferior carina of the dorsal vertebræ extends their entire length, and the sides of the centrum are concave. The articular faces are transversely oval. The articular cup of an anterior lumbar is round, and its inferior surface is not angulate. The centrum of a posterior lumbar is depressed appropriately to the form of the sacrum. The balls of the first caudal are depressed, and the centrum is angulate below. The ninth caudal vertebra possesses diapophyses, and is longer than the first. The femur displays a strong tuberosity of the proximal middle of the shaft. The dermal bones are coarsely pitted, and have a trace of a median carina.

Measurements.

	M.
Thickness of the frontal bone at the middle	0.004
Length of a dorsal centrum	0.015
Transverse diameter of the cup of the same	0.0075
Length of the posterior lumbar	0.0145

Depth of the cup of the same	0.006
Width of the cup of the same	0.008
Length of the first caudal	0.020
Transverse diameter of the centrum	0.011
Length of the eighth caudal	0.020
Diameter of the centrum in front	0.009
Long diameter of the head of the femur	0.017
Long diameter of the shaft of the femur	0.009

The condyle of the *os quadratum* is concave in longitudinal section, and the exterior convexity is stouter than the interior. The exterior border has a projecting ala as in other specimens. This character is observed in the quadrate bone of a second specimen, which agrees in the frontal and vertebral bones, &c., with that first described. It is much smaller, a condition due to immaturity, as indicated by the free neural arches of the vertebræ.

I refer here specimens from New Mexico which I formerly called *C. heterodon.** This species was found in corresponding beds in Wyoming, and differs from the *C. chamensis* in the compressed, trenchant character of the premaxillary teeth.

AVES.

DIATRYMA, Cope.

Proceedings Academy Philadelphia, 1876, p. 11.

Whether birds were numerous during the Wahsatch epoch of the Eocene period is not yet ascertained. The accidents to which the remains of the Vertebrata of this formation in New Mexico have been subjected would be especially destructive to the fragile bones of birds. The expedition of 1874 obtained only one of the most solid bones of a species of large size, which I have referred to a genus distinct from any previously known, under the name above given.

This bone, a tarso-metatarsus, lacks a part of its shaft and the external distal condyle. Its proximal end presents a massive hypotarsus, with truncate posterior face, with a single, rather small, ligamentous groove on its inner side. The perforating foramina are large, and widely separated on both anterior and posterior faces. The inner edge is compressed, and bears

* System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 34.

at the proximal end a rough longitudinal surface, which looks as though adapted for squamosal union with a splint bone. The distal condyles are of large size, and the usual foramen is present just above the union of the external with the median condyle.

The affinities of this genus are not sufficiently indicated by the bone in our possession, although it is diagnostic for the principal divisions of recent Birds. The proximal end resembles the corresponding part in the Ostriches and *Dinornis;* while the distal end, so far as preserved, is similar to that of the *Gastornis* (Hèbert) of the corresponding horizon in France. It is probable that it will be found that the latter genus is its nearest known ally. *Gastornis* has, however, not yet been definitely assigned to its place. Prof. A. Milne-Edwards thinks that it is allied to the *Natatores;* while Lartet and Owen have seen in it characters of the *Cursores.*

Diatryma gigantea, Cope.

Plate xxxii, figs. 23-5.

Proceedings Academy Philadelphia, 1876, p. 11.

This species was of large size, the proximal end of the tarsometatarse being nearly twice the diameter of that of the Ostrich. Its discovery introduced this group of Birds to the known faunæ of North America, recent and extinct, and demonstrates that this continent has not been destitute of the gigantic forms of Birds now confined to the southern hemisphere faunæ. The description is as follows:

The hypotarsus is moderately prominent, with broad, truncate face, and does not inclose the ligamentous groove of its inner side. Its superior angle is broken away in the specimen. The two foramina which pierce the shaft just below the head are subround; they are well separated from each other, both on the posterior and anterior faces, marking nearly equal thirds of the transverse diameter of the bone. The cotyloid cavities for the tibiotarsus are bounded by an elevated margin, and are separated medially by a single low oblique ridge. The groove of the posterior face is particularly wide, and the inner part of the shaft is thinned, while the outer border is broadly convex. The proximal part of the inner border (as far as it is preserved) is marked with a flat surface, which is roughened with ridges, which is possibly the sutural articulation of the proximal end of the metatarsus of the hallux. No such surface exists on the corresponding bone of the Ostrich or Emeu. Only two of the free distal phalangeal extremities are preserved. The shaft is broken, showing that its interior is filled with cancellous tissue. The free extremities are remarkable for the great inferior extent of the articular trochlear face. The median is strongly grooved with an obtuse excavation, and the lateral or bordering ridges are equal and rounded. The groove is continuous with the superior surface, but not with the inferior. There the convergent lateral ridges inclosing the open groove terminate in an abrupt elevation above the adjacent surface of the shaft. The sides at this point are concave. The inner free condyle has an oblique articular face; the external ridge dropping away internally, as in many Birds, and produced beyond the inner ridge distally. The articular face becomes then a part of a spiral, and is little grooved above, but strongly grooved medially. The vertical diameters of the sides differ, the inner being much greater, and both are concave. A strong foramen pierces the shaft just within the point of junction of the inner and medial free extremities.

Measurements.

		M.
Transverse diameter of the proximal end of the tarsometatarsus		0. 100
Antero-posterior diameter of the same (partly inferential)		0. 070
Interval between penetrating foramina on anterior face of shaft		0. 071
Median distal condyle	long diameter	0. 050
	vertical diameter	0. 048
	transverse diameter	0. 040
Internal distal condyle	long diameter	0. 037
	vertical diameter	0. 040
	transverse diameter	0. 031

The large size and wide separation of the penetrating foramina, and the thin internal edge with suture-like facet, distinguish this form as distinct from any of the genera of *Struthionidæ* and *Dinornithidæ*.

MAMMALIA.

BUNOTHERIA.

I.

Animals which fulfilled the functions of the existing *Carnivora* were abundant in North America during the Eocene period. The Wahsatch beds of New Mexico have yielded remains of more than a dozen species which ranged from the size of a Weasel to that of a Jaguar. Investigation into the structure of these shows, that while they differ in minor points among themselves, they agree in possessing characters which distinguish them from the true *Carnivora.* I have already pointed out* that, in the genera *Ambloctonus*, *Oxyæna*, *Stypolophus*, and *Didymictis*, the tibio-tarsal articulation differs from that of the existing *Carnivora*, and suggested that these forms might prove to be gigantic *Insectivora.* Further investigation satisfied me† that they cannot be included in the order *Carnivora*, and their systematic position has proved to be of considerable interest.

A greater or less part of the cranial chamber is preserved in specimens of *Oxyæna forcipata* and *Stypolophus hians.* In these animals, it has a long, narrow form like that of the Opossum, and in the first named, where the interior form can be seen, it is evident that the cerebral hemispheres were small and narrow, and that the olfactory lobes were relatively large, and were entirely uncovered, projecting beyond the hemispheres.

A study of the dentition, which is largely preserved to us in all of the genera, has resulted in establishing the following relations with that of the *Carnivora.*

Professor Harrison Allen has shown‡ that, in the human superior molar, the anterior inner cusp represents by continuity the inner root, and he calls the posterior inner cusp a cingulum. He rightly supposes that it consists of a developed basal cingulum; but as all other cusps beyond the primitive cone have originated in the same way, the completeness of its development in *Homo*, as in other genera, entitles it to the appellation of

* Systematic Catalogue of the Vertebrata of the Eocene of New Mexico, 1875, p. 7.

† On the supposed *Carnivora* of the Eocene of the Rocky Mountains, Proceed. Acad. Phila., 1875; published December 22.

‡ Dental Cosmos, 1874, 617.

cusp as well. An inspection of the molar teeth of the *Mammalia* generally, confirms the view taken by Professor Allen, *i. e.*, that the posterior inner cusp is appendicular to the anterior or true representative of the inner root.

The way being thus prepared, it is a comparatively easy matter to trace the homologies of the cusps of the superior sectorial tooth of the *Carnivora.* In *Procyon*, the posterior inner tubercle is smaller than the anterior; the same is true in the insectivorous genus *Erinaceus.* In *Ursus americanus*, the posterior inner tubercle is the larger, if its position and the occasional presence of a rudimental cusp in front of it truly indicate its homology. In *Scalops*, the posterior inner tubercle is wanting. In *Carnivora* generally, it is wanting; and the anterior tubercle has a much smaller development than the external ones, being largest in the *Viverridæ.*

The flattening of the external tubercles has resulted in the ungulate series, in the crescentoid patterns of the *Perissodactyla* and *Artiodactyla.* The same process, slightly modified, has produced the sectorial blade of the superior dentition of the *Carnivora.* The essential difference in the two cases is, that in the former the resulting crests are concave, not separated by a fissure, and readily worn at the summit, by which they soon lose the cutting character; in the latter, the crests are in a single straight line, are separated by a fissure, and are furnished with a deep layer of enamel on the superior edge. The crests are also, in the *Carnivora*, always unequal.

This inequality is due to the greater elevation of the anterior crest, or, as it should be termed in the greater number of genera, anterior cusp. This cusp is homologous with the principal cusp of the other premolars, while the posterior crest of the sectorial is represented in the *Canidæ* and *Felidæ* by the combined posterior lobe and heel of the typical premolars. In some other groups, the posterior blade may represent the heel only of the premolars; and, in *Prototomus* and *Oxyæna* from the American and *Pterodon* (teste Gervais) from the European Eocene, there are two cones in place of the anterior cusp of the sectorial, the posterior of which may represent the posterior cutting lobe of the premolars of the *Canidæ*, &c.; but this is not absolutely certain.

In a former essay,* I regarded the simple four-lobed or quadritubercu-

*On the Homologies and Origin of the Types of Molar Teeth of Mamm. Educabilia, Phila., 1874.

late molar of the hypothetical *Bunotherium* as the starting-point of all more specialized forms of crested teeth. The second and third lower molars of the Peccaries (*Dicotyles*) represent such a type. It was also pointed out that additional tubercles may be added to this, or to a still simpler form, by the development of basal cingula.

Subsequently* I gave the following account of the homologies of the cusps of the sectorial tooth of the inferior series.

The genus *Hyopsodus* presents a modified form of quadrituberculate molar; in the genera *Pantolestes* and *Sarcolemur*, we observe that the tubercles are similar excepting that the anterior inner is double, or slightly bifid. In some of the molars of *Tomitherium* the two apices of this tubercle are separated more widely from each other, so as to constitute two cusps. These are connected with the anterior outer cusp by acute ridges, which thus form two sides of a triangular area; the anterior ridge is evidently a developed cingulum.

The tubercular molar of some *Viverridæ*, and among the Eocene forms especially of the *Didymictis protenus*, Cope, present a similar structure to that just described. This furnishes a ready explanation of the tooth immediately in advance, which is the primitive form of the sectorial tooth characteristic of that type of *Creodonta*. The three anterior tubercles are largely developed, standing at opposite angles of a triangular space; the outer and anterior cusps are the most elevated, and the ridge which connects them is now a cutting blade. The posterior portion of the tooth does not share in this elevation, and its two tubercles are in some genera obsolete, and in others replaced by an elevation of one margin, which leans obliquely toward the middle of the crown. In *Mesonyx*, this is represented by a median longitudinal crest. If the two tubercles of the posterior part of this tooth (which I have termed a *tubercular sectorial*) are elevated and acute, we have the molar of many recent and extinct *Insectivora;* if the same portion, now called a *heel*, is much reduced, we have the type of *Oxyæna* and *Stypolophus*. In the *Canidæ*, the three anterior tubercles are much less elevated than in the genera above named; the external is much the larger, and the anterior removed farther forward, so as to give the blade a greater antero-posterior

* Proceedings of the Academy of Philadelphia, 1875, p. 21.

extent. The heel is large and without prominent tubercles. In the *Mustelidæ*, the inner of the two median cusps is often reduced to a rudiment, or is entirely wanting, and the heel is large. The lower sectorial of the *Hyænidæ* has no inner tubercle, and the heel is much reduced. In some of the saber-toothed Tigers, the heel remains as a mere rudiment, while in the true Cats it has entirely disappeared, and the carnassial tooth remains perfected by subtraction of parts, as a blade connecting two subequal cusps. The *Hyænodontidæ*, as is known, possess three carnassial teeth without inner tubercle. The history of this form is as yet uncertain, as it was evidently not derived from cotemporary forms of the Eocene with tubercular sectorials.

The development of the carnassial dentition has thus been accomplished first by an addition of an anterior cusp, and subsequently by the subtraction of the inner and posterior cusp, so that of the original four of the quadrituberculate molar, but a *single one*, *i. e.*, the anterior external, remains.

In addition, these animals exhibit the following characters of the skeleton:

The glenoid cavity of the squamosal bone is transverse, and well defined anteriorly and posteriorly, as in some *Carnivora*. Of the first series of carpal bones of the four genera named, I have been able to learn nothing; but in the genus *Synoplotherium*, from the Bridger Eocene of Wyoming, which probably belongs to this group, the scaphoid and lunar bones are separate, and not united as in the *Carnivora*. In all the genera, the ilium has a well-marked external anterior ridge, which continues from the acetabulum to the crest, distinct from the internal anterior ridge. The ilium has therefore an angulate or convex external face, as in *Insectivora* and *Marsupialia*, and does not display the usual expansion in a single plane of most of the placentals. In all the genera, there is a strong tuberosity in the position of the anterior inferior spine, which is wanting in the *Mammalia*, excepting certain *Insectivora* and *Prosimiæ*, although it marks the position of the origin of the rectus femoris muscle in all types.

In *Ambloctonus*, *Didymictis*, and three undetermined forms, the femur supports a third trochanter.

Cuvier describes* the tibia of *Carnivora* as follows: "Quant à la tête inférieure, tous les carnassiers se distinguent de l'homme par sa figure plus étroite du côté externe que le l'interne, et par sa division en deux fosses oblique, au moyen d'une arête arrondie qui repond à la poulie de l'astragale. . . . Le phoque l'a cependant d'une forme très-particulière par l'excessif aplatissement de sa moitié supérieure, et par sa facette particulaire inférieure, qui est en concavité simple et peu profonde."

The astragalar articular face of the tibia, in the genera above named, is not divided into the two oblique fossæ by "a rounded crest which corresponds to the groove of the superior pulley-shaped face of the astragalus". It is uninterrupted and more or less oblique in the transverse direction; always so at the posterior border. The inner malleolar process is produced downward, and rests in a concavity on the inner side of the neck of the astragalus. The astragalus, which I have seen in several of the species, presents a corresponding trochlear face; that is, instead of a groove, it presents an open angle upward, which separates the superior from the oblique internal face. The superior plane is flat, but is interrupted on the posterior side by a groove. This groove is the posterior extremity of that which divides the superior face of the astragalus in the higher *Mammalia*, but here it contracts to a point and disappears next the fibular face just as it reaches the superior surface. The fibular face is vertical, and shares on its posterior part a large ligamentous fossa with the opposed part of the fibula. The distal end of the fibula is remarkably stout.

This structure finds its counterpart in the internal half of the astragalus of the Opossum. The arrangement permits a rotary movement of the astragalus, and thus of the whole foot, on the tibia; the fibula, with its fixed articulation with the astragulus, rotating on the tibia, as in the Pedimanous *Marsupialia*. The flatness of the inner malleolus in some of the species indicates that the capacity for rotation was less in them than in others. This arrangement exactly reverses the extensive oblique fibulo-astragalar articulation seen in the Opossum, the *Petaurista*, *Dasyurus*, &c. Professor Owen, in describing the astragalus of the Wombat (*Phascolomys*), says: "The upper articular surface for the tibia is, as usual, concavo-

* Ossemens Fossiles, vii, p. 122.

convex, the internal surface for the inner malleolus flattened, and at right angles with the preceding, but the outer articular surface presents a triangular flattened form, and, instead of being bent down parallel with the inner articular surface, slopes away at a very open angle from the upper surface, receiving the articular surface of the fibula so as to sustain its vertical pressure. . . . This form of astragalus is also characteristic of the Koala, Petaurists, Dasyures, and the Pedimanous Marsupialia."

In one species, where the cuboid bones are preserved, it is evident that the distal end of the astragalus articulated with this as well as with the navicular bone, although the facet of the astragalus is single and continuous. As the extensive transverse distal astragalar face is characteristic of all the species where it is preserved, the contact of the cuboid and astragalus is probably common to all of this division. There is no elongation of the navicular; it is, on the contrary, very short, since the astragalus projects beyond the calcaneum (in the genera where they have been observed). The cuboid is, on this account, rather elongate, but not remarkably so. There were five toes in the hind feet of some of the species. The ungues in some of the genera are compressed and acute. In the genus *Synoplotherium*, from the Bridger Eocene, I found one of the claws to be broad and flat, so as to be subungulate. I found an ungueal phalange in New Mexico, probably belonging to a species of this group, which presented a similar, though less expanded, form. I have every reason for believing that there were five toes on the hind foot of *Stypolophus hians* and a second species.

The characters now adduced lead to the following conclusions as to the systematic position of these animals.

The small size of the cerebral hemispheres and the very slight indication of convolutions, refer this group to the Lissencephalous or Lyencephalous *Mammalia*. The characters presented by our crania are borne out by those exhibited by the *Arctocyon primævus*, De Blainv., from the Lower Eocene or Suessonian beds of France. Professor Gervais* has discovered that the olfactory lobes are large, and project far beyond the hemispheres, while not only the cerebellum but also probably the corpora quadrigemina were exposed behind. We are therefore restricted, early in the inquiry, to

* Nouvelles Archives du Muséum, 1870, p. 150.

comparisons with a few orders. These are the *Insectivora*, *Marsupialia*, and some of the *Prosimiæ*, which have small brains. Other characters, however, exist, which add to the reasons for separating them from the *Carnivora.*

There is nothing in the dentition inconsistent with the orders *Carnivora*, *Insectivora*, and *Marsupialia.* It resembles that of some *Viverridæ* of the first, *Mystomys* of the second, and the *Sarcophaga* of the third. Nevertheless, in the often limited number of incisor teeth, it approaches most nearly to the *Insectivora.*

The transverse glenoid cavity is that of the three orders named, and distinguishes the group from the *Rodentia.*

So far as known, the coössification of the scaphoid and lunar bones, the distinguishing character of the *Carnivora*, is wanting. The angulate shape of the ilium is that of *Insectivora* and *Marsupialia.* It is less apparent in *Chiromys*, and is not characteristic of the higher *Mammalia.* The large anterior inferior tuberosity is especially a character of the Lemurs, other than *Nycticebinæ* (Mivart),* the *Chiromys*, and of certain *Insectivora*, especially *Solenodon.* It is figured by Mivart in *Indris* and *Loris*, by Owen in *Chiromys*,† and by Peters in *Solenodon.*‡ It is absent in *Carnivora*, the true *Quadrumana*, *Marsupialia*, and many *Insectivora.* Allman§ does not represent it in *Mystomys.* The third trochanter of the femur is wanting in the Gyrencephalous orders generally, characterizing only the *Perissodactyla.* Among Lissencephalous orders, it is very common in the *Edentata*, and still more usual in the *Insectivora.* It does not occur among Marsupials. But in the *Prosimiæ*, there is often a third trochanter (Mivart, *l. c.; e. g.*, *Lemur*, *Galago*). In *Talpa* and some other *Insectivora*, and also in *Chiromys*, it is situated high up, nearly opposite the little trochanter.

In the tibio-tarsal articulation, this group resembles no living genera with which I am acquainted. So far as the tibia is concerned, it is remarkably like that of the Ungulate genus *Coryphodon*, but the astragalus is very

* In a memoir in the Philosophical Transactions, vi, p. 421.

† Proceedings of the Zoölogical Society of London, v, pl. xxi.

‡ Abhandlungen der königlichen Academie der Wissenschaften, 1863, pl. 3, Ueber *Solenodon cubanus.*

§ Transactions of the Zoölogical Society of London, vi, pl. 2, On *Potamogale* (*Mystomys*) *velox.*

different. The astragalus in its oblique inner side reverses the form seen in the Lemurs and that of the Seals, and resembles more nearly that of the true Quadrumana. From these it differs in the absence of the superior groove. The cuboid and navicular are not elongate as in Lemurs. The number of toes, supposed to be five, is that of most of the Lissencephalous Mammals, belonging also to the Bears, the Quadrumana, &c. The flat claws of some of the genera tend to obliterate the distinction between the Unguiculate and Ungulate series, but they are not present on all the digits of all the species.

The comparison of this group brings out principally affinities to the *Insectivora* and *Prosimiæ*. Besides the differences from the *Marsupialia*, already pointed out, in the genera *Oxyæna* and *Didymictis*, the posterior part of the inferior border of the mandibular ramus is not inflected, as in *Marsupialia;* in *Stypolophus* (*viverrinus*), the lachrymal canal is within the orbit, and not exterior to it. The reduced number of incisors in the lower jaw and the normal number above, are a further ground of distinction from the Carnivorous *Marsupialia*.

Comparison with the *Prosimiæ* shows that the differences consist in the sectorial character of the molar teeth and large development of the canines in the Eocene forms; in the short tarsal bones, and peculiar tibio-tarsal articulation; with convex external face of the ilium. This *ensemble* of characters can hardly be regarded as ordinal; and there only remains, to give character to such a distinction, the difference in the size and form of the cerebral hemispheres. This character, in some of the smaller living *Lemuridæ*, is not strongly marked, and in them the approximation of the Gyrencephalous to the Lissencephalous Mammals is at its closest.

The differences from the *Insectivora* are less numerous. The only trenchant distinctive character upon which I can seize, in comparison with *Mythomys* and *Solenodon*, is the peculiar tibio-tarsal articulation. On this account, and because of the rather more marked carnassial characters of the molar teeth, I have proposed to place the genera *Ambloctonus*, *Oxyæna*, *Stypolophus*, and *Didymictis* in a suborder of *Insectivora*, under the name of *Creodonta*.* They stand also in relationship to the Lemurs, and more remotely to the *Carnivora*.

* On the Supposed Carnivora of the Eocene of the Rocky Mountains, by E. D. Cope. 8vo. Philadelphia, December 22, 1875.

II.

Since 1872, the Eocene formations of the Rocky Mountains have been known to contain the remains of numerous species of Mammals which possess greater or less proportions of characteristics of the order *Quadrumana.* Some of these were referred by their first describers to the *Insectivora,* and others to the *Ungulata.* In October, 1872, the writer described a genus, *Anaptomorphus,* represented by a jaw found in the Bridger beds of Wyoming, in whose dentition Quadrumanous characteristics are so marked as to have induced me to compare it with such typical forms as *Simia.* The characters of the mandibular dentition then recorded are those of the true monkeys, but the permanent separation of the mandibular rami, distinguishes the genus from these and from the marmosets, constituting a resemblance to the lemurs. The dental formula is I. 2; C. 1; P. M. 2; M. 3; the crowns of the premolars with a single, undivided, compressed tubercle. In the following year, I published (May 6, 1873) a second paper, in which the characters of *Anaptomorphus* and of the earlier described *Tomitherium* (Cope) were more fully elaborated. In this essay, I referred* the latter genus also to the *Quadrumana,* but as expressing a type even more aberrant than the Lemurs, and therefore well separated from the true Monkeys. I cited, as reasons for this reference, the flat ilium, the long femur, the round head of the radius, the form of the distal end of the radius, with the coössified symphysis and four transverse incisors of the lower jaw. I pointed out that the forms of the molars are similar to those of the *Quadrumana,* and to animals of some other orders as well, while the number of molars is greater than in the Lemurs, or any other known group of the order. The formula of the mandible is I. 2; C. 1; P. M. 4; M. 3. I also pointed out the resemblance between this genus and *Hyopsodus,* which was then estimated as Ungulate, but which has since been stated to be Lemurine. Finally, I added to this series, in the same year,† the genus described by Leidy as *Notharctus,* and a fourth species, which belongs to the genus *Pantolestes,* Cope.

* On the Primitive Types of the Mammalia Educabilia.

† Annual Report U. S. Geol. Surv. Terrs., 1872 (pub. 1873), p. 549.

At the time of the discovery of *Anaptomorphus*, Prof. O. C. Marsh expressed the opinion† that some of the forms noticed by him in the Bridger formation of Wyoming are allied to the Lemurs. He, however, did not state the characters which led him to entertain this opinion, nor did he give such descriptions as would enable the anatomist to judge of its correctness. Up to the present date (May, 1876), no more complete account of these animals has appeared.

In the Actes of the Linnæan Society of Bordeaux for 1873,* M. Delfortrie published a description of the cranium of a Mammal which he named *Palæolemur betillei*, which he referred to the Lemurs, pointing out certain differences. He gave a number of characters which he deemed sufficient reasons for such a course. Chief among these are the completed orbits, directed partially forward, which are associated with elongate nasal bones, large petrous bone, and acutely tubercular molars. M. Delfortrie also points out that the dentition differs from that of the known *Lemuridæ* in the more numerous premolars, giving the following formula: I. ?2; C. 1; P. M. 4; M. 3; or the same as that of *Tomitherium*.

The history of discovery of the European forms of this group is similar to that of our own, in respect to the difficulty at first experienced by paleontologists in referring them to their proper systematic position. The investigations conducted by Cuvier, during the early part of this century, into the extinct *Vertebrata* of the Eocene of the neighborhood of Paris, revealed, among other types, the genus *Adapis* (Cuv.). This he referred to the Ungulates, and to the neighborhood of *Anoplotherium*. Laurillard and Blainville believed that its affinities are to the *Insectivora*. The above-mentioned discovery by M. Delfortrie, of Bordeaux, of the greater part of the cranium, at Bebuer (Department of Lot), of his *Palæolemur betillei*,‡ led him to announce that Lemurs inhabited France during early Tertiary times. This was in confirmation of the opinion of M. Rütimeyer, who had already described a *Cœnopithecus lemuroides* from the Eocene of Switzerland. But M.M. Gaudry and Gervais, on further investigation, came to the conclusion

* The separate copies of this paper are dated May 25, 1873, while a supplement attached to the last page is dated September 4, 1873.

† Amer. Jour. Sci. and Arts, Oct. 8, 1872.

‡ Actes de la Société Linnéenne de Bordeaux, xxix, 1873.

that the *Palæolemur* is the *Adapis* of Cuvier, and that *Aphelotherium*, Gerv., and *Cænopithecus* are also synonyms of it. And they are disposed to accede to the conclusion of Delfortrie as to its affinities. Subsequently, M. Filhol established for this genus, and a new one which he called *Necrolemur*, a family, the *Pachylemuridæ*, adding a new species, *Adapis magnus*.* In this paper, he recognizes the characters pointed out by previous authors, as allying this family to the *Lemuridæ*, as well as the higher dental formula which distinguishes it, and adds some important characters, which are strongly marked in the genus *Adapis*. He finds the cranium to be strongly contracted just behind the orbits and at the pterygoid plates, in a manner unknown to existing *Lemuridæ*.

Subsequent to the above dates, the number of known species of these puzzling Eocene *Mammalia* has been increasing, and the Wheeler expedition of 1874 added a number of genera and species to those previously known. An account of these will be found in the following pages.

I have seen no reason to modify the view originally expressed as to the Quadrumanous affinities of *Anaptomorphus*, but new light has been thrown on the structure of *Tomitherium* and its allies. The fragments of skeletons of two species of this genus (*T. jarrovii* and *T. tutum*) include numerous bones of the tarsus, and these are identical with corresponding parts in the *Creodonta*, and different from those of the *Lemuridæ*. The astragalus extends anterior to the shortened calcaneum, and the navicular is short and the cuboid not elongate. The superior aspect of the first presents two oblique surfaces, one for the internal malleolus, the other for the transverse facet of the tibia. The portions of femur including the third trochanter, the proximal part of the ulna, and the distal portion of the humerus are all closely similar to those of the *Creodonta*. The type specimen of *Tomitherium* includes some parts of the skeleton not present in the New Mexican species. Thus the ilium of *T. rostratum*, while furnished with the prominent anterior inferior spine of the *Creodonta*, is flattened toward the crest, and is not angulate on the external face. The femur is furnished with a very elevated third trochanter, which is opposite to the little trochanter, as in *Chiromys* and *Talpa*,

*Ann. Sc. Géol., t. iv, No. iv, p. 18, pl. vii, viii, 1874, and Journal de Zoologie, iv, p. 464.

and not low down, as in *Creodonta.* The head of the radius is rounder than in *Creodonta.* The skeleton of *Tomitherium*, in fact, bears a strong resemblance to that of *Chiromys*, leaving the skull out of view.

The skeleton of the New Mexican form includes an entocuneiform, like that of *Stypolophus hians*, which indicates a non-opposable hallux.

It is apparent that the supposed Lemurine *Mammalia* of the type of *Tomitherium*, which have the formula of the molar teeth 4–3, cannot be separated by ordinal distinction from the *Creodonta.* They differ from them, it is true, in their wholly tubercular molar teeth, but in this relate to them as the Bears and *Procyonidæ* do to other *Carnivora.* I propose, therefore, to constitute these a distinct group or suborder, intermediate in position between the *Creodonta* and the *Prosimiæ*, under the name of the *Mesodonta* I cannot now find characters by which to distinguish this division from the *Insectivora* as an order.

III.

The remarkable type first introduced to the notice of paleontologists by Leidy, represented by the genus* *Anchippodus*, has been separated as a distinct order of *Mammalia*, under the name of *Tillodontia*, by Marsh, to whom we are indebted for a knowledge of many of its characters. He states these to be, the possession of claws, plantigrade feet with five toes, a third trochanter of the femur, and separate scaphoid and lunar bones; also, that the dentition is characterized by molars of the Ungulate type, small canines, and large scalpriform incisors in both jaws, faced with enamel, and growing from persistent pulps, as in the *Rodentia.* He says this order "seems to combine characters of the orders of Carnivores, Ungulates, and Rodents".

Except in the dentition, the definition above given applies to the *Creodonta;* and an analysis of the dentition shows so many points of resemblance as to render it probable that they pertain to the same order of *Mammalia;* also, except in the incisor teeth, the characters given by Professor Marsh do not differ from those of the *Insectivora.* The structure of the superior molars is not inconsistent with the same order, and the small canines and large incisors are even more like those of most *Insectivora* than

* Amer. Journ. Sci. and Arts, 1875, 221.

are those of the *Creodonta*. The form of these incisors, with their anterior enamel band and growth from persistent pulps, is that of the order *Rodentia.* In all respects, however, there is relation to the *Insectivora* of the type of the *Erinaceidæ* (Hedgehogs). In the latter, the molars and posterior premolars have the same tubercular character, and the inferior molars are similarly composed of two Vs, with the apex outward, an arrangement which is indeed common to a majority of the *Insectivora.* The reduced canines and exterior incisors of *Tillotherium* are again repeated in *Erinaceus,* and the enlarged incisors separated by an interval, are common to both types. The essential difference in the structure of the incisors entitles the *Tillodonta* to a position as a distinct suborder of the *Insectivora,* but the interval is diminished by the genus *Esthonyx.* This genus, with the molar teeth of the type common to the two groups, presents incisors which are intermediate in character. While the anterior face only is covered with enamel, and the edge is thus scalpriform, the latter is not persistently developed, but terminates at a point which obviously distinguishes crown from root. The combination of "characters of Carnivores and Ungulates" with those of Rodents, supposed to exist by Professor Marsh, is thus not obvious.

IV.

Another group of this order was discovered by the writer in New Mexico, and is an especial subject of this report. They differ from the preceding, and all other Mammalian types, in the structure of their superior incisor teeth. These have two band-like enamel faces, one anterior and the other posterior, the result of which is a truncate or concave extremity of the crown on attrition. The inferior incisors are Rodent-like, with an anterior enamel band only. This group I have called the *Tæniodonta.* So far as known, the structure of the molar teeth is more simple than in the *Tillodonta,* and the enamel is reduced in its extent, being chiefly present in bands on their external faces. In one genus, *Calamodon,* the surfaces thus left uncovered are invested with a layer of cementum.

V.

It appears to me that the four divisions above defined are not separable as orders from each other, but are connected by very close gradations. It appears to me also that it is impossible to frame a definition for them all which shall exclude the *Insectivora* of the present geologic period. The definition in question must be the following:

Cerebral hemispheres small, leaving the olfactory lobes and cerebellum exposed; the surface smooth, or nearly so. Limbs ambulatory, armed with a greater or less number of compressed ungues. Articulation of the mandible transverse. Molar teeth of the superior series (and usually of the lower) tubercular, and without continuous crests. Incisor teeth present in the premaxillary bone. Teeth invested with enamel. Feet with five digits (with a few exceptions). Usually a third trochanter of the femur.

I have applied to this order the name *Insectivora*, so as to avoid the creation of a new one. I now think that the latter would have been the better course. The name *Insectivora* has acquired currency as applied to the well-known modern group of that name, and its application to types of such apparent diversity as those now associated under a single head is not a convenience. I therefore propose the name *Bunotheria* for the order, and include under it the suborders *Creodonta*, *Mesodonta*, *Insectivora*, *Tillodonta*, and *Tæniodonta*. Further investigation will be necessary in order to determine the relations of the *Prosimiæ* to this order. The suborders are characterized as follows:

Superior incisors normal, not growing from persistent pulps; canines much enlarged; premolars compressed; molars more or less sectorial; astragalus not grooved above, articulating with cuboid and navicular; scaphoid and lunar bones distinct; five toes on the hind foot.. *Creodonta.*

Incisors not growing from persistent pulps; molars tubercular, never sectorial; ? third trochanter elevated; astragalus not grooved above.............................. *Mesodonta.*

Incisors enlarged, simple, not growing from persistent pulps; canines reduced; astragalus concave or grooved above... *Insectivora.**

Incisors much enlarged, growing from persistent pulps, and faced with enamel in front only; therefore scalpriform .... *Tillodonta.*

Incisors much enlarged, growing from persistent pulps, the superior faced with enamel in anterior and posterior bands, and hence truncate.................. *Tæniodonta.*

The order of *Bunotheria* with these subdivisions is not more heterogeneous than that of the *Marsupialia*, and presents a great similarity in its component parts. Thus the *Creodonta* resemble the *Sarcophaga*, the *Insectivora* the *Entomophaga*, and the *Tillodonta* the *Rhizophaga*. *Phasco-*

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* Linn., Bonap., Gill. The typical *Insectivora.*

lomys, the type of the last suborder, presents several points of resemblance to the *Tillodonta*.

The affinities of the groups here combined under one ordinal caption are very divergent. The order is generalized, and, as such, does not present the peculiar features of the *Chiroptera*, *Rodentia*, and *Edentata*, but is so far negative in its character as to preclude more than subordinate subdivision. While the existing division *Insectivora* maintains the typical characters, the *Dermoptera*, also existing, are doubtless relics of the group from which the *Chiroptera* derive their ancestry. The *Tillodonta* present some kind of affinity to the Rodents, while the *Tæniodonta* present us with a point of connection with the *Edentata*. The discovery of this fact is particularly welcome, as we have not previously had any hint of the relations between that anomalous order and the remainder of the *Mammalia*. So far, I have only indicated relationships to smooth-brained (lissencephalous) orders. The connections with the *Gyrencephala* (or *Educabilia*) are quite as close, namely, as already pointed out, through the *Mesodonta* to the *Prosimiæ* and the *Quadrumana*, and through the *Creodonta* to the *Carnivora*.

Standing in this structural relation to different existing types, and in an antecedent relation as to time, it is easy to look on the *Bunotheria* as ancestral to some of them. In the first place, the *Insectivora* represent them in the existing fauna. The *Creodonta* are probably the ancestors of the *Carnivora* and the *Mesodonta* of the *Prosimiæ*. This ancestry is rendered almost certain by the recent discovery, by Drs. A. Milne-Edwards and Grandidier, of the affinity existing between the *Prosimiæ* and the *Carnivora*.

Before the discovery of the species and genera which form the subjects of this report, I wrote* as follows: "I trust that I have made it sufficiently obvious that the primitive genera of this division of Mammals must have been Bunodonts with pentadactyle plantigrade feet. * * We may anticipate the discovery of such a genus, and believe that it will not be widely removed from the Eocene *Hyopsodus*, or perhaps *Achænodon*. * * But it will be more than this: it cannot be far removed from the primitive Carnivore and the primitive Quadrumane. The *Carnivora* are all modified Bunodonts, and the lower forms (*Ursus*, *Procyon*, &c.) are pentadactyle

* On the Homologies and Origin of the Types of Molar Teeth of Mammalia Educabilia. Journal Academy Philadelphia, 1874, p. 20.

and plantigrade. As to the *Quadrumana*, man himself is a pentadactyle plantigrade Bunodont. * * Such a hypothetical type might be expressed by the name *Bunotheriidæ*, with the expectation that it will present subordinate variations in premolar, canine, and incisor teeth. The premolars might be expected to differ in the degree of development of the internal lobes, the canine in its proportions, and the incisors in their number."

The history of discovery of the Eocene forms of this order is briefly told. Professors Leidy, Marsh, and myself had described *Creodonta* as *Carnivora*, until I pointed out, in some remarks before the Philadelphia Academy (published December 22, 1875), their true relations. The first species of *Tillodonta* was described by Leidy from an inferior molar from New Jersey in 1868. Dr Leidy next described the dentition of the mandible of the same genus from Wyoming. Subsequently, Marsh described the superior molars of an allied genus, also from Wyoming. In 1874, the writer described the dentition of the *Tæniodonta* from specimens collected in New Mexico. In March, 1875, Marsh proposed the *Tillodonta* as an order of Mammals, giving its dental characters, and stating that the brain was "small". In December, 1875, in his remarks on *Creodonta*, Professor Cope referred this group to the *Insectivora* as a suborder. In March, 1876, Marsh gave a full description of the cranial characters of the genus *Tillotherium*, describing the characters of the brain from a cast of the cranial cavity. In the same month of 1876, the writer characterized the suborder *Tæniodonta*, referring to it the genera *Ectoganus* and *Calamodon*.

CREODONTA.

The genera of this suborder found in the Wahsatch beds of New Mexico differ as follows:

I. First and third inferior true molars without internal cusp; last superior molar longitudinal; last inferior molar carnassial.................*Ambloctonus*.
II. Inferior carnassials with interior tubercle; no tubercular molar; last superior molar transverse:
  Three tubercular carnassials.................................*Stypolophus*.
  Two tubercular carnassials...................................*Oxyæna*.
III. Inferior carnassial with interior tubercle; a tubercular molar:
  One tubercular carnassial....................................*Didymictis*.

The number of toes on the hind foot cannot be certainly stated in all the genera; but, in *Stypolophus hians*, there were probably five, the inner being of reduced size. There is present in those species an entocuneiform bone, which resembles that of *Canis;* it is compressed, with one truncate concave terminal facet, and an internal oblique one at the opposite and proximal extremity. The form of the truncate articular face of the distal end indicates the existence of an inner metatarsal bone of moderate proportions, which probably supported a small hallux. This thumb could not be opposable, as in the Opossum.

In general appearance, the *Creodonta* differed from the *Carnivora*, in many of the species at least, in the small relative size of the limbs as compared with that of the head, and in some instances as compared with the size of the hind feet. The feet were probably plantigrade, and the posterior ones capable of some degree of horizontal rotation. The probable large size of the rectus femoris muscle indicates unusual power of extension of the hind limb. They were furnished with a long and large tail. Probably some of the species resembled in proportions the *Mystomys* and *Solenodon*, now existing in Africa and the West Indies, but they mostly attained a much larger size.

To the *Creodonta* must be referred, according to the information which we possess, the genus *Arctocyon* of Blainville. Professor Gervais has discovered that it possessed the very small cerebral hemispheres characteristic of the *Creodonta.* The olfactory lobes are large, and project far beyond the hemispheres, while not only the cerebellum, but probably the corpora quadrigemina, were exposed behind. The tarsal articulation and the posterior part of the mandibular bones are unknown, hence this reference is not certain. Professor Gervais* regards it, after Laurillard,† as a Marsupial, and establishes an especial family of the order for its reception. It is, however, more probable that its affinities are with the contemporary genera of flesh-eaters *Palæonyctis*, Blv., and *Pterodon*, Blv., genera which have near allies among the subjects of this memoir. *Palæonyctis* was the contemporary of the Coryphodons in the Suessonian period of Western Europe, and presents a strong resemblance to *Amblotonus* in its mandible, the only part of the

*Nouv. archives du museum, 1870, p. 150.
†Dict. univ. d'hist. naturelle, ix, p. 400.

skeleton known. The posterior part of the ramus is not inflected according to Gervais, and he therefore does not refer it to the *Marsupialia.** The nearest European representative of *Oxyæna* is *Pterodon*, in which the form of the mandible also forbids a reference to the *Marsupialia*, as Gervais has remarked. Both genera are doubtless members of the suborder of *Creodonta.* The genus *Hyænodon*, on the other hand, is not referable to the same group, since the figure given by Professor Gervais† representing the brain of the originally-described type, *H. leptorhynchus* of the Miocene period, displays characters of the true *Carnivora.* The anterior part of the cranial cavity of the specimen moulded is broken away.

It is possible that the genus *Diacodon*, Cope, belongs here also; its species resemble slightly the *Chiroptera* in the inferior dentition, and are of small size. Here must also be referred supposed *Carnivora* from the Eocene of Wyoming, stated by Marsh to be allied to the *Viverridæ.*

The genus *Mesonyx*,‡ which I discovered in the Bridger beds of Wyoming, cannot be referred to the *Creodonta* as here constituted, since the trochlear face of its astragalus is completely grooved above as in the true *Carnivora*, and its distal end presents two distinct facets, one for the cuboid, and the other for the navicular bones. It represents on this account a peculiar family, the *Mesonychidæ.*

There are various degrees of development of the sectorial structure of the molars in this suborder. In some of them, as *Didymictis*, only one of the inferior molars presents this structure; in others two, and in others three. In one type, the last superior molar is longitudinal; in others, it is transverse. In *Arctocyon*, the superior true molars are tubercular. For the present I point out the three following families as well defined:

1. *Ambloctonidæ.*—Last superior molar longitudinal; inferior molars with the internal tubercle little developed. Genera,—*Ambloctonus*, and perhaps *Palæonyctis.*

2. *Oxyænidæ.*—Last superior molar transverse; the preceding ones sectorial; inferior molars sectorial. Genera,—*Stypolophus*, *Oxyæna*, *Pterodon*, and perhaps *Patriofelis.*

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* Nouv. archives du muséum, 1870, 151.

† Loc. cit., pl. vi, fig. 5.

‡ Ann. Rept. U. S. Geol. Surv. Terrs., 1872, p. 550.

3. *Arctocyonidæ*, Gervais.—Posterior superior molars tubercular. (One or more posterior inferior molars tubercular in American genera.) Genera *Arctocyon*, and probably the American genera *Miacis* Cope, (*Uintacyon*, Leidy), and *Didymictis*.

No genus of this suborder has been found in any formation above the Eocene either in Europe or America, and all, excepting *Miacis*, *Patriofelis*, and *Stypolophus*, are from the Suessonian or Wahsatch beds only; the three genera named being from the Bridger. The nearest ally in Miocene beds appears to be *Hyænodon*, which approaches nearly to *Pterodon* in its dentition, so that the two have been regarded as identical by some authors. If the latter genus resembles the *Creodonta* in its brain form, it is quite distinct from the Miocene genus; but, on this point, we are not yet in possession of the necessary information.

AMBLOCTONUS, Cope.

System. Cat. Vert. Eocene of New Mexico, U. S. Geog. Survs. W. 100th M., 1875, p. 7.

The fossil remains which illustrate this genus include the greater part of the dentition of one side of the cranium and that of the posterior part of the mandible, with a number of bones of the limbs; the teeth are somewhat worn, but not so much so as to prevent determination.

The superior molars preserved are three in number, which extend posteriorly from below the orifice of the *foramen infraorbitale exterius*. The crowns are longitudinal, and consist of a three-lobed exterior blade and an inner depressed tubercle. The last molar is longitudinal, and not transverse, as in *Oxyæna*. The superior canine is large, and is preceded, with a short intervening diastema, by a very large exterior incisor. The last inferior molar consists of two cusps and a rudimental heel. The cusps form a short carnassial blade. Their number cannot be determined on the penultimate molar, but there is a well-developed heel, and the anterior part of the crown is wide. The molar which precedes has three principal cusps, the two anterior forming together a blade; in the type-species, there are accessory tubercles adjacent to the posterior cusps.

Among the fragments of the limb-bones of *A. sinosus* some characteristic features may be noted. Thus the distal extremity of the ulna exhibits an extensive transverse articulation with the carpus, and an external tuberosity relatively little produced. The external ridge of the shaft of the femur is developed into a protuberance, which is a low third trochanter. In the tibia, the trochlear surface is oblique and nearly uninterrupted, much as in *Oxyæna*, and without the grooves for an hourglass-shaped astragalus, as in *Mesonyx*.

This genus resembles *Hyænodon* in the structure of its superior molars. It differs in the inferior molars, especially in the existence of a tubercular heel of the antepenultimate and penultimate, and probably in the arrangement of cusps on the anterior part of the latter.

Ambloctonus sinosus, Cope.

Plate xxxiii.

System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. 100th M., 1875, p. 8.

Two imperfect skeletons represent this species in the collections of the Survey. The best preserved includes the right maxillary bone, with crowns and roots of the last four molars. The first of these is wider behind than before, the posterior root being double. The next has a triangular crown, with the exterior and anterior borders at right angles to each other, and of subequal lengths. The fourth tooth is not quite so wide, but about as long as the one just described, has three lobes of the outer summit, and a convex anterior border. The interior heel of the first molar is constricted at a point of its border, indicating an additional internal cusp, probably basal. The foramen infraorbitale is remarkably large. Owing to the state of the specimen, the number of premolars cannot be ascertained. The canine is worn almost to the alveolar border in a vertical truncation; the diameter of the alveolus for the third or outer incisor is but little less than that of the canine.

The characters of the three last inferior molars may be partially determined from the two individuals. The last molar is smaller in the specimen already partially described than the two which precede it, and which are subequal. It has a very short heel, with a cutting-edge on the outer side. The remainder of the crown is subtriangular in section at the base, supporting a posterior and an anterior tubercle, which are connected on their inner sides by a cutting-edge. There is a cingulum on the internal base continuous with the border of the heel, but none on the outer side. The antepenultimate molar has three cusps, of which the median is largest, and the anterior and posterior have subequal bases. The anterior turns to the inner side of the tooth, the median stands on the outer side, while the posterior is median. It has an accessory tubercle on each side of it, that of the inner side much the more elevated, and combining with the median to form an incurved grinding-surface on attrition. This cusp sends a ridge downward and forward to the interior base of the crown, where it is succeeded anteriorly by a rudimental cingulum. There is no external basal cingulum. The enamel bears marks of obsolete rugosities.

Of bones of the limbs, there were found the distal end of the ulna, the shafts of both femora, and the distal third of the length of the tibia. The first-named piece is very characteristic. The articular face, although oblique, has nothing like the form seen in *Ursus*, *Canis*, and *Felis*, since the external tuberosity is far less prominent, and its surface passes by a gentle slope into that of the inner part of the extremity. The radial facet is, on the other hand, presented inward and slightly forward, at a strong angle with the carpal surface The usual transverse fossa is present below, within the carpal extremity, while the superior surface is convex in transverse section, and is without well-marked tendinous grooves. The remarkable transverse extent of its carpal articulation has already been noted. The shafts of both femora are preserved, but the trochanters and condyles are wanting. The head displays the fossa for the ligamentum teres continuous with the deep emargination of the postero-internal border. The plate connecting it with the great trochanter is strongly emarginate, and the trochanter has an elevated position; the extremity is broken off. The shafts are compressed, the transverse diameter being the greater. The external border is the narrower, and, on the proximal regions, is produced into a low rib, which expands into the compressed tuberosity of the third trochanter. The base of the condyles shows that the internal condyle is the more elevated, and the external the more oblique.

The shaft of the tibia is normally remarkably compressed at its distal third, so as to have an oval section, with the long diameter antero-posterior. The distal end has a remarkably produced malleolus, whose inner side, like that of the shaft with which it is continuous, is nearly flat. The narrow, prominent, anterior face of the shaft is continued obliquely into the malleolus, while the posterior face expands gradually, and without irregularity, into the entire distal extremity. The ligamentous groove on the postero-interior aspect could not have been large, although its precise character is obscured by injury of the surface of the bone. The astragalar face is more oblique transversely than in any of the genera of this group: the posterior margin is, as elsewhere, the most so; but the anterior is in no part transverse, as in *Stypolophus*. As in the other genera, it forms an angle with the malleolar surface, but a very open one. As usual, the strongest concavity of the astragalar face is next the malleolus. The external margin is narrowed and slightly recurved, not truncate as in *Stypolophus*. This tibia also differs strikingly from that of the latter genus in the absence of the postero-external longitudinal angle and the compression of the shaft. It differs from that of *Oxyæna* in the absence of the exterior ridge, the posterior and interior tuberosities, and compression of the shaft. The distal part of the calcaneum is rather elongate and compressed.

This species of Carnivore is of robust character, and about the size of the Jaguar.

Measurements.

		M.
Length of the bases of the last four superior molars (No. 1)		0.0710
Length of the crown of the antepenultimate superior molar		0.0175
Width of the same		0.0170
Length of the crown of the last molar		0.0180
Width of the same		0.0160
Length of the last three inferior molars		0.0410
Length of the crown of the last inferior molar		0.0120
Width of the same		0.0080
Length of the crown of the antepenultimate inferior molar		0.0140
Width of the same		0.0110
Diameter of the superior canine		0.0170
Length of the last three inferior molars of specimen No. 2		0.0490
Length of the antepenultimate molar of the same		0.0150
Depth of the ramus of the jaw at the penultimate molar		0.0420
Diameter of the shaft of the femur of No. 1 below middle		0.0240
Diameter of the head of the femur		0.0270
Diameter of the shaft of the tibia (least)		0.0190
Diameter of the distal end of the tibia measured obliquely		0.0350
Diameter of the calcaneum	vertical	0.0260
	transverse	0.0130

As compared with the *Synoplotherium lanius*, Cope, to which this species is probably allied, all the teeth are wider and more robust, excepting the canines. Although the disposition of the tubercles of the lower molars in *Synoplotherium* is unknown, the narrow form of their bases renders it probable that the structure is rather as in *Hyænodon* than as in *Ambloctonus*, especially in regard to the antepenultimate, which is so exceptionally tubercular in the present animal.

PACHYÆNA, Cope.

Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 13; Id. Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 125.

Established on a single superior molar tooth of a large Carnivore, apparently allied to the group of flat-clawed *Carnivora*. It is either the last premolar or first true molar. It is characterized by the absence of the cutting-edge seen in the allied genera, and its replacement by a conic tubercle.

The crown supports three principal tubercles, two external and one internal. Of the two external, the anterior is the largest and most prominent, and it is separated from the posterior one by a deep notch. The internal tubercle is opposite the anterior external, from which it is separated to the base by a deep notch. The sections of the tubercles are subround. Thus the principal lobe is a cone, and the inner one a perfect cone, a little less elevated than the principal one.

The affinities of this curious genus are not yet determined.

Pachyæna ossifraga, Cope.

Plate xxxix, fig. 10.

Report, loc. cit., p. 13.
Report, loc. cit., p. 125.

Crown with well-developed anterior and posterior basal tubercles, which resemble the short heels of some inferior teeth; no cingula, either internal or external. The external cones exhibit an obtuse anterior and posterior cutting-ridge, but there is none on the internal cone. Enamel slightly rugose.

Measurements.

	M.
Length of the crown	0.020
Width of the same	0.018
Elevation of the anterior basal tubercle	0.006
Elevation of the central cone	0.011
Elevation of the interior cone	0.010

This is the largest Carnivore yet observed in this formation, and of peculiar character; its structure indicating a diet not purely carnivorous.

OXYÆNA, Cope.

Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 11; Id. Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 123; System. Cat. Vert. Eocene New Mexico, 1875, p. 9.

Dental formula: I. $\frac{3}{0}$; C. $\frac{1}{1}$; Pm. $\frac{4}{4}$; M. $\frac{2}{2}$. Two small median superior incisors and a very large external one separated by a diastema from the canine. The latter is large, and is followed with little interval by the first premolar. The two last premolars and all the molars of the superior series with an internal heel; the last molar transverse; third and fourth upper premolars with an anterior cone and posterior cutting-lobe; the first true molar with two anterior acute cones, the posterior forming a sectorial edge with the posterior lobe; last superior molar with a single trenchant edge.

In the mandibular dentition, the canine teeth are directed forward and upward without intervening incisors. First premolar one-rooted; second and third consisting of an anterior elevated cone and posterior heel, which is elevated and trenchant in the middle. The fourth premolar is nearly similar, with the posterior tubercle sharp-edged. The two true molars with an anterior elevated portion and small, low heel; the former consisting of three acute tubercles, of which the largest or exterior forms with the anterior, a sectorial blade oblique to the axis of the mandibular bone.

This genus has one less superior molar with double median cone than *Stypolophus;* in that genus, I find also in the lower jaw three sectorials of the form described, instead of two only. It is one of the group which, with *Synoplotherium*, Cope, presents in its dentition a nearer resemblance to the genus *Hyænodon* than to any other of later age. It differs from both the genera named in having only six molar teeth, and the triangular type of inferior sectorial teeth is not seen in either.

On a former occasion, I wrote the dental formula of *Oxyæna*, molars. 3–3 (Annual Report of the Chief of Engineers, 1874, p. 599), but now transfer one tooth from the premolar to the molar series, in accordance with the correct homology, so as the read 4–2.

The exterior portion of the posterior transverse superior molar is a transverse blade, interior to which is one or probably two subtriangular cusps. The blade shuts down in contact with the plane posterior face of the united middle cusps of the last inferior molar, and the cusp shuts down on the inner side of the heel of the same where the surface is often seen to be worn obliquely by it. The elevated cusps of the last inferior molar close into a deep fossa of the maxillary bone; the blades of the external and anterior cusps shearing against the inner side of the posterior median cusp and posterior blade of the penultimate superior molar. The inner heel of the latter opposes transversely the posterior heel of the penultimate inferior molar, shearing somewhat with the posterior border of the united median cusps. The external and anterior cusps of the penultimate inferior molar, with their external shear, fit within the median cusp and posterior blade of the antepenultimate superior molar, and are received into a corresponding pit of the maxillary bone, which is not so deep as the posterior fossa. The surface of the maxillary between this tooth and the last premolar is only slightly concave. Thus, in this genus, and the arrangement is similar in *Stypolophus*, each inferior tubercular sectorial tooth makes two shears with two corresponding superior molars, viz, a posterior transverse with the superior molar behind it, and an external oblique with the superior molar corresponding to it. This does not occur in any recent *Carnivora*, and is a more complex, although much less powerful, arrangement than they possess.

The skull in this genus is robust. In the *O. forcipata*, there is an elevated sagittal crest, and the superior walls of the cranium are massive. The crest divides on the posterior part of the frontal region, and disappears. The zygomata are short and deep, and laterally expanded. The malar bone rises in a strong postorbital process, partially inclosing the orbits, as in the Cats.

The head of the humerus in *O. morsitans* exhibits a rather large greater tuberosity and small lesser one. The spine of the scapula rises abruptly near the glenoid cavity. In a fragmentary skeleton of probably the same species, a portion of the ilium is preserved. It exhibits a tuberosity above the acetabulum which represents the "anterior inferior spinous process" of human anatomy, and is larger than in the existing genera *Ursus*, *Canis*, and *Felis*. The middle of the shaft of the femur is wanting in all our specimens of this genus. The proximal portion of that of *O. morsitans* is wide and flat, and has a large great trochanter about equal in elevation to the head, which does not inclose a deep or large fossa. The fossa for the ligamentum teres is at the fundus of a deep emargination of the rim of the head. The distal part of the femur is flattened as in *Ambloctonus*, and the patellar groove is not elevated as in *Stypolophus viverrinus*, but wide, although less so than in the Bears.

The distal end of the tibia of probably *O. morsitans* exhibits the ungrooved astragalar surface of the other *Oxyænidæ*, with abruptly projecting internal malleolus. Its border is less regular than in the genera described. The outer extremity is not truncate, but gives rise to a longitudinal external ridge of the lower part of the shaft, and there is a tuberosity on the posterior and one on the inner aspect of the lower extremity. The posterior as well as the anterior astragalar border is angulate at the base of the malleolar process. The ligamentous grooves are shallow. I have no astragalus of this genus, but the proximal part of a calcaneum displays the usual two astragalar facets. It is remarkable for the obliquity of the facet for the cuboid, which presents upward as well as forward (when in the supine position). The calcaneum is wide, especially in its postero-inferior face, and the posterior free portion is narrow and oblique, indicating a plantigrade habit. Its flatness exceeds that in *Ursus arctos*, and the expanse of the anterior portion is similar to that genus, while greater than in *Canis* and *Felis*. The obliquity of the cuboid facet is not seen in either of the recent genera named. Numerous phalanges have been obtained, but none of them ungueal. They are depressed, with their distal articular facets slightly emarginate. None of them present the triangular section characteristic of many recent *Carnivora*. Their proportions are not different from those seen in the *Ursus arctos*.

But few vertebræ have been preserved: those of the tail indicate that that member was of full proportions.

This genus resembles *Pterodon*, as described and figured by Gervais, in the dentition of the maxillary bone; but the teeth of the lower jaw are totally distinct in character, approaching more nearly those of the *Palæonyctis* of De Blainville. According to Gervais,* the inferior molars of *Pterodon* are like those of *Hyænodon*, without interior tubercle, and the inner lobes of the superior molars are not so large as in *Oxyæna*. The latter differs from *Palæonyctis* in the character of the antepenultimate lower molar, which, in *Oxyæna*, is characterized by the presence of a median blade, but, in *Palæonyctis*, by a heel supporting (in the typical species) two tubercles.

The Oxyænas were the most abundant of the Eocene *Carnivora*, estimating them by the relative frequency of occurrence of their remains. There were at least three species, which ranged from the size of a Terrier-dog (*O. morsitans*) to that of a Jaguar (*O. forcipata*). They are of robust structure, and resemble *Synoplotherium* in the anterior production of their canine teeth, which are so closely approximated as to exclude the incisors altogether. Specimens obtained include the dentition of both jaws and bones of the skeleton. The phalanges have the same flattened form seen in the flat-clawed genera discovered in Wyoming, but I have not been so fortunate as to obtain those of the ungues.

Oxyæna morsitans, Cope.

Plate xxxiv, figs. 1–13.

Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 12; Id. Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 124.

This, the smallest species of the genus, is represented by parts of the skeletons of three individuals, while others in the collection probably belong to it. The original description was based on a series of inferior molars, found in association by myself, but not attached to the jaw. A second specimen includes a portion of the jaw with the last three molars, and a

* Paléontologie française.

considerable number of fragments of bones of the skeleton. The third includes a number of superior molars of both sides of the skull.

The posterior true lower molar is larger than the penultimate. Its heel is very small, and has its border elevated all round; the inner tubercle only marks about half the elevation of the outer, which is also considerably more elongate than the anterior. At the point of junction of the last-named cusps, there is a fissure which completes the sectorial effectiveness of their blade-like opposed edges. There is no cingulum except a trace at the antero-external base. There is a well-marked tubercle at the anterior base of the anterior cusp. The penultimate molar is distinguished by the larger heel and smaller median cusp. The inner border of the heel is elevated and acute; the inner tubercle marks more than half the external cusp. There are no cingula, and no subordinate tubercles. The last premolar has the usual anterior cusp and posterior heel, with median cutting-edge. A cingulum descends from the postero-superior angle of the latter to near the base of the large cusp; there are no other cingula. The canine is a compressed oval in section. The enamel on all the teeth is rugose, except where smoothed by attrition.

Measurements.

	M.
Length of the base of the crown of the sectorial tooth	0.014
Width of the base of the crown of the sectorial tooth	0.009
Elevation of the principal cusps	0.015
Elevation of the inner posterior cusps	0.007
Length of the basis of the penultimate molar	0.012
Width of the basis of the penultimate molar	0.007
Length of the heel of the penultimate molar	0.005
Elevation of the principal cusps	0.011
Elevation of the anterior cusps	0.006
Long diameter of the canine at the base	0.018

The last molar of the second specimen mentioned differs from the type in wanting the anterior basal tubercle; the heel is also a little larger. The last premolar has a tubercle at the anterior base of the principal cusp. The humerus is distinguished by the antero-posteriorly-compressed form of the proximal part of the shaft, caused by the strong projecting ridge which descends from the antero-exterior border of the greater tuberosity. The posterior face is a flat plane bounded by two longitudinal angles, the outer and more prominent being a continuation of the posterior projection of the lesser tuberosity. There is no internal bicipital ridge. The glenoid cavity of the scapula is a wide oval.

Measurements.

	M.
Length of the bases of the two inferior true molars	0.026
Length of the base of the last true molar	0.014
Elevation of the anterior cusp of the last molar	0.0085
Depth of the ramus at the penultimate molar	0.034
Length of the crown of the last premolar	0.014
Width of the same	0.0076
Diameter of the head of the humerus across both tuberosities	0.031
Diameter of the shaft of the humerus below the tuberosities (transverse)	0.0135
Diameter of the same (antero-posterior)	0.0215
Width of the proximal end of the femur	0.040
Diameter of the ball	0.018
Antero-posterior diameter at the little trochanter	0.0125
Least diameter of the glenoid fossa of the scapula	0.014

The superior molar teeth of the third specimen are accompanied by an inferior molar of the same character as that of the type, and I suspect that they belong to the *O. morsitans*. The three molars preceding the last one occupy nearly the same length as the two corresponding posterior molars in the *O. lupina*. The structural differences between the teeth of the two species are, the greater prominence of the internal heel of the third premolar in *O. morsitans* and the greater length of the posterior blade of the penultimate molar in *O. lupina*.* There is a weak external basal cingulum in *O. morsitans*, and the two triangular molars have each a small anterior tubercle. The penultimate molar has, besides the low cusp of the inner heel, a strong internal cingulum, and a small tubercle on each border at the inner base of the central cusps. The enamel is strongly but delicately wrinkled.

Measurements.

	M.
Length of the bases of the three triangular molars	0.0385
Length of the bases of the last triangular molar	0.0143
Width of the same	0.0114
Width of the bases of the second triangular molar	0.012
Length of the bases of the second triangular molar	0.0137
Length of the bases of the fourth inferior molar	0.012

* Compare Plate xxxiv, fig. 10, with figs. 14*a* and 16*a* of the same plate.

A fourth specimen includes portions of almost all parts of the skeleton, including a few teeth, whose proportions refer them to this species. The crown of the canine is long and acute, and the enamel is rugose, with delicate reticulations and longitudinal grooves. The zygomas are strongly convex, and the prominent borders of the glenoid cavities are of equal development. The caudal vertebræ are large and elongate. The inferior extremity of the tibia has been already described in its more important features. The shaft is subround in section, the outer margin produced by the presence of two longitudinal ridges of the outer side, one of which extends to the lower extremity; the other lying close to it disappears above that point.

Measurements.

	M.
Length (transverse) of the glenoid cavity	0.031
Length of the caudal vertebra	0.0285
Diameter of the end of the centrum of the caudal vertebra	0.012
Diameter of the shaft of the tibia	0.014
Diameter of the astragalar face (transverse)	0.022
Diameter of the astragalar face (antero-posterior)	0.015

This Carnivore was about the size of the Coyote (*Canis latrans*).

Oxyæna lupina, Cope.

Plates xxxiv, figs. 14–37, and xxxv, figs. 1–4.

Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 11; Id. Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 123.

I refer to this species five individuals, all including more or less completely preserved dentition, and some of them embracing portions of the limbs and vertebræ.

These specimens are all intermediate in size between those referred to the *O. morsitans* and the *O. forcipata*, and are readily distinguished by that test from those species. They differ among themselves in the relative development of the internal heel of the third superior premolar; in some, this heel is well marked; in others, quite rudimental. The inferior sectorials of the individual regarded as typical of the species differ from the corresponding ones of the *O. forcipata* in the relatively smaller size of the interior tubercle; it is very insignificant in the *O. lupina*, and does not reach the elevation of the line of the anterior cusp, while in the larger species the two cusps have the same elevation, and the interior is separated from the external by a fissure. How far this character will define large series of specimens, I have no means of knowing; but it is constant in four of the *O. forcipata.*

The typical specimen of the *O. lupina* includes part of the dentition of both jaws, with bones of the cranium, limbs, and vertebræ in a fragmentary condition. The fourth and fifth superior molars have well-developed anterior tubercles and elongate posterior blades; the internal heel of the fourth is large, much exceeding that of the fifth, and there are no intermediate tubercles: both have a weak internal basal cingulum. There is a weak external basal cingulum on both. The third premolar has no anterior basal tubercle in this or any of the other specimens, but the heel has a median cutting-edge nearly as long as the long diameter of the large compressed median cusp. There are faint cingula on both bases of the crown. In a more anterior premolar, the posterior blade is reduced to a trenchant cusp, and the principal cusp has low cutting-edges. Its external face is convex; the internal, concave in the longitudinal direction. The crown of one of the small median incisors is larger in antero-posterior than transverse diameter, and contracts to a short subconic apex.

The posterior lower molars have a small heel, one border of which forms a cutting-edge higher than the other; the anterior cusp is much less elevated than the external median, and is obtuse and without basal tubercle in front. It differs in this respect from the three specimens of *O. forcipata,* where the corresponding part of the tooth is preserved. In these, the anterior margin of the anterior cusp is an acute edge, with a subacute lobe at the base. The canine is a vertical oval in section at the base of the crown, and the enamel extends much farther downward on the external than the internal face, as in other species of the genus. The enamel of the teeth is rugose with impressed punctæ, which are least marked on the penultimate superior molar.

A caudal vertebra of the same animal, without neural arch, is of full relative size, and quite slender in form, indicating a long tail for the species. A wide saucer-shaped bone, resembling the navicular of a Bear in form, is wider than that of *Canis* and *Felis:* it is thin and concavo-convex. One border is concavely emarginate, with a small tuberosity. Its convex face is smooth, with a slight interruption, and is undivided. Another bone resembling that which I described as cuneiform in *Synopolotherium lanius* is deficient in one end. One side presents a concave facet, the other two parallel concave facets separated by a ridge. The precise reference and relation of these two bones are rendered somewhat obscure by their incompleteness. Portions of three metapodial bones are relatively of small size, and have the proximal articular faces slightly concave in an antero-posterior direction. The shafts are cylindric, and the distal articular condyle slightly oblique, with strong lateral ligamentous fossæ, and small inferior keel. A proximal phalange is of appropriate size: it is everywhere flat, and is widened at the proximal end by lateral tuberosities. The distal end is contracted, and the articular face angularly concave below. The tendinous insertions are a pair of longitudinal tuberosities. The patellæ, as well as the bones of the feet, are small in proportion to the size of the teeth, indicating small limbs and feet. The patella is stout, and has the inner face moderately convex in transverse section.

Measurements.

	M.
Length of the crown of the penultimate superior molar	0.018
Width of the same	0.013
Length of the posterior blade of the same	0.009
Elevation of the cusps of the same	0.011
Length of the crown of the antepenultimate molar	0.018
Width of the same	0.015
Length of the posterior blade of the same	0.006
Elevation of the median cusp of the same	0.012
Length of the crown of the third premolar	0.017
Width of the same	0.009
Length of the posterior blade of the same	0.005
Elevation of the median cusp of the same	0.011
Length of the base of the last inferior molar	0.017
Length of the heel of the same	0.005
Width of the base of the same	0.009
Elevation of the median cusp of the same	0.012
Elevation of the anterior cusp of the same	0.008
Diameter of the base of the crown of the canine	0.014
Width of the patella	0.014
Long diameter of the head of the metapodial bone	0.010

Length of a proximal phalange	0.015
Vertical diameter of the proximal end of the same	0.005
Length of a caudal vertebra	0.026
Diameter of the extremity of the same	0.010

The pieces above described were all found together and alone, where they had weathered from the rock, and without apparent intermixture of other individuals. Accompanying them is the olecranon and adjacent portion of an ulna of such small size that I hesitate to refer it to the same species. It may pertain to it however, and, if so, indicates a reduction in the size of the fore limb still greater than that observed to characterize the hind limb. The end of the olecranon is subvertically truncate and compressed, and vertically grooved: its depth, $0^{m}.012$; length, $0^{m}.012$; depth of ulna at the glenoïd emargination, $0^{m}.008$.

The second specimen, of the same size as the preceding, presents nearly all the teeth, except the last two inferior molars, so that some specific characters cannot be verified on it. The remainder of the fragments are all cranial. The superior molars are a little smaller than those of the typical specimen, but resemble them closely, except in the rather larger inner tubercle of the third premolar. The posterior transverse molars of both sides are partially preserved, exhibiting an external blade, a median cusp, and a small lobe of the blade between them. Of the inferior premolars, only the fourth possesses an anterior basal tubercle; the second, besides the posterior lobe, possesses a posterior basal tubercle. The enamel is rugulose. There is a weak cingulum on the outer base of the true molars, and a similar one at the exterior base of the posterior lobe of the premolars. The *foramen infraorbitale exterius* is of medium size, and issues above the third premolar. The mental foramina are two: one below the first premolar; the other below the posterior margin of the third premolar.

The mandibular ramus is deeper than in Dogs and Cats, and more compressed. The inferior border is but little thickened, and is gently convex downward below the posterior molars. The masseteric fossa is well defined anteriorly, but not inferiorly, and the coronoid process is elevated and thin.

Measurements.

	M
Length of the inferior molar series	0.0725
Length of the inferior premolar series	0.0430
Depth of the ramus at the third premolar	0.0275
Width of the ramus below the third premolar	0.0120
Depth of the ramus at the last molar	0.0335
Thickness of the coronoid process at the base	0.0120
Length of the four posterior superior molars	0.055
Length of the first true molar	0.016
Width of the first true molar	0.015
Length of the second true molar	0.016
Width of the third (transverse) molar	0.018
Length of the five anterior inferior molars	0.054
Long diameter of the base of the inferior canine	0.015

Portions of both maxillary bones, with teeth of a third individual, add some characters. From it we learn that the first superior premolar is one-rooted; that the second has a short posterior basal tubercle and a weak basal cingulum in front.

A third individual is represented by a portion of the ramus mandibuli supporting the premolars, by the first true molar separate, and by other pieces. This specimen I formerly alluded to as belonging to the *O. morsitans* (Report on Vert. Foss. New Mexico, p. 13). The first, single-rooted premolar is absent, perhaps abnormally, as there are no other marked characters. The posterior mental foramen is below the anterior part of the fourth premolar. Depth of ramus at posterior border of symphysis, $0^m.027$; thickness at the same point, $0^m.015$; depth of ramus at posterior border of fourth premolar, $0^m.028$.

A fifth individual is represented by a portion of the mandible supporting two molars.

Oxyæna forcipata, Cope.

Plate xxxv, figs. 7–12; Plate xxxvi; Plate xxxvii, figs. 1–5.

Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 12; Id. Ann. Report U. S. Geog. Survs. W. of 100th M.; 1874, p. 124.

This, the largest species of the genus, is represented in five individuals, chiefly by cranial fragments. The type of my first description embraces, among other parts, both mandibular rami with most of the teeth, with some of those of the maxillary series.

The rami are stout, with well-defined masseteric fossa and masseteric ridge. The anterior extremity rises in a regular open curve with the canine teeth, which are directed strongly upward as well as forward. The inferior border is thickened, and somewhat flattened, narrowing posteriorly, and bounding a longitudinal shallow concavity below the premolar teeth. The inner alveolar border is not protuberant. One mental foramen is below the first, the other below the fourth premolar. The first one-rooted premolar is a stout tooth; there is no anterior basal tubercle on the second and third premolars, but a distinct one on the fourth. There is a small compressed tubercle at the base of the anterior lobe of the last or second sectorial molar, which is acute in front as well as behind. This tooth is larger than the penultimate. The enamel of all the teeth is quite rugose, although they are well worn by use.

The premaxillary bone displays the two very small median and large exterior premaxillary teeth. The superior parietal walls are a three-sided mass of bone, of extraordinary thickness, excavated in front by the large cells of the frontal sinus. The sagittal crest is much elevated, and the external surface slightly concave at its base.

Measurements.

	M.
Length of the inferior dental series	0.103
Depth of the ramus at the last molar	0.040
Depth of the ramus at the second premolar	0.030
Diameter of the canine tooth	0.019
Length of the premolar series	0.035
Length of the base of the penultimate molar	0.016
Length of the base of the last molar	0.019
Width of the base of the last molar	0.012
Elevation of the crown of the last molar	0.019
Width of the penultimate superior molar	0.017
Width of the sagittal mass of the cranium	0.024
Depth to the base of the crest	0.015

A second specimen includes inferior molars and canines. The former display typical characters; the latter have very stout roots and curved, regularly acuminate crowns. The apex is quite acute, and a band is worn through the enamel by the friction of the superior canine, commencing on the upper side of the apex and extending to the supero-external side of the base of the crown. The enamel border is deeply emarginate at the base on the inner side, as in the other species. The enamel surface is rugulose on all the teeth, and on the canines the rugosities are thrown into longitudinal shallow grooves.

Measurements.

	M.
Length of the base of the last inferior molar	0.021
Length of the heel of the last inferior molar	0.007
Width of the base of the last inferior molar	0.011
Elevation of the interior cusp of the same	0.017
Elevation of the exterior cusp of the same	0.012
Elevation of the anterior cusp of the same	0.012

A third specimen presents many fragments of the cranium, including some molars in place in the mandible. The frontal bone is concave in transverse section, and its posterior part is deeply grooved as it rises to the base of the crista sagittalis, where its posterior suture forms a median acute angle directed backward. The sides of the base of the sagittal crest are slightly concave. The malar bone is especially thick below the postorbital process. The premaxillary presents a marked but open groove in front of the canine, and the lateral ascending portion is narrow antero-posteriorly and transversely. The mandibular ramus displays a large and deep masseteric fossa, with a well-defined inferior border. The inferior border of the jaw at the angle is slightly incurved.

The interior surface of the frontal and parietal bones is represented on Plate XXXV, fig. 7. The frontal sinuses are of large size, expanding outward and backward above the outer portion of the olfactory lobes of the brain. The postero-internal border of each is marked by six longitudinal fossæ. Enough of the surface of the brain-cavity remains to enable me to determine a number of important peculiarities in the form of the brain. A cast of this surface is represented on Plate LXIII, fig. 5. From this it appears that the olfactory lobes were disproportionately large, and the hemispheres disproportionately small. The former are greatly expanded outward and upward; the latter were narrowed and depressed in front, and give no indication of overhanging even the bases of the olfactory peduncles, as is observed in the lowest existing Mammals. The olfactory lobes appear, on the contrary, to be continuous with the anterior extremity of the hemispheres, as in *Arctocyon* and in Reptiles. The rib, representing the superior longitudinal sinus, is distinct, and of equal width; there are no grooves distinguishing convolutions on that part of the surface of the hemispheres which can be obtained by moulding. The posterior part of the hemispheres does not appear to have been expanded, judging from the form of the parietal bones.

The sixth specimen is referred to this species with question, as the penultimate inferior molar (the only tooth preserved) is larger than the corresponding one in those above mentioned; the length of its base is $0^{m}.018$, and the width $0^{m}.009$. It is accompanied by various fragments, among which is the distal extremity of the tibia. This resembles that ascribed to the *O. morsitans*, and differs from that of *Ambloctonus* and *Stypolophus* in the presence of a subacute longitudinal angle of the extero-posterior margin of the shaft, giving the section an acuminate outline at that point. The internal malleolus is greatly produced and thickened, and the posterior astragalar border is even more oblique than in the other cases described; a portion of the anterior border is subhorizontal. The posterior face of the shaft is longitudinally concave. Long diameter of shaft, $0^{m}.016$; short diameter of the same, $0^{m}.012$; diameters of astragalar face, $0^{m}.018$ and $0^{m}.015$.

This animal differs in specific characters from the Wyoming Carnivores, already referred to, in the greater robustness of all its parts. From *Synoplotherium lanius*, it also differs in the regular increase backward in the size of the molars. In the Wyoming species, the penultimate is largest in the lower jaw.

The fragments of the *Oxyæna forcipata* are as large as corresponding parts of the Jaguar.

A comparison of the cranium of this species with that of the Jaguar reveals the following differences: The tooth-line of the lower jaw is of the same length, but includes six teeth instead of three. The ramus is deeper, especially posteriorly, but it gradually narrows to the canine tooth instead of continuing nearly horizontal to the beginning of the symphysis, and then abruptly rising. The latter arrangement in the Jaguar is related to the more vertical direction of the canine teeth. The Bear is a little nearer the *Oxyæna* in this respect, but not much. The produced inferior border of the masseteric fossa of the Cats is wanting in the *Oxyæna*, as it is in the Dogs and

Bears. The zygoma and glenoid cavity are similar in size and other features to those of the Jaguar, but are much thicker and more robust in the *Oxyæna*. Especially is the brain-case smaller and narrower, while the superior osseous walls are much thicker, and the sagittal crest more elevated than in the Jaguar. The frontal region is concave in transverse section in the *Oxyæna*, convex in the Jaguar.

STYPOLOPHUS, Cope.

Stypolophus, Cope, Second Account New Vertebrata Bridger Eocene (Paleontological Bulletin No. 2), p. 1, Aug. 3, 1872; Proc. Amer. Philos. Soc., 1872, p. 466; Ann. Rept. U. S. Geol. Surv. Terrs., 1872, p. 559.

?*Prototomus*, Cope, Report Vert. Foss. New Mexico, 1874, p. 13; Id. Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 125; System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 9.

Molars seven below, *i. e.*, four premolars and three true molars, and probably the same number above. Inferior true molars consisting of three elevated cusps in front, and a low horizontally-expanded heel behind; the external cusp largest, the internal smallest, and the anterior intermediate, forming with the external a short sectorial blade. The inferior premolars, two-rooted (the first only seen in *S. hians*); the crown consisting of a compressed cusp and short trenchant heel. Of the superior molars, the last is narrow, transverse, and with a blade-like crown. The two preceding have crowns forming right-angled triangles in horizontal section, the right angle being the antero-external. The antero-posterior cutting-edge consists of two cusps in the middle, and a short blade at the posterior angle of the crown. The internal angle supports a cusp. The last premolar has a trilobate section at the base, and supports a median subconic cusp, a short posterior blade, and an internal tubercle. The second premolar is compressed, without internal heel, and with a rudimental posterior one. The first premolar is two-rooted in *S. hians*.

The species of *Stypolophus* of which I obtained the best preserved remains is the *S. viverrinus*, an animal about the size of the domestic cat. Its mandibular bones and teeth are unknown, but I have derived from it the characters of the dentition of the maxillary bone, as above stated. The maxillary teeth of the *S. multicuspis* are similar in generic characters, and of this species I know almost the entire dentition of the lower jaw.

The posterior part of the cranium of *S. viverrinus* displays a low sagittal crest. The supraoccipital bone has a moderate extent on the upper surface of the cranium, supporting part of the sagittal crest, as well as the prominent oblique ones of the inion. The front is rather wide, and the nasal bones are flat, and but little narrowed posteriorly. The lachrymal foramen is large, and entirely within the prominent anterior margin of the orbit; it is of a vertically oval form. A suture extends from it postero-externally to the rim of the orbit, and then returns forward and upward on the facial surface, inclosing what I suppose to be the lachrymal bone. On cleaning the surface, I cannot trace any lachrymal bone posterior to the foramen, as is usual in *Carnivora* (*Canis*, *Felis*), and must therefore suppose that this genus presents an external and anterior position of the lachrymal bone, as in Ungulates. The evidence of this arrangement is seen on both sides of the head. The *foramen infraorbitale exterius* is large, and issues above the third premolar.

The characters presented by the vertebræ are those of the *Creodonta* in general, with the following modifications: A cervical is of medium length, possesses a hypapophysial keel, which is produced downward behind, and has but little trace of a neural spine. The neural arch is wide and flat above, and it is pierced on each side by a foramen not far from the lateral border. Two anterior lumbars, from just behind the flying ribs, have no diapophyses unless a small, narrow, broken area indicates the base of a very rudimental one. This is at the anterior end of a strong longitudinal ridge, which marks the inferior part of the side of the centrum. The metapophyses are strong, inclosing the anterior zygapophyses of the succeeding vertebra on the lower side. In *Ursus arctos*, *Canis familiaris*, and *Felis catus*, there is no vertebra intervening between the last bearing a rib and the first bearing a diapophysis. In *Ursus arctos*, the centra are short, and the diapophysis occupies an elevated position. In *Stypolophus viverrinus*, the centrum is moderately elongate, and the ridge representing the diapophysis has an inferior position, resembling rather *Canis* and *Felis* in these particulars. A portion of the sacrum preserved shows it to have been of robust proportions. Besides the superior intervertebral foramina, there is a small one each side of the neural arch in front of the posterior zygapophysial ridge. A caudal vertebra is relatively large in all its dimensions.

A fragment of the femur shows that both the great and little trochanters are well developed, the former inclosing the usual fossa. The distal halves of both tibiæ are preserved, one of them adhering to a mass of the vertebræ. The shaft below the middle is subcylindric, while the distal end presents the peculiarity common to all the flesh-eaters of the Eocene of New Mexico. The astragalar surface is without groove, and is oblique both transversely and longitudinally. The inner extremity of the bone is produced downward, fitting the inner oblique face of the astragalus, as well as the concavity of the side of the neck by its end. There are no strong ligamentous grooves. The bones of the feet are unknown.

A comparison of such portions of the limb-bones as I have observed (those of *S. viverrinus*) with those of *Felis catus* (*domesticus*), *Canis familiaris*, and *Ursus arctos*, has the following result: In the humerus, the tuberosities are not so pronounced; especially is the great tuberosity more produced upward and outward in the recent genera, whence the bicipital groove is deeper. In *Ursus arctos*, the greater tuberosity is also produced more posteriorly, and in all of the species named its posterior bounding ridge is more pronounced on the shaft than in *P. viverrinus*. The great trochanter of the femur has the elevated position of that of *Felis* and *Canis* rather than the depressed form of that of *Ursus*, and the compressed and moderately elevated distal end is that of the former two rather than like the same region in the latter genus. The distal end of the tibia is unlike that of either of the three genera named, but resembles most that of *Ursus*. The entirely distinct character of the astragalar articular extremity has been already described. The anterior end of the shaft is convex in *S. viverrinus*, flat in *Felis* and *Canis;* flat behind in the former, convex in the latter. The external end of the shaft is transverse in *S. viverrinus*, oblique in *Canis* and *Felis*, especially so in the former, being more or less parallel with the inner astragalar groove, while in *S. viverrinus* it diverges from the angle which represents the groove. The tendinous groove is wider and better defined than in *C. familiaris*, more resembling that in *Felis*. The inner malleolus is more anterior in position than in the two genera named, and bears a distal articular facet, which is wanting in *Felis* and *Canis*. As compared with *Ursus arctos*, the inner malleolus is more produced, and the outer distal border quite different; the truncate outline of *Stypolophus* being represented by a tuberosity. The anterior face of the shaft is convex in *Stypolophus*, concave in *Ursus arctos;* the posterior flat in the former, convex in the latter. The entire distal end of the tibia is more transversely expanded in *Ursus.*

This genus, as now defined, is identical with that called by me, in previous papers on the paleontology of New Mexico, *Prototomus.* It may be found to be proper to use this name; but for the present I use an older one, which I proposed for similar flesh-eaters of the Bridger Eocene of Wyoming. Unfortunately, I am not able to state the number of the tubercular sectorial molars of those animals, as my specimens only have the last two preserved. The structure of the separate molar teeth of both jaws is identical in the species from the two regions, and it is even possible that *Prototomus multicuspis* is identical with *Stypolophus aculeatus,** Cope, which is an older name.

The three tubercular sectorials in the lower jaw, and the two bicuspid molars in the upper, distinguish this genus from the allied *Oxyæna.*

Stypolophus viverrinus, Cope.

Plate xxxviii, figs. 1-11.

Prototomus viverrinus, Cope, Report Vert. Foss. New Mexico, 1874, p. 13; Id. Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 125; System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 9.

This small Carnivore is represented in our collections by portions of the skeleton of a single individual. These embrace a cranium somewhat distorted by pressure, and with the nose broken off; vertebræ from all parts of the column; parts of the humerus, femur, and tibiæ.

Although abnormally depressed in the specimen, it is evident that the frontal region was wide, and the muzzle rather rapidly contracted. The *foramen infraorbitale exterius* is large, and issues above the third premolar. The molars are worn, indicating an adult animal. The first premolar is wanting in the specimen; the second is compressed, and with the median cusp rather low; its base is produced anteriorly, but is without tubercle. The heel is elongate, trenchant, and recurved behind. The third and fourth

* *Triacodon aculeatus*, Cope, Proc. Amer. Philos. Soc., July, 1872.

premolars are destitute, or have but a trace, of external basal cingulum. A narrow basal ledge connects the internal heel of the fourth with its anterior basal tubercle. There is an external basal cingulum on the first and second true molars, but none on the base of the internal heel. An angular tubercle stands between that of the internal heel and the anterior one of the central pair, on the first and second true molars. The V-shaped shear which works against that of the antero-external side of the inferior tubercular sectorials is formed by the posterior of the two median cones and the short blade of the posterior external heel. The last and transverse molar has a median cusp and small internal heel. A fragment of a lower jaw of a small Mammal of similar size accompanied the cranium, which was supposed to belong to the same animal when I first described this species. Additional specimens of other species of the genus have led me to the conclusion that this fragment belongs to a different genus, and was accidentally introduced among the remains of *S. viverrinus*.

Measurements.

	M.
Length of the last five molars	0.0250
Length of the true-molar series	0.0135
Length of the last premolar	0.0060
Width of the same	0.0050
Length of the penultimate molar	0.0050
Width of the same	0.0068
Width of the last molar	0.0047

A cervical vertebra is not shortened, and the centrum is depressed and one-third longer than wide behind. The anterior lumbars are less depressed, and the centra are marked below by a median protuberance in front, and an infero-lateral tuberosity on each side, causing the existence of a subtriangular, irregularly flattened area on the anterior two-thirds of the inferior surface. The superior face of the neural arch is grooved above in continuation of the emargination between the posterior zygapophyses. The spine only rises from the position of a keel between the anterior zygapophyses, where it has a small basis directed forward. A lumbar from a more posterior position has a median keel-like angle dividing the inferior aspect of the centrum. On the sacrum, the neural spines and zygapophyses are indicated by longitudinal and oblique ridges. The centrum is depressed at the anterior extremity. The transverse processes are massive but not long. A caudal vertebra is of moderate length, indicating a well-developed tail. It has large diapophyses, and a narrow median plane below, a little wider at the ends of the centrum.

The head of the humerus has about equal transverse diameters; the condyle is slightly produced posteriorly, and then strongly recurved. The greater tuberosity is not produced in any direction, and is flat on the outer side; the lesser tuberosity is rather protuberant, bounding a wide, shallow bicipital groove, which is not defined on the shaft. The great trochanter of the femur is slightly expanded transversely, and is connected with the head by the usual broad plate, inclosing with it a strong fossa. At the base of the little trochanter, the section of the shaft is oval, with the external end narrowed and the internal widened, as in that of the egg. The distal end of the femur is somewhat compressed, with a moderately elevated patellar groove, with slightly unequal bounding ridges. The condyles diverge slightly, and are marked on the outer side with pit-like muscular insertions. The middle of the shaft of the tibia is cylindric. The distal end presents the peculiar character already observed, and noted under the head of the genus. The posterior face of the bone is flat for the distal fourth, and is separated from the outer face by a longitudinal solid right angle. The anterior face is convex, and the horizontal border of the distal or astragaline surface forms a right angle with the produced malleolus of the inner side of the bone. The posterior margin of the astragaline surface is very different, being a straight diagonal, which crosses the plane of the anterior border at the angle just mentioned. The inner face of the distal part of the shaft is flattened-convex, and expands to the distal end of the malleolus. The inferior margin of the latter is oblique, the anterior margin being produced. A large shallow groove marks its posterior part, which is divided by a faint longitudinal ridge, indicating the positions of the *tibialis posticus* and *flexor longus digitorum* tendons. It is bounded by low ridges, the posterior bounding the plane posterior face of the shaft.

Measurements.

	M.
Length of the centrum of a cervical vertebra	0.010
Width of the same anteriorly	0.007
Width of the same posteriorly	0.007
Depth of the same posteriorly	0.006

Extreme width between the zygapophyses behind	0.015
Length of the centrum of the anterior lumbar	0.011
Width of the anterior articular face of the same	0.009
Depth of the same	0.006
Elevation to the base of the neural spine	0.011
Extreme width between the posterior zygapophyses	0.0075
Total width of the sacrum anteriorly	0.0250
Width of the same between the interneural foramina	0.0084
Total depth in front	0.0120
Depth of the centrum in front	0.0072
Length of a caudal vertebra	0.013
Diameter of the centrum behind	0.007
Greatest diameter of the head of the humerus	0.012
Diameter of the shaft below the head	0.008
Transverse diameter of the shaft of the femur at the little trochanter	0.0126
Transverse diameter of the same just below the little trochanter	0.0085
Antero-posterior diameter of the distal end of the femur	0.014
Width of the patellar groove	0.0055
Diameter of the shaft of the tibia at the middle	0.0055
Diameter of the distal end (transverse)	0.0095
Diameter of the same (antero-posterior)	0.0066

The size of this Carnivore was less than that of the domestic cat, and perhaps nearly that of the skunk.

Stypolophus secundarius, Cope.

Prototomus secundarius, Cope, System. Cat. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 9.

Represented by an incomplete mandibular ramus, which supports four molars. The penultimate has a well-developed heel, whose outer border is elevated and acute, and turned in, so as to approach the middle of the crown. The fourth molar from behind has a heel with a symmetrically median cutting-blade. Enamel smooth. The ramus indicates a species the size of an Opossum, and intermediate between the *P. viverrinus* and the *P. multicuspis*.

Measurements.

	M.
Length of the crowns of two anterior true molars	0.0150
Length of the penultimate molar	0.0075
Width of the same	0.0033
Depth of the ramus mandibuli at the penultimate molar	0.0125
Thickness of the same at the penultimate molar	0.0050
Length of the crown of the third premolar	0.0080

Stypolophus multicuspis, Cope.

Plate xxxix, figs. 12–14.

Prototomus multicuspis, Cope, System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 10.

Established on a series of superior molars, which accord so closely with two series of inferior molars as to leave no room for doubt that they pertain to the same species. One of the latter specimens includes the greater part of the right ramus of the mandible; the other the principal part of both rami.

The superior molars are twice the size of those of *S. viverrinus*, and have much the same structure. The last or transverse molar has less extent, and is inserted by one root only; the penultimate molar is wider than long; the antepenultimate longer than wide. There is a short blade in front of the double cone in the penultimate, but none in front of the corresponding cones in the two molars which precede. The cingulum of the inner base is very obscure.

In the true inferior molars, the three anterior cusps are much elevated above the heel. The latter is quite elongate on all of these teeth, and forms a cutting-blade on the last premolar and anterior two molars; the second and third premolars support a low, trenchant, posterior heel. No external cingulum; enamel smooth. Rami of the mandible slender.

Measurements.

	M.
Length of the posterior four molars	0.0270
Length of the penultimate molar	0.0070
Width of the same	0.0090
Width of the antepenultimate molar	0.0070
Width of the first molar	0.0060
Length of the same	0.0075
Elevation of the same	0.0050
Length of the last six inferior molars	0.0450
Length of three true molars	0.0235
Length of the last true molar	0.0090
Elevation of the same	0.0070
Length of the second true molar	0.0075
Elevation of the third premolar	0.0035
Depth of the ramus at the penultimate molar	0.0015

About the size of the Red Fox.

Stypolophus strenuus, Cope.

Plate xxxix, fig. 11.

Prototomus strenuus, Cope, System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 10.

Both mandibular rami, with representatives of all the teeth except the first premolar, form the basis of our knowledge of this Creodont. The characteristic feature is the great robustness of the jaw, as compared with the species last described, as well as the somewhat larger size. The third premolar has a cutting-edge and basal tubercle in front, which are wanting in the *S. multicuspis*. The third and fourth premolars are stout teeth, composed of a large cusp of lenticular section, and a trenchant heel. The fourth is thickened on the inner side, but the apex cannot be described, as it is broken away. The penultimate molar is larger than the last one, and its heel, like that of the preceding tooth, is well developed. The first true molar is smaller than the second, and its cuspidate portion smaller than the corresponding parts of the last molar. The inferior canine is stout at the base and acute at the apex. The external face exhibits two shallow longitudinal grooves, separated by a low convex rib. Enamel of all the teeth smooth.

Measurements.

	M.
Length of the last five molars	0.0375
Length of the last premolar	0.0080
Length of the first true molar	0.0080
Length of the second true molar	0.0080
Width of the same	0.0065
Length of the last true molar	0.0075
Depth of the jaw at the last true molar	0.0210
Depth of the jaw at the second premolar	0.0175
Thickness of the jaw at the same	0.0080
Length of the inferior canine	0.0123
Long diameter of the same at the base	0.0065

The thickness of the mandibular bones is twice as great as that of the species last described.

Other species formerly referred to this genus were subsequently placed in *Apheliscus* and *Pelycodus* respectively.

Stypolophus hians, Cope.

Plate xxxviii, figs. 12–20.

This species is represented by the greater part of the skeleton of one individual. The bones are remarkable illustrations of the result of pressure when in a plastic condition; their surfaces cracked in every direction, so that each one is a mosaic of pieces; but in many instances the normal form of the bones is preserved. Under these circumstances, I have concluded to describe it, as the unusually complete skeleton throws much light on the structure of the genus, and as the largest species of the genus, it may be profitably compared with the *S. viverrinus*, the smallest.

The greater part of the skull with the mandible is preserved, but the teeth are all broken off. There were, however, seven molars in the upper jaw, indicating that the species is not an *Oxyæna*. The last two lower molars are subequal, and the last superior molar is transverse. A character which distinguishes this species from the *S. strenuus*, besides its superior size, is the diastemata which separate the premolar teeth from each other in both jaws. These interspaces are as long as the long diameters of the teeth themselves. The inferior margin of the mandibular ramus is thick and slightly ascending anteriorly, where it gives exit to a remarkably large canine tooth, one which exceeds in relative dimensions that of any other described in these pages. Its section is a vertical oval, flat on the inner face. The roots of the superior molars are as follows: First and second simply two-rooted. The third has the posterior root of double the usual width, its long diameter directed inward and forward, indicating the presence of a posterior or interior heel. The fourth premolar and first and second true molars subequally three-rooted; third true molar transverse, only two roots visible. The diastema between the canine and the first premolar is in both jaws so extensive as to lead to the impression that a premolar exists, perhaps with a single root, as in *Oxyæna lupina*, but no such root or alveolus is discoverable; whence the first premolar is two-rooted. The diastema following the latter is almost equally great, but the third and fourth pemolars are in juxtaposition. The *foramen infraorbitale posterior* is above the anterior part of the fourth premolar. A character distinguishing this species from the *S. viverrinus* is seen in the wide posterior part of the fourth premolar; in the latter, this tooth is narrow throughout.

The posterior part of the cranium is preserved to a point a little behind the orbits. It is long and narrow, relatively even more so than in the Opossum, and is surmounted by an elevated sagittal crest throughout its length. The squamosal bone has a considerable extent upward and forward, but does not approach near the frontal, although the latter is extended downward and backward. This wide separation is characteristic of the Opossums; they approach nearer in *Ursus*, *Canis*, and *Felis*.

Measurements.

	M.
Length of the superior molar series from the canine	0. 082
Length from the canine to the first premolar	0 009
Length from the first to the second premolar	0. 006
Length of the true molars	0. 032
Width of the base of the third premolar	0. 006
Width of the base of the fourth premolar	0. 009
Width of the base of the last true molar	0. 013
Vertical diameter of the inferior canine	0. 010
Transverse diameter of the same	0. 006
Length of the base of the second premolar	0. 007
Length of the base of the last molar	0. 0085
Length of the symphysis	0. 035
Depth of the ramus at the first premolar	0. 020
Depth of the same at the last molar	0. 023
Length of the brain-case preserved	0. 070
Transverse diameter of the same just behind the orbits	0. 023

There are four cervical, two dorsal, six lumbar, and thirteen caudal vertebræ preserved, all more or less injured. The atlas has a large transverse process, which is perforated by the vertebral foramen, as in true *Carnivora*, thus differing from *Didelphys* and *Macropus*. The perforation enters the base of the transverse process posteriorly, and issues at its middle inferiorly, thus resembling *Felis* rather than *Canis*. There is a slight notch at the posterior base of the neurapophysis, not a deep one as in *Macropus*, nor a continuum as in *Canis*. A well-preserved dorsal vertebra is robust, and the stout diapophyses stand on the posterior inferior portion of the neural arch. This arch is elevated, and the spine is narrow. The centrum is regularly convex in section, and without carinæ.

The centra of the lumbars are depressed, the posterior much larger, and relatively longer than the dorsals; their sides are concave so as to contract the middle line below. The caudal vertebræ are elongate, and present the usual two inferior longitudinal angles. Their combined lengths are $0^{m}.480$, or nineteen inches, and many are lost.

Measurements of the vertebræ.

	M.
Antero-posterior length of the base of the transverse process of the atlas	0.016
Vertical diameter of the facet for axis of the same	0.014
Length of the centrum of a dorsal	0.018
Vertical diameter of the same	0.012
Transverse diameter of the same	0.017
Elevation of the neural arch	0.010
Length of the basis of the neural spine	0.010
Length of the centrum of a lumbar	0.032
Vertical diameter of the same	0.013
Transverse diameter of the same	0.020
Length of a median caudal	0.027
Diameter of the centrum of the same	0.012
Length of a distal caudal	0.031
Diameter of the centrum of the same	0.011

The glenoid cavity of the scapula is a narrow oval, and is produced at the base of the coracoid process, which has a narrow basis and unknown length. The spine of the scapula rises abruptly a little above the border. The outline of the glenoid cavity is like that of *Ursus americanus*, but is produced at the coracoid as in *Canis lupus*, nearly resembling that of *Didelphys virginiana.* The head of the humerus exhibits subequal diameters; the lesser tuberosity projects more in proportion to its width than in the Wolf and Cat, and is larger than that of *Ursus arctos;* it sends a strong rib down along the shaft. The posterior angle of the shaft rises between the latter and the posterior support of the head. Fragments of the condyles of the humerus indicate that they had considerable transverse extent, resembling in this respect the Bears and carnivorous Marsupials, rather than the higher *Carnivora.* The inner edge of the trochlear face is a raised acute border, and within it is a remarkably prominent epicondyle similar in proportions to that of the Opossum, and exceeding that of *Ursus.* The external part of the trochlea is subcylindric, and the olecranar fossa is large and deep. The olecranon is compressed, and longer than deep.

Measurements of fore limb.

	M.
Transverse diameter of the glenoid cavity of the scapula	0.014
Longitudinal diameter of the same	0.021
Transverse diameter of the head and lesser tuberosity of the humerus	0.026
Longitudinal diameter of the proximal condyle of the humerus	0.020
Antero-posterior diameter of the inner extremity of the distal condyles of the humerus	0.012
Length of the olecranon	0.023

The ilium presents a stout tuberosity above the acetabulum on the outer edge of its anterior face, which is not seen in *Didelphys*, *Macropus*, *Hypsiprymuus*, *Canis*, nor *Felis*, and is feebly present in *Ursus*. In all, it is the seat of origin of the rectus femoris muscle. The extero-anterior angle of the ilium maintains its distinctness from the intero-anterior, so far as the ilium is preserved, and does not run into the same plane as in *Felis*, *Canis*, and *Quadrumana*; but it does not diverge from it so widely as in *Didelphys*, where its position gives the ilium a prismatic form. The form in the *Stypolophus hians* is in this respect intermediate between *Didelphys* and *Ursus*. The sacral articular face commences but little beyond the line of the anterior-inferior spine, in which it resembles *Ursus* more than any other genus above mentioned. The ischio-acetabular groove is very strong, as in *Canis* and *Didelphys;* it is weak in *Ursus*. The pubis is lost.

The head of the femur presents a fossa ligamenti teris, connected with the border by a shallow groove. The remainder of the bone is lost. The head of the tibia presents a very large cnemial crest and a distinct spine. The facets for the femoral condyles are separated by the tendinous emargination. The external and posterior fossæ are deeply excavated, and separated by the extero-posterior longitudinal ridge of the shaft. The distal end of the tibia presents characters like those of the other *Creodonta*. The inner malleolus is wide and produced, and the exterior extremity of the astragalar face is angular and recurved. The part of the anterior border of this face adjacent to the malleolus is at right angles to the latter, but all the other borders are oblique to it, especially the external parts of it. There is an external angle of the shaft rising from the external angle of the astragalar face, and there are no marked tuberosities around the borders of the latter. The postero-internal ligamentous groove is well marked, but shallow.

The calcaneum is wide and depressed anteriorly; posteriorly, it is compressed. Not possessing an entire bone, I cannot give its relative length. The cuboid facet is not oblique in any sense, and is slightly concave. The distal ends of the metapodials are depressed, and have a low carina on the inferior aspect.

Measurements of pelvis and hind limb.

	M.
Longitudinal diameter of the acetabulum	0.024
Antero-posterior diameter of the ilium at the middle	0.016
Transverse diameter of the same	0.010
Antero-posterior diameter of the ischium at the base	0.017
Diameter of the head of the femur (transverse)	0.018
Antero-posterior diameter of the proximal end of the tibia	0.036
Antero-posterior diameter of the distal end of the tibia	0.017
Transverse diameter of the same	0.016
Antero-posterior diameter of the astragalar face	0.013
Vertical diameter of the shaft of the calcaneum	0.013
Vertical diameter of the cuboid facet of the calcaneum	0.010

This species is smaller than the *Canis lupus* and larger than the Red Fox, and differently proportioned from either. On comparing the heads of the tibia and femur with those of the Wolf, those of the present species are observed to be but little smaller, while the head of the humerus is much smaller than that of the Wolf. In other words, while the head of the humerus is very large as compared with the bones of the hind limb in the Wolf, it is very small in the extinct species. The cranium of the *S. hians* is about the size of that of the Coyote. Hence we can suppose this animal as possessing relatively larger hind limbs than in the Dogs and existing *Carnivora* generally.

The specimens which form the subject of the preceding description were all found together by the author, and without intermixture of other fossils.

As the forms of the crowns of the molars of this species are unknown, it is not absolutely certain that it is properly referred to *Stypolophus*, but the number and positions of the teeth justify the reference so far as they go.

DIDYMICTIS, Cope.

System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 11.

Inferior molars six, consisting of four premolars and two true molars. True molars, a posterior tubercular and anterior tubercular sectorial, *i. e.*, with three elevated cusps and a posterior heel. Premolars with a lobe behind the principal cusp. The canine teeth are directed forward, and are very close together, so that it is doubtful whether there were any incisors. An ungual phalange of the typical species is strongly compressed.

The humerus in this genus is distally expanded transversely, and the margin is pierced by the humeral artery. The astragalus exhibits two entire trochlear faces; the wider external and directed intero-superiorly, the inner presenting supero-interiorly. They are separated by an obtuse longitudinal angle, and are little or not at all concave transversely. The form is depressed. The head supports a single transverse convex facet for the navicular, and, with the neck, is as long as the trochlear portion.

The resemblance of this genus to the existing *Viverra*, in the dentition of the lower jaw, is so great that the only distinctive feature appears to be the deficiency of the full number of incisors.

Didymictis protenus, Cope.

Plate xxxix, figs. 1-9.

Didymictis protenus, Cope, System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 11.
Limnocyon protenus, Cope, Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, 15; Id. Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 126.

This fine species left its remains in moderate abundance in the Wasatch beds of the Gallinas country. As usual, the lower jaws were most commonly obtained, and these represent six individuals. The size of this bone is that of the largest varieties of the Red Fox.

Selecting as typical of the species the most completely preserved specimen, it may be observed that the ramus is slender and produced anteriorly. The symphysis is narrow, the suture being close to the base of the crown of the canine where it issues from the alveolus. The posterior extremity of the suture is opposite to the anterior border of the third premolar. There are two mental foramina; one issuing opposite to the first, the other opposite to the fourth premolar. The inferior border of the ramus is convex in the antero-posterior direction, and is not inflected below the masseteric fossa. This fossa is deeply excavated, shallowing gradually downward and outward.

The canine tooth is large, compressed, and directed forward, judging by the character of the alveolus. The first premolar is broken at the alveolus; it was small, one-rooted, and directed forward. The other premolars are two-rooted. A marked character of the species is the relatively small size of the first true molar, or the tubercular sectorial. Its length antero-posteriorly equals that of the third premolar, and is less than that of the fourth premolar. All the premolars except the first are characterized by the presence of an obtuse lobe on the posterior cutting-edge, which is quite prominent on the third and fourth; these two have also a prominent anterior basal tubercle. The posterior part of these two premolars is widened, so as to form a kind of heel, the posterior tubercle standing on the outer side, the cingulum-like heel extending round behind it, and terminating in a narrow basal cingulum which extends on the entire outer side. The heel is most fully developed on the fourth premolar, where it supports a small tubercle behind that of the outer side. The tubercular sectorial is distinguished from the premolars by the great difference between the elevations of the anterior and posterior portions. The three cusps which constitute the former unite into a triangular mass at their bases. The inner and outer are opposite to each other, the inner the less elevated; the anterior is at the inner side, and is intermediate between the others in elevation, and forms the sectorial blade with that of the outer side. The posterior side of the united bases of the internal and external cusps is transverse and smooth. The heel is large, has a raised border and concave crown; the outer border forms an obtuse blade and is directed obliquely inward. There is a faint cingulum on the external base. The tubercular is composed of the same elemental cusps as the tooth preceding it, but differently proportioned. Thus the anterior three cusps are small, occupy a small part of the crown, and are not more elevated than the posterior raised border of the heel. The latter is elongate, and supports on the outer side an oblique cutting tubercle which bounds a narrow basin on its inner side, and is bounded by a slight cingulum on the outer. This tooth is about two-thirds the length of the sectorial.

The dental foramen is large, and its inferior border marks the middle of the depth of the ramus. The ramus, while not exceeding in length that of the large varieties of the Red Fox, is deeper. No teeth certainly referrible to the superior series were found.

Accompanying the jaw above described, I found a number of other bones of the skeleton, which I have no reason to doubt belonged to the same animal. They are so fragmentary that little more than measurements can be given. The distal end of the radius is about as large as that of a domestic Cat. Its carpal surface is narrow and transverse, and slightly concave in a transverse direction. The external tuberosity is a ridge of twice the length of that of the Cat, and is decurved. The superior tendinous groove is well marked; a smooth oblique face descends from it to the external border of the bone. The ilium is a stout bone, more massive than that of a Cat, and is distinguished for a large inferior anterior "spinous process," of which only a rudiment exists in the Dog and the Bears, and still less in the genus *Felis*. The astragalar face of the tibia is uninterrupted by grooves or ridges, and the inner border is probably produced as in *Oxyæna*, etc., though broken off in the specimen. There is a concavity on the outer margin of the neck of the astragalus to receive the extremity of the fibula. The astragalus is about as large as that of a Cat, and, as above remarked, is not grooved above, but presents two superior facets, of which the inner and superior is slightly concave. The interior side of the astragalus is vertical, and is mainly occupied by an extensive internal malleolar facet. The inferior aspect of the astragalus presents the usual interior convex and exterior concave longitudinal facets for the calcaneum. The distal extremity of a metapodial bone has strong ligamentous fossæ on each side, and keel on the middle of the articular face below. An ungual phalange is compressed, and has a strong inferior tuberosity, and no basal sheath nor trace of one. The cotylus is not divided by a keel, and there are no large basal foramina.

Measurements.

	M.
Length of the molars from the canine	0.0600
Length of the fourth premolar	0.0110
Greatest width of the fourth premolar	0.0045
Elevation of the same	0.0075
Length of the sectorial	0.0100
Width of the same	0.0060
Length of the tubercular	0.0080
Width of the same	0.0045
Depth of the ramus at the first premolar	0.015
Depth of the same at the first true molar	0.012
Width of the distal end of the radius	0.014
Antero-posterior diameter of the shaft of the humerus	0.009
Antero-posterior diameter of the neck of the ilium	0.011
Transverse diameter of the same	0.009
Transverse diameter of the shaft of the femur	0.012
Transverse diameter of the shaft of the tibia	0.008
Transverse diameter of the distal end of the tibia	0.013
Length of the astragalus	0.020
Width of the same behind	0.012
Width of the navicular facet	0.011
Depth of the same	0.005
Depth of the external face behind	0.007
Depth of the unguis at the base	0.007
Diameter of the centrum of a caudal vertebra	0.007

The caudal vertebræ associated with this specimen prove that the species possessed a tail of good proportions.

A second specimen represented by portions of both mandibular rami is rather larger, but with rather smaller tubercular molar.

Measurements.

	M.
Length of the dental series	0.0680
Length of the four premolars	0.0340
Length of the first molar	0.0105
Length of the second molar	0.0100
Width of the same	0.0055
Length of the third molar	0.0080
Width of the same in front	0.0040
Depth of the ramus at the third premolar	0.0130
Depth of the same at the last molar	0.0150

A third specimen of mandible presents the canine tooth in place. Its section is a vertical oval, and it displays an anterior as well as a posterior worn surface. The posterior is produced by the superior canine, and the anterior by the exterior superior incisor. From the extent of the surface worn by the latter, I suppose it to be a large tooth. There is no indication of inferior incisors.

Creodus incertæ sedis I.

Plate xxxvii, figs. 23–31.

A number of well-preserved portions of the skeleton of a Creodont of about the size of the *Stypolophus multicuspis* furnish some important structural characters. The *mandibular ramus* of the left side is preserved as far as the sixth molar, but the teeth are all wanting. The alveolus of the canine is of very large size, excluding the usual space for incisors seen in *Carnivora.* First premolar one-rooted, the others two-rooted, and all closely placed. The alveoli are large, indicating robust teeth. Mental foramina below anterior part of second and posterior part of the third premolars. The symphyseal suture extends to opposite the front of the third premolar.

Two proximal caudal vertebræ are stout, wide, and with depressed centra. They have stout diapophyses at the base of the neural arch, which is wide. Centra weakly keeled below. Distal caudals have the usual elongate form.

The proximal part of a *scapula* is preserved. This shows an interesting peculiarity in the form of the coracoid. This process forms the usual protuberance at the end of the glenoid cavity, and its anterior border is turned inward, culminating in another tuberosity on the inner side of the first named. This incurved border incloses a deep groove with the body of the scapula. The spine is elevated, and commences abruptly.

The shaft of the humerus exhibits a strong deltoid ridge, which is not flattened on its edge, and descends gradually into the shaft. The distal end in the specimen lacks the inner half. The arterial bridge is present, and the supracondylar fossa is perforate. The external part of the condyle is separated on the posterior side from the external epicondyle, by a keel, which is like that of *Canis*, and which falls opposite the middle of the anterior face of that part of the condyle. External ligamentous pit deeply impressed; external border of lower end of shaft of humerus acute.

The greater part of the *ilium* and adjacent portion of the *ischium* are preserved. The former is more completely represented than that of any other specimen obtained. It shows that the anterior exterior ridge of the ilium maintains its distinctness from the anterior interior ridge (from the pubis), and does not fall into the same plane with it at the iliac crest as in placental mammals generally, but forms a continuous ridge dividing the external face of the ilium into two planes. These planes are not so equal as in the kangaroo and the opossum, the anterior being the narrower. The external angular ridge is also quite obtuse, the whole form being intermediate in character between the Marsupials and Placentals. The anterior inferior ("spine" or) tuberosity is well developed, as in other *Creodonta.* The *incisura acetabuli* is deeply excavated in the anterior base of the ischium.

The *femur* is an elongate and compressed bone. The great trochanter is large, and produced a little beyond the head, and separated from it by a deep emargination. The proximal end of the bone is flat, but the posterior border is recurved, inclosing a fossa. The head is rather small, and has the usual *fossa ligamenti teris.* The little trochanter is well marked, and continues into a low *linea aspera.* The superior part of the outer border of the shaft is compressed, and, about as far below the little trochanter as the latter is below the head, supports a "third trochanter" in the form of a flattened tuberosity, with well-defined borders. The lower part of the shaft has an oval section, the long axis in the plane of the proximal end.

The inferior extremities of both *fibulæ* are preserved. A section of the lower part of the shaft is subtriangular. The distal end is enlarged, and obliquely truncated by the astragalar face. It is a little more flattened than in *Didelphys,* but resembles that genus much more than any Carnivore. The peroneal groove is defined by a low, acute tuberosity on its outer side. The calcaneum, as I have observed in other species of the *Creodonta,* is large in proportion to the size of the other bones. It is rather flat, and the free portion is compressed so obliquely as to be almost depressed. The cuboid facet is characterized by being oblique in a transverse sense, while in a vertical plane.

Measurements.

	M.
Length of the anterior five molars	0.048
Length of the base of the fifth molar	0.008
Length of the base of the second molar	0.008
Depth of the ramus at the second molar	0.0135
Depth of the same at the fifth molar	0.0153
Vertical diameter of the canine	0.0085
Transverse diameter of the same	0.0055
Length of the glenoid cavity of the scapula	0.0130
Width of the same	0.008
Long diameter of the shaft of the humerus at middle	0.012
Long diameter of the neck of the ilium	0.010
Short diameter of the same	0.008
Long diameter of the acetabulum	0.015
Long diameter of the base of the ischium	0.011
Long diameter of the shaft of the femur	0.011
Short diameter of the same	0.0075
Length of the femur to the end of the third trochanter	0.040
Width of the proximal end of the femur	0.026
Long diameter of the distal end of the fibula	0.009
Short diameter of the same	0.007
Greatest width of the calcaneum	0.017
Width of the cuboid facet of the same	0.008
Depth of the same	0.008
Length of a proximal caudal vertebra	0.015
Widthof the centrum of the same	0.013
Depth of the centrum of the same	0.008

Creodus incertæ sedis II.

Plate xxxvii, figs. 10–22.

A number of pieces of the skeleton of a species supposed to be a Creodont were found in connection with a superior molar tooth of appropriate size, as well as with fragments of some smaller Mammals. It is uncertain whether the tooth belongs to the species represented by the bones; should it so belong, it refers the animal away from the three genera in which the superior molars are known, and leaves the question of its pertinence to *Didymictis* uncertain, as in that genus the superior molars are unknown. In the crown of the tooth in question, two external cusps are regularly trihedral and acute; within these is an extensive tubercle with crescentic base, whose horns terminate at the internal bases of the outer cusps; it has two apices, a small one at the base of an outer cusp, the other at one side of the convexity. Within this is a prominent ledge giving this portion of the crown a broadly rounded form. A strong external cingulum. Length of crown, $0^m.0075$; width of crown, $0^m.009$; elevation of crown, $0^m.0040$.

A cervical *vertebra* displays the usual vertebral foramen and deflected parapophyses. The centrum is depressed, and has oblique articular extremities, and is longer than wide. Its inferior face is prominent along the median line; the low rib dividing posteriorly into two sublateral longitudinal ridges, which form angles on the inferior border of the articular face. The centra of the dorsal vertebræ are considerably smaller than that of the cervical, and are strongly and regularly convex below. The anterior are relatively wider, equaling the cervical in transverse diameter, but being smaller in the longitudinal. The caudals are slender, finally having a quadrangular section, the angles representing the arches and diapophyses.

All parts of the *humerus* are preserved. The proximal tuberosities are not protuberant above, but the greater is continued into a large deltoid crest. This crest is very prominent, and has a flat margin, which terminates rather abruptly near the middle of the shaft. From its terminus, its flat border widens upward, so as to include the entire width of the great tuberosity. The distal end of the humerus is much expanded in the plane of a line drawn between the middle of the lesser and the posterior border of the great tuberosity. Its inner epicondyle is greatly developed, so as to measure two-fifths the distal diameter. The arterial foramen is remarkably large, and the supra-condylar fossæ shallow and not perforate. The condylar surface has a projecting border, which separates it from the inner condyle from front to rear, but is bounded at the outer extremity by such a rim on the posterior aspect only; the articular face extending to the external limit of the bone on the anterior face.

The *ulna* is shallow, and with a convex inferior border in the antero-posterior direction. The inferior border is thickened, so as to produce a longitudinal concavity on each side of the shaft. This thickening becomes a wide transverse expansion of the inferior side of the olecranon, so that the width of this part equals its elevation. The superior margin of the olecranon is acute and incurved; the extremity wide and truncate. The surface of attachment of the proximal end of the radius is flat. The distal end of an unrecognized bone is preserved. It is much narrowed, the entire extremity being occupied by the distal tuberosity, which is moderately concave on the inner side. The external face is convex, and there are two internal faces, separated by a right angle. It may be the superior extremity of the ilium: if so, its form is unusually narrowed.

The head of the *radius* is a transverse oval, presenting a shallow concavity to the humerus. The proximal end is slightly curved, with a strong, grooved biceps insertion on the convexity. The distal end is subtriangular, with the narrow base inward. The external border is acute; and just within it, on the superior face, is a subacute tuberosity. A low, short ridge, produced backward from the latter, divides the upper side into two shallow grooves, the inner and much the wider being bounded by a tuberosity, which forms the supero-internal angle of the extremity. This is separated by a narrow groove from a median inner tuberosity, which is in turn separated by a larger groove from an inferior, inner, prominent angle. The articular face is concave.

Measurements.

	M.
Length of the humerus to the end of the deltoid crest	0.048
Long diameter of the shaft at the end of the deltoid crest	0.014
Short diameter of the same at the end of the deltoid crest	0.009
Long diameter of the head of the humerus	0.021
Long diameter of the proximal condyle of the humerus	0.017
Long diameter of the shaft just below the deltoid crest	0.010
Transverse extent of the distal extremity	0.028
Transverse extent of the distal condyles	0.0165
Antero-posterior diameter of the condyles within	0.0110
Antero-posterior diameter of the same at the middle	0.0060
Depth of the ulna at the cotylus	0.0093
Depth of the same at the olecranon	0.0110
Width of the same at the olecranon below	0.0115
Width of the same below the cotylus	0.0050
Long diameter of the head of the radius	0.0110
Long diameter of the shaft of the radius	0.0080
Long diameter of the distal end of the radius	0.0130
Short diameter of the same	0.0100
Length of the centrum of a cervical vertebra	0.0130
Width of the same	0.0100
Length of the centrum of a dorsal vertebra	0.0100
Width of the same	0.0100

Depth of the same	0.0065
Length of the same (posterior)	0.0115
Width of the same (posterior)	0.0110
Depth of the same (posterior)	0.0070

The size of this species is about that of a domestic Cat. It is more robust than the species last described, and appears to have nearly the proportions of the *Didymictis protenus.* From this species it differs strongly in the form of the distal end of the radius. The remains described were all found together by myself.

DIACODON, Cope.

System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 12.

Four inferior molars, which are composed of two portions; the anterior much elevated, and supporting two opposite acute cusps; and a posterior, much depressed, bounded by some low tubercles posteriorly. Number of premolars unknown. Superior premolar compressed, without basal tubercles.

This form is probably, but not certainly, a true *Creodont.* It differs from many genera of *Insectivora* in the number of complex molars, adding one to the usual number. It differs from most of them, also, in the absence of the anterior cusp of the molars, among others from *Herpetotherium,* Cope, of the Miocene, where the number of molars is the same. Of the numerous genera of *Insectivora* reported from the Eocene of Wyoming, but few have been described, and among the latter I find none without the anterior cusp.

Diacodon alticuspis, Cope.

Plate xlv, fig. 19.

System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 12.

Represented by a right mandibular ramus, which supports the last premolar and four ?true molars, with a superior premolar included in an attached portion of matrix. The hardness of the rock, with the softness of the osseous tissue, has determined me not to attempt to clean the specimen entirely.

The two elevated cusps of the anterior part of the crown are of equal height, and are separated by a pronounced notch. There is a narrow cingulum extending across their front. The heel supports two or three low cusps, of which the exterior sends an oblique ridge to the base of the inner of the anterior pair. No basal external or internal cingulum. Enamel smooth. The mandibular ramus is quite robust.

Measurements.

	M.
Length of the five posterior molars	0.0125
Length of the three true molars	0.0085
Length of the penultimate molar	0.0025
Width of the same	0.0018
Depth of the ramus at penultimate molar	0.0045

The jaw is nearly twice the size of that of the common Mole (*Scalops aquaticus*).

Diacodon celatus, Cope.

Plate xlv, fig. 20.

System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 12

The smallest Mammal of the Wasatch Eocene yet known is represented by a left mandibular ramus, which I found exposed in the face of a precipice of sandstone, on a peak of the bad-lands. It supports the three last molars, which have nearly the character of those of the species last described. The last molar is smaller than the others in the present animal, but equal to them in the *D. alticuspis*. The posterior part of the crown is deeply excavated, and supports on its outer angle a sharp cusp. The anterior cusps are twice as high. There is no external basal cingulum. The ramus is shallow, the inferior border rising to the masseteric fossa, which is deeply excavated.

Measurements.

	M.
Length of the ramus from the antepenultimate molar to the angle	0.0100
Length of the last three molars	0.0048
Length of the penultimate molar	0.0015
Elevation of the same anteriorly	0.0013
Depth of the ramus at the antepenultimate molar	0.0018

This species resembled some of our very small Sorices in dimensions.

MESODONTA.

In my report to Dr. Hayden on the paleontology of the Bridger Eocene of Wyoming,* I included six species, viz, *Tomitherium rostratum*, *Pantolestes longicaudus*, *Sarcolemur furcatus*, *S. pygmæus*, *Hyopsodus vicarius*, and *H. paulus*, Leidy, which belong to this suborder. As many species of *Mesodonta* referred to various orders are described by Dr. Leidy in his quarto report in the same series. In my report to you on the Vertebrata of the Eocene of New Mexico obtained by the expedition of 1874, eleven species are included, none of which had been certainly obtained from the Bridger beds.

A synopsis of the genera is given below, in which the characters are derived from the dentition of the lower jaw, the part usually preserved. While considerable variety is to be observed in the structure of the teeth, they furnish also close approximations, so that their discrimination requires careful scrutiny. On examination of Dr. Leidy's type-specimens, it appears that the parts preserved (the last two inferior molars) of his genus *Washakius* do not differ from corresponding parts of *Anaptomorphus* of prior description. It also appears very probable that *Microsus*, Leidy, is identical with *Microsyops*, Leidy, and, according to rule, should take position as a synonym of the latter. The genus *Anaptomorphus*, Cope, although included in the synopsis, may not belong to the *Mesodonta*.

I. Last true molar with cusps in opposing pairs.
  A. Anterior inner cusps, two or a double one, on some of the molars.
    * Three premolars.
      "Last premolar without inner tubercle" (Leidy), like the other premolars .... *Omomys.*
      Last premolar with inner tubercle like the molars .... *Microsyops.*
    * * Four premolars; last molar heeled.
      Last premolar without inner tubercle; premolars two-rooted .. *Pantolestes.*
      Last premolar with inner cusp; all the molars with basin-shaped heel behind .... *Tomitherium.*
      Last premolars with inner cusp; all the molars with elevated cusps behind; the anterior inner bifid .... *Sarcolemur.*

*Ann. Report U. S. Geol. Survey Terrs. for 1872, 1873, pp. 546, 607.

I. Last true molar with cusps in opposing pairs—Continued.
AA. The anterior inner cusp undivided on all the molars.
Last molar with heel; last premolar with inner cusp; four premolars .... *Hyopsodus.*
Last molar without heel; last premolar large, sectorial, without inner cusp .... *Apheliscus.*
Three or two premolars, last without inner cusp .... *Anaptomorphus.*
II. Last molar with a longitudinal series of alternating cusps, including a heel.
Anterior inner tubercle of molars 1–2, bifid .... *Notharctus.*
Anterior inner tubercle simple .... *Opisthotomus.*

TOMITHERIUM, Cope.

Third Account of New Vertebrata from the Bridger Eocene of Wyoming, p. 2, Aug. 7, 1872; Proceedings American Philosophical Society for 1872 (published Jan., 1873); On the Primitive Types of Mammalia Educabilia, 1873, May 6, p. 2; Annual Report U. S. Geol. Survey Terrs., 1872, p. 546 (1873).

Dental formula of the inferior series: I. 2; C. 1; Pm. 4; M. 3. The last molar has an expanded heel. The third premolar consists of a cone with posterior heel; the fourth premolar exhibits, besides its principal cone, an interior lateral one, and a large heel. The true molars support two anterior tubercles, of which the inner is represented by two distinct cusps in one or more of them, and the external is crescentoid in section. The posterior part of the crown is wide and concave, and is bordered at its posterior angles by an obsolete tubercle on the inner and an elevated angle on the outer side. In the *T. rostratum*, the type of the genus, the middle incisors have transverse cutting-edges.

This genus is allied to *Adapis*, Cuvier, of the French Eocene, but differs in the possession of but two incisors on each side; in *Adapis*, there are three, according to Filhol. From *Notharctus* and *Opisthotomus*, it differs in the structure of the last inferior molar, as exhibited in the analytical table.

An account of the osteology of this genus, so far as indicated by my material, was given in the papers above referred to. It was shown that the hind limbs, especially the femur, are quite elongate, more so than the fore limbs, and that the proportions of both fore and hind limbs are slender. The head of the radius is subround, and its distal extremity a subequilateral triangle. The humerus is distally expanded, with large inner and outer epicondyles and an arterial foramen. The tuberosities of its head are small. The ilium is rather narrow and flat, except at the acetabulum, where it supports a large anterior inferior spine.

Associated with the teeth of the *T. jarrovii* and *T. tutum* were found the bones of the skeletons of two animals, corresponding in size to those represented by the teeth. They have the same nearly white color, which is unusual in fossils from this formation, and are in every respect similar to the portions of jaws supporting the teeth. I suspect that they belong to the same animals, and describe them under those heads respectively. The reason why I avoid positive assertion is the fact that I did not discover these pieces myself, but they were brought to me by one of my guides, who stated that he discovered them together.

The characters displayed by these bones are closely similar to those exhibited by the *Creodonta.* The humerus of the *T. rostratum* from Wyoming is also of the same type, resembling, as I originally pointed out, that of the Carnivorous genus *Nasua.* The distal part of the humerus described under *T. jarrovii* is of the same form. Most of the parts of the New Mexican specimens, however, are wanting from the Wyoming specimen, and consist chiefly of bones of the hind foot. They display the calcaneum broad and short in front, compressed and produced behind. The astragalus has the oblique inner side for the malleolus, and the less oblique flat surface for the tibia. The cuboid is longer than wide, with one extremity convex, and the navicular is very short. The metatarsals are moderately elongate only, and the phalanges not slender, resembling those of the *Carnivora.* The only diversity I observe between corresponding parts of *T. jarrovii* and *T. rostratum* is that in the femur of the former the third trochanter occupies its usual position, while in the latter, it is opposite the little trochanter. As the bones described under *T. jarrovii* are less certainly parts of that animal than are those known to be parts of *T. tutum* which are described under it, I defer using this character to substantiate the genus *Pelycodus,* which I originally proposed for the reception of these species.

I originally described this genus as Lemurine, with added characters of the plantigrade *Carnivora.* The position is confirmed by my discovery of their resemblance to the *Creodonta,* the Eocene representatives of the

Carnivora. Of the species from the New Mexican Eocene, now included in it, only the dentition is known, and that incompletely. The *T. jarrovii* differs in several respects from the *T. rostratum.* Thus, in the latter, the first true molar is the only one in which the anterior inner tubercle is represented by two separated cusps; in *T. jarrovii*, this peculiarity characterizes all the true molars. In *T. rostratum*, the second premolar is one-rooted; in *T. jarrovii*, two-rooted. In the *T. frugivorum*, the true molars are similar to those of *T. jarrovii.* It is possible that these species will be found to be worthy of separation from *Tomitherium* as a distinct genus, as I have already proposed, and require the use of the name of *Pelycodus* (Systematic Catalogue of the Vertebrata of the Eocene of New Mexico, 1875, p. 13). The teeth of the species described as *P. angulatus* resemble those of *Microsyops*, but the dental series is not sufficiently complete to warrant its final generic reference.

Tomitherium jarrovii, Cope.

Plate xxxix, figs. 17–18; Plate xl, figs. 1–15.

Prototomus jarrovii, Cope, Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 14; Id. Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 126.

Pelycodus jarrovii, Cope, System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, 13.

This species is represented in the collections of the Survey by a fractured right mandibular ramus, each fragment supporting a molar tooth, accompanied by bones of a skeleton which probably belong to it; also by part of the right mandibular ramus of another individual, with the last two molars; probably also by a mandibular fragment of a third, with a premolar tooth in position.

The second specimen displays the last molar. The base of its crown is an elongate oval, narrower behind. It supports two low cusps in front, a lobe on the middle of its outer border, and a lobe-like heel. The inner border is low, and continuous to the anterior cusp. The latter has a small tubercle on its anterior border, which is continued into the border of the crown without interruption to the anterior outer cusp. The center of the crown is concave and basin-shaped; an external cingulum at the front of the crown only.

In the second specimen, the ramus is thick and moderately deep, with thick inferior border, regularly convex from side to side. Masseteric ridge prominent.

The last molar is wanting in the next specimen, only the first and second true molars remaining. In the first, the two anterior interior cusps are low and well separated. The anterior exterior cusp is larger, and is approximated to them in position. It is connected with the anterior interior cusp by a curved ridge, which forms the anterior border of the crown, and with the posterior of the two, by a yoke directed slightly backward, whose superior margin is emarginate between the cusps. The posterior part of the crown is wider than the anterior, and consists of a basin-shaped concavity surrounded by an acute, raised margin, which rises into a large subtrihedral cusp at the posterior exterior border, and a smaller angular elevation at the posterior interior position. The ridge bounding this basin reaches the posterior of the two anterior interior cusps; its external line curving inward to the base of the cusp. The same description applies to the second true molar, excepting that the two anterior interior cusps are closely approximated, and that the cusps of the external side are less elevated. It is also slightly larger than the second. The enamel of both teeth is of glassy smoothness, and the base of the crown is marked on the external side only by a continuous cingulum.

Measurements.

	M.
Depth of the mandibular ramus of No. 1 at the anterior part of the last molar tooth	0.015
Thickness of the same at the anterior part of the last molar tooth	0.008
Length of the last molar tooth	0.007
Width of the same in front	0.0045
Width of the second molar behind	0.0050
Width of the second molar of No. 2 behind	0.0055
Width of the same in front	0.0045
Length of the same	0.0065
Length of the first molar of No. 2	0.0063
Width of the same in front	0.0040
Width of the same behind	0.0054
Elevation of the crown of the same at anterior interior cusps	0.040

Among the bones which accompanied this specimen were a few teeth of *Hyracotherium*. I cannot trace any of the bones to this genus, however, unless it be the fragment of the shaft of the femur. Yet this agrees in proportions with the associated pieces. The large individual is represented by many fragments, including portions of vertebræ and fore and hind limbs. The shaft of the *femur* has an acute external margin, which culminates in a tuberosity or third trochanter. Two patellæ are elongate ovals, convex in cross-section below. The inferior extremity of the fibula is especially stout in both diameters. The inner face is divided between a large vertical astragalar facet and a large posterior ligamentous fossa. The posterior face is marked by a prominent tuberosity, which bounds the peroneal groove exteriorly. The external face is convex and smooth.

The *calcaneum* is similar to that of the last specimen, but one-half larger in all linear measurements. The astragalus is even more oblique on its inner face. The superior face is produced backward to a narrow point, bounding the inner face above, and is itself bounded externally by a groove directed forward and outward, which ceases at the superior plane. The neck is elongate and depressed. In the structure of this tarsus, we observe some of the most interesting characters of the *Creodonta.* On account of the inequality in the length of the astragalus and calcaneum, the proximal ends of the navicular and cuboid are not continuous as in the *Carnivora.* Hence, also, the cuboid possesses an oblique proximal inner facet for the astragalus, which is in line with the proximal face of the navicular without irregularity. From this it follows that the head of the astragalus articulates with both navicular and cuboid by a continuous convex facet, and not, as in *Mesonyx* and *Perissodactyla,* by distinct facets. The cuboid is longer than wide, slightly convex proximally, concave distally, and concave on its exposed sides. There is no external tuberosity, but a moderate posterior one. The superior facet for the external face of the ectocuneiform marks about the middle of the internal face of the cuboid. A bone resembling the navicular of the *Carnivora* is rather small and shallow, and has a moderate exterior anterior tuberosity. The outline of the superior face is subrhomboid, the longest side being the external, where it is squarely truncate for contact with another bone. Where this side joins the posterior is a posterior tuberosity. Although this bone resembles the navicular of the *Carnivora,* I am not sure that it is that bone; it differs considerably from that described under *Oxyæna lupina.* The ectocuneiform is plane above, and concave antero-posteriorly below. It has the usual flat quadrate form, and the inner side is concave. Its axis diverges upward from the long axis of the cuboid. The mesocuneiform was not found, but the entocuneiform has the form already ascribed to that of the *Stypolophus hians.* Its inner face displays facets for the navicular and mesocuneiform, and the superior extremity is narrowed by an oblique truncation from behind. The distal facet is slightly concave in the long (*i. e.*, antero-posterior) direction, and is truncate with an obliquity outward in the transverse direction. It does not display the convex articular face for the metatarsus of the hallux seen in the *Quadrumana,* so that, although the great toe may have diverged somewhat from the others, it was not probably prehensile.

The *anterior limb* of the same animal is represented by a few fragments. The olecranon is shallow, and wide and flat below, but not so much so as in the skeleton No. 2. A strong crest rises from its extremity to the middle of the inner side, ceasing below the posterior coronoid process. The head of the radius is a wide transverse oval; the neck is but little curved, and the biceps insertion is strongly marked. The distal end of the radius is like that of No. 2, subtriangular in outline, with a small acuminate tuberosity at the external angle. The external portion of the distal condyles of the humerus is a portion of a cylinder.

Measurements of No. 4.

	M.
Depth of the olecranon	0.012
Length of the same	0.020
Transverse diameter of the head of the radius	0.0135
Vertical diameter of the same	0.0085
Vertical diameter of the distal end of the same	0.0135
Transverse diameter of the same	0.0085
Diameter of the head of the femur	0.0155
Length of the calcaneum	0.035
Width of the calcaneum at the astragalar facets	0.018
Depth of the cuboid facet of the calcaneum	0.0085
Depth of the astragalus externally	0.0085
Depth of the distal facet of the astragalus	0.0065
Width of the same	0.0115
Width of the trochlea of the astragalus	0.0100
Length of the cuboid	0.0135

Transverse proximal diameter of the cuboid	0.012
Transverse distal diameter of the cuboid	0.008
Antero-posterior distal diameter of the cuboid	0.009
Length of the navicular anteriorly	0.0055
Transverse diameter of the navicular	0.0110
Antero-posterior diameter of the same	0.009
Length of the ectocuneiform	0.0075
Transverse diameter of the same	0.005
Antero-posterior diameter of the same	0.009
Length of the entocuneiform	0.0125
Transverse distal diameter of the same	0.004
Antero-posterior distal diameter of the same	0.008

This species was about the size of the Raccoon, and its jaws indicate a greater degree of robustness. It is dedicated to my friend Henry C. Yarrow, M. D., to whom was committed the charge of that party of the Survey to which I was attached, and to whose zeal in the cause of the natural sciences the success of the special expedition is largely due.

Tomitherium tutum, Cope.

Plate xxxix, fig. 19; Plate xl, figs. 16–25.

Represented by a fragmentary ramus of the mandible, which supports the last two premolars and the first true molar, with the alveoli of the canine, and first and second premolars. Accompanying it is a number of skeletal fragments entirely appropriate in size to this jaw. All were found with the pieces belonging to the *T. jarrovii.* I originally referred all the teeth to a single individual, as they belong to the right side, and nearly resemble each other. Having the last molar of *P. jarrovii* in the ramus of another individual, I was compelled, in order to accommodate the molars in one jaw, to regard the teeth now described as canine and first premolar as incisor and canine. This determination I now regard as impossible, since the positions of those teeth in relation to the symphysis require them to be identified as canine and first premolar. Their relative sizes accord with this arrangement, and the first premolar retains its normal one-rooted character. As a consequence of this determination, the last tooth in the ramus becomes the first true molar, and, as such, presents such a different form and size from the corresponding tooth of the other specimen, as to require that I should regard it as a distinct species. This appropriately corresponds with the bones which accompany the teeth, since they also belong to two individuals, a larger and a smaller. The smaller is certainly precisely adapted in size to the *T. tutum*, and I have no hesitation in describing them together.

In the mandibular ramus in question, the canine alveolus is small and has a nearly vertical direction. That of the first premolar is smaller and vertical. The second has left two roots. The third is compressed, but stout, and has a broad but very short heel behind. It has no cingulum, and the anterior border of the crown rises nearly vertically from its base. The fourth premolar has three cusps and a wide heel. The principal cusp is external; at the inner side of its anterior base is a small one, and a little behind its middle on the inner side is one of intermediate size, the two apices separated by a notch. The heel is without tubercles, but has a short, low, submedian ridge. There is a faint cingulum on the external side of the heel. The first premolar has three anterior cusps standing close together, and a wide posterior crown. The three anterior cusps are connected by yokes, of which the anterior is convex. The posterior part of the crown is concave, and is not surrounded entirely by an elevated ridge. It is bounded on the external side by a V-shaped ridge, whose limbs extend, the one to the posterior of the two interior anterior cusps, the other to the middle of the crown behind, the angle rising into a low cusp. On the inner side, a low ridge extends from the inner cusp mentioned, and terminates in a low cusp at the posterior third of the inner side. There is a continuous cingulum on the external base of the crown, and the enamel is smooth.

As compared with the *T. jarrovii*, this species is distinct in the form of the first true molar tooth. In that species, the posterior basin is completely surrounded by a raised border, as in the succeeding molars; in this one, it resembles a premolar in having the posterior cusps unconnected with each other. It is also materially smaller than in *T. jarrovii*.

Measurements.

	M.
Length of the bases of the molars from the first to the fifth inclusive	0.0205
Length of the last premolar	0.0055
Width behind	0.0040
Elevation anteriorly	0.0045
Length of the crown of the first true molar	0.0050
Width of the same anteriorly	0.0035
Width of the same posteriorly	0.0045

This smaller species is represented by *bones of the feet*, chiefly posterior. The inferior extremity of the tibia has the usual form, and fits exactly the trochlear superior face of the astragalus. The inner face of the inner malleolus forms an open angle with the subtransverse face posteriorly, and nearly a right angle anteriorly. This form represents the relation between the superior and interior faces of the astragalus from behind forward. Medially, the two faces are but little defined, while at the neck they are distinguished by a short angulation. This angulation is at the middle of the neck; inside of it, the surface is depressed to receive the inferior extremity of the internal malleolus. The superior trochlear face is oblique and at the middle plane, and it is separated by a sharp angle from the nearly vertical external or fibular face. The neck is elongate and the head is incurved. The navicular face is transverse and convex in both directions. This astragalus resembles somewhat that of the *Didymictis protenus*. The calcaneum, like that of the *Creodonta*, is shorter in proportion to its width than in true *Carnivora*, the shortening being in front, and the expansion in the lateral astragalar facets. Thus, the anterior extremities of the astragalus and calcaneum do not terminate in the same vertical plane as in *Ursus*, *Canis*, and *Felis*, and many other *Mammalia*, but the neck and head of the former project far beyond the cuboid facet of the latter. As a consequence, the cuboid bone is relatively longer, and the navicular shorter, than in the other forms mentioned. The cuboid facet is in a vertical plane, and is oblique to the long axis of the bone. The posterior portion is of moderate length, and compressed in an oblique plane. Distal end, a wide irregular oval. Only one entire metacarpal bone is preserved, with the extremities of several others. The former is not long in proportion to its distal diameter. The head presents a fore-and-aft convex surface, which is slightly concave transversely. Two others are convex fore and aft, and plane and convex in transverse section. The distal end of the entire metacarpal is depressed, with an inferior keel, and strong lateral ligamentous fossæ. The phalanges are depressed, with subinferior distal articular face, which has a shallow trochlear emargination. An ungual phalange is compressed, with a dorsal keel, and is moderately curved. There is a strong basal ligamentous insertion, with a deeply-placed nutritive foramen on each side. Apex lost.

Measurements.

	M.
Length of the calcaneum	0. 025
Width of the calcaneum at astragalar facet	0. 013
Length of the astragalus	0. 0165
Length of the head and neck of the same	0. 007
Width of the superior trochlear face of the same	0. 007
Length of a metacarpal bone	0. 031
Proximal width of the same	0. 0045
Distal width of the same	0. 0075
Proximal depth of the unguis	0. 0065
Proximal width of the same	0. 0050

Tomitherium frugivorum, Cope.

Plate xxxix, fig. 16.

Pelycodus frugivorus, Cope, System. Cat. Ext. Vertebrata New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 14.

This species is known from a portion of the mandibular ramus, which supports the last two molars. The size of the animal is about half that of the *Pelycodus jarrovii.* The last molar is oval and narrowed behind. The lateral margins are raised, inclosing a concavity. The border is thickened behind at the heel, and supports an inner anterior tubercle, which has a lesser one at its anterior base. There are two obtuse external tubercles. The penultimate molar is robust, and presents two inner and one outer anterior tubercles, the former connected with the latter by ridges. A stout posterior outer tubercle sends an oblique ridge to the anterior inner, while the tubercle at the posterior inner angle is insignificant. Enamel smooth, the external bases of the last two molars furnished with a cingulum.

Measurements.

	M.
Length of the penultimate molar	0. 0045
Width of the same	0. 0040
Length of the last lower molar	0. 0060
Width of the same	0. 0035
Depth of the ramus at the penultimate molar	0. 0090
Width of the ramus at the same point	0. 0040

Tomitherium angulatum, Cope.

Plate xxxix, fig. 15.

Pelycodus angulatus, Cope, System. Cat. Extinct Vert. New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 14.

This species was probably less than one-fourth the size of the last described, and is represented in our collections by but few specimens.

One of these is a portion of the mandibular ramus with a single perfect molar; another individual is known from an isolated molar. The former displays the characters of the larger species, viz, a crown narrowed in front, where it supports three approximated cusps, and widened behind, where an elevated border embraces a basin-shaped concavity. In this species, the anterior cusps are well defined and subequal in size, and the posterior angles of the posterior concavity each support a cusp. The outer posterior cusp is connected by a strong oblique ridge with the posterior of the two anterior inner cusps. A well-marked cingulum surrounds the external basis of the crown, and extends round its front nearly to the anterior inner cusp. Enamel smooth.

Measurements.

	M.
Length of the crown of the molar	0.0034
Width of the same	0.0027
Depth of the ramus at the same	0.0065
Thickness of the same	0.0030

As already observed, this species may be referrible to *Microsyops*.

PANTOLESTES, Cope.

Proceed. Amer. Philos. Soc., 1872, p. 467 (*separata* August 30).

The type of this genus resembles, in structural characters of the dentition of the lower jaw, the *Hyopsodus* and *Sarcolemur*, already known in the collections of the different explorations of the Rocky Mountain lake-basins. While it possesses the normal number of molar teeth belonging to these, it preserves a sectorial character of the premolars more posteriorly then in any of the allied genera. The typical specimen of the *P. chacensis* presents four premolar and three molar teeth; the fourth premolar alone remaining with the three true molars. The premolars are all two-rooted, except perhaps the first. The fourth is a simple, flattened, triangular cusp, with a small tubercle at the base behind, wanting the inner cusp of other genera. The molars exhibit the usual four cusps, the external crescentoid, the inner discoid in section, excepting the inner anterior, which is double, an anterior twin cusp of smaller size being closely united with it. The last molar has a distinct fifth tubercle, or heel.

Pantolestes chacensis, Cope.

Plate xlv, fig. 17.

System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 15.

The mandibular ramus of this species is very slender in both vertical and transverse diameters. There is a minute tubercle on the anterior base of the fourth premolar. There is a very minute median tubercle on the posterior border of the first and second true molars, and no anterior ledge. The heel of the last molar is short, and the other tubercles protuberant. The enamel is smooth, and there is no basal cingulum on either side of the teeth preserved.

Measurements.

	M.
Length of the bases of seven molars	0.037
Length of the bases of three true molars	0.018
Length of the base of the last premolar	0.005
Width of the same	0.0025
Length of the penultimate molar	0.0055
Width of the same	0.0040
Length of the last molar	0.0070
Width of the same	0.0040
Depth of the ramus at the fourth premolar	0.0080

This species is considerably larger than the type of the genus, *P. longicaudus*, Cope. (See Ann. Rep. U. S. Geol. Surv. Terrs., 1872, p. 549.)

APHELISCUS, Cope.

System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, pp. 13–16.

The present genus is nearly allied to *Pantolestes*, but differs in the absence of the heel of the last inferior molar and the simplicity of the inner anterior tubercle of all the molars. The characters of the inferior molars are as follows: Premolars, four; molars, three; the latter subequal in size. Premolars compressed, the fourth with a heel, but no internal tubercle. Last two molars with four subequal angular cusps, connected round a central concavity by their adjacent angles. Symphysis mandibuli persistent.

The affinities of this genus cannot now be ascertained, but the molar teeth are so much like those of the Lemurine genus *Anaptomorphus*, Cope, from the Eocene of Wyoming, as to suggest relationship. The premolars are totally different.

Apheliscus insidiosus, Cope.

Apheliscus insidiosus, Cope, System. Cat. Vert. New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 17.

Prototomus insidiosus, Cope, Report on the Vertebrata of New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 14; Id. Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 126.

Represented in the collections of the Survey by parts of the maxillary bone and both mandibular rami with teeth. The species is much smaller than the preceding, and differs materially in the forms of the teeth. The two anterior tubercles of the tubercular molars are similar and approximated; the posterior are slightly divergent, and on the last tooth inclose a third of small size. The last premolar has a broad heel and stout anteromedian cone, but no anterior tubercle. The tooth immediately preceding is much smaller, and also possesses a heel. The mandibular ramus is particularly slender, and the angle is not inflected.

Measurements.

	M.
Length of the last two inferior molars	0.0060
Length of the last molar	0.0034
Width of the last inferior molar	0.0020
Depth of the ramus at last inferior molar	0.0045
Length of the last premolar	0.0030
Elevation of the same	0.0028

SARCOLEMUR, Cope.

Sarcolemur, Cope, Proc. Acad. Nat. Sci. Phila., 1875, p. 256.

Antiacodon, "Marsh," Cope, System. Cat. Vert. New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 17; Ann. Rept. U. S. Geol. Surv. Terrs., 1872, p. 608.

Inferior molars 4–3, the last with a heel. Anterior inner cusp of the true molars bifid or double; the external cusps subcrescentic in section; all the cusps subequally developed. Last premolar with an inner, and sometimes anterior cusp.

This genus is nearly related to *Hyopsodus* in the dentition described, differing in the double inner anterior cusp of the inferior true molars. The type, *S. furcatus*, Cope (Ann. Rept. U. S. Geol. Surv. Terrs., 1872, p. 609), possesses an almost sectorial character of the last premolar. This tooth has, besides a median compressed cusp, a stout anterior one.

In attempting the identification of this genus with one of those named by Professor Marsh, it appears that I have been in error. The absence of sufficient diagnosis in the single description yet published by this author explains my want of success. In several other instances, I have used the generic names of the "Preliminary Description of New Tertiary Mammals, by Prof. O. C. Marsh", bearing date August and September, 1872, hoping to be able to give them currency by supplying definitions. My want of success in these instances also, has more than ever convinced me of the importance of preserving the rule requiring definitions for genera as the only basis of authority for their names; and it is evident that to suspend this rule of nomenclature is impracticable, even were it desirable. I have therefore made a final examination of the names and descriptions of the above-mentioned paper, with the view of ascertaining which of them are introduced in such a way as to constitute additions to nomenclature. I find that of thirty-seven generic names proposed in that and a previous essay (On New Fossil Mammals and Birds from the Tertiary Formation, July and August, 1871), twenty-two are not accompanied by a mention of their generic characters; while of the remaining fifteen there are only two cases in which the nomenclator states what he regards as their distinctive features. These are *Orotherium,* which is adopted in the present work, and *Telmatolestes,* the character of which, as given, is of very doubtful value. To the list of undefined names must be added *Tinoceras* and *Lemuravus,* of later date.

I may add that a few of the names early proposed by me, are open to the same criticism; but their publication was followed, at the earliest practicable moment, by the issue of elaborate descriptions, in which the generic and specific characters are fully detailed. This has not yet (March 1, 1877) been done in the case of any of the names of the two papers above commented on.

Two species are provisionally referred to the genus *Sarcolemur* on account of their resemblance to the known species *S. pygmæus,* Cope, and *S. furcatus,* Cope, but not definitely, because the premolar teeth are unknown in both cases. One of them is similar in size to the species mentioned, while the other is much larger than any of the allies, approaching the larger species of *Hyracotherium*.

Sarcolemur mentalis, Cope.

Plate xlv, fig. 15.

Antiacodon mentalis, Cope, System. Cat. Vert. New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 17.

Established on a portion of a ramus mandibuli, on which the first and second true molars only remain. The fangs of the last premolar are stout, and evidently supported a robust crown. The cusps of the true molars are as usual, crescentic in section on the outer side, the posterior inner conic, while the double anterior inner is rounded on the internal face, and not flattened, as in many species. The second true molar has a distinct posterior median tubercle. There are no basal cingula except a trace between the external cusps. This species resembles the *A. furcatus*, but differs materially from it, as from *A. pygmæus*, in the deeper and more robust mandibular bone.

Measurements.

	S. mentalis. M.	*S. pygmæus.* M.
Length of the first true molar	0.0044	0.0043
Width of the first true molar behind	0.0033	0.0031
Depth of the ramus at front of the third molar	0.0085	0.0075
Depth of the ramus at front of the last premolar	0.0078	0.0055

Sarcolemur crassus, Cope.

Plate xlv, fig. 16.

Antiacodon crassus, Cope, System. Cat. Vert. New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 57.

Represented by a portion of the right mandibular ramus, which supports the first and second true molars. It is a peculiar species, known among its allies by the obtuseness of the cusps and ridges of the crown. The double cusp is thick, and the component apices little separated; the anterior only is connected with the external anterior tubercle. The posterior part of the crown is wider than the anterior, and is quite concave. The outer border supports a stout tubercle; the inner, a very small one behind, and there is a small ledge representing the posterior median. The oblique ridge from the posterior external cusp is low, and the anterior cusps rise abruptly. The enamel is smooth, and the cingulum is represented by a trace between the bases of the external tubercles.

Measurements.

	M.
Length of the second true molar	0.0080
Width of the same posteriorly	0.0075
Elevation at same point	0.0040
Transverse diameter of the ramus	0.0080

HYOPSODUS, Leidy.

Leidy, Report Geol. Surv. Terrs., i, p. 75.

In this genus, the cusps of the true molars are all elevated and simple, and the last premolar presents an internal cusp. According to Leidy, there are three incisors, which are in immediate contact with the canine, as the latter is with the premolars. *Hyopsodus* has been regarded by Leidy as a "Pachyderm", as was done by Cuvier in the case of the allied form *Adapis.* As observed by Leidy, the American genus nearly resembles the European (under the synonym *Aphelotherium*). As the latter is believed by Gaudry and Gervais to be Lemuroid in affinity, *Hyopsodus* must have a similar reference. This is confirmed by the approximation in dentition to *Tomitherium* through intermediate genera.

The type is *H. paulus*, Leidy; a second species is *H. vicarius*, Cope, both from the Bridger beds of Wyoming. A single jaw-fragment from New Mexico, was referred by me in the "Systematic Catalogue" to the former, but the material is insufficient for final determination.

Hyopsodus miticulus, Cope.

Plate xlv, figs. 10–12.

Hyopsodus miticulus, Cope, System. Cat. Vert. New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 18.

Esthonyx miticulus, Cope, Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 8; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 120.

Parts of several specimens of this species show that the molars are similar in size to the *H. paulus*, but that it has a much smaller last inferior molar, which has such a low heel as to resemble the corresponding tooth of the species of *Esthonyx.* The last two premolars are more robust than in *H. paulus*, and possess rudimental anterior basal tubercles, of which a trace only exists in the *H. paulus*. The mandibular ramus is considerably shallower, and the species was probably more diminutive.

Represented by portions of mandibular rami of three or four individuals of the same size as those referred to some of the species above described. There are represented two premolars and three molars; other teeth are lost. The molars differ from those of the three preceding species in lacking the notch or groove dividing the inner anterior cusp of the crown, giving the worn surface a more simply sigmoid form; the anterior portion is, moreover, not materially more elevated than the posterior. The last molar has a large heel, an inner and two anterior tubercles when little worn. The premolars preserved are each two-rooted, and the penultimate is without heel or inner tubercles.

Measurements.

	M.
Length of the three true molars (No. 1)	0.0120
Length of the two last premolars (No. 2)	0.0064
Length of the first true molar (No. 1)	0.0040
Width of the first true molar (No. 1)	0.0030
Depth of the ramus at first true molar (No. 1)	0.0080

The worn surfaces of the first and second true molars are much like those of the corresponding teeth of *Menotherium*, Cope. That genus differs in the reduced form of the last inferior molar and in the premolars.

OPISTHOTOMUS, Cope.

Cope, System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 15.

Represented by inferior molar teeth of two species. These do not display a bifid or double anterior interior cusp, and the crowns exhibit two anterior cones, and an inner cone and outer crescent posteriorly. The posterior crescent is well defined, and is continued on a narrow crest to the anterior inner tubercle. The posterior molar presents the peculiarity of a series of three cusps in one line, the median having another or lateral cusp near it.

This genus is also probably Mesodont, but differs widely in the form of the last molar from *Tomitherium*, *Pantolestes*, &c. This tooth would appear by its form to be capable of a sectorial function in relation with the opposing tooth of the superior series.

Opisthotomus astutus, Cope.

Plate xlv, fig. 9.

Loc. cit., p. 16.

Established on two posterior lower molars, which were found in immediate association, but not attached to the jaw. The penultimate molar has a convex cingulum in front connecting the two cusps, and a median posterior cusp of small size. The last molar has a wide ledge in front, and the anterior cusp is on its outer side. It is separated by a valley from the middle cusp, which is the most elevated. Directly on its inner anterior aspect, a stout cusp is attached, and connects by a low ridge with the anterior. The posterior cusp is elevated, conic, and median, and is connected with the central cusp except at its apex. There is no heel behind it, nor any cingulum on this or the anterior molar tooth. The enamel of both teeth is nearly smooth.

Measurements.

	M.
Length of the crown of the median lower molar	0.0065
Width of the same	0.0060
Length of the crown of the posterior lower molar	0.0085
Width of the same in front	0.0050
Length to the middle cusp	0.0045
Elevation of the middle cusp	0.0050

Opisthotomus flagrans, Cope.

Plate xlv, fig. 8.

Loc. cit., p. 16.

A larger species belonging to this genus, is represented by a portion of the lower jaw, from which the molars are broken, excepting the last. The outline of the base of the crown of the latter is elongate-subtriangular, the base of the triangle being anterior. The anterior fourth of the crown is a ledge with angulate border, and a tubercle at the outer anterior corner; the remainder of the crown consists of three elevated cusps, an external alternating with an internal, and a median posterior. The inner and outer cusps are rather obtuse, and are separated by a deep notch; the posterior cusp is much lower, is obtuse, and has a still smaller tubercle at its inner basis. The surface of the heel is oblique, for the external anterior tubercle sends a ridge to the internal median cusp, so that the line of elevation of the crown is a zigzag of three limbs.

Measurements.

	M.
Length of the crown of the last inferior molar	0.012
Width of the same anteriorly	0.006
Length between first and third cusps of the same	0.006
Depth of the ramus at the same	0.020

INSECTIVORA.

To this suborder I refer the genus *Esthonyx*, on account of the near resemblance of such parts of the dentition as are known to some of the genera now existing. It is not unlikely that other genera of the Eocene which have been referred to the *Insectivora* belong here. *Esthonyx* exhibits an approximation to the *Tillodonta* in the restriction of the enamel-layers of the incisors of one of the jaws to the anterior face only. The inferior molars have much the constitution of those of *Anchippodus*, and in their details resemble also those of *Erinaceus*. As compared with the *Creodonta*, there is a near resemblance between these teeth and the tubercular molars of *Didymictis*, and through them to the tubercular sectorials of the *Oxyænidæ*, with which they agree in essential composition.

On the other hand, resemblances between the dentition of *Esthonyx* and the supposed Lemurine genus *Tomitherium* are not wanting, and the Rodent-like anterior teeth of the Lemuroid *Chiromys* suggest still further affinities between the Eocene members of that group and the *Tillodonta*.

ESTHONYX, Cope.

Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 6; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 118; System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 23.

Incisors of two forms; the inferior subgliriform, but not growing from persistent pulps; the enamel covering a long and narrow external vertical face, and terminating above the alveolus, thus distinguishing crown and root. The other form of ?incisor with the apex encased in enamel, but extending much farther on the outer than the inner side; the crown compressed, not wider than the root. Molars supporting two V's, with rounded apices directed outward, the posterior soon wearing into a triangle lower than the anterior. The anterior elevated and transverse, only distinguished from a triangle by a notch on the inner side. Last lower molar with this anterior transverse triangle, a diagonal ridge, and a heel with raised border. The fourth premolar has a V-shaped crest on its anterior half, the angle being an elevated apex of the external face, the limbs descending inward.

This genus differs from *Anchippodus* and *Ectoganus* in the far less gliriform character of the incisor teeth, although the composition of the molar teeth exhibits a true resemblance to that seen in those genera. The incisor is annectant to the form usual in Mammals, betraying the Rodent character in the absence of enamel from the posterior face, and the oblique bevel posteriorly from the apex to the shank. The ? canine or superior incisor (second form) is elongate, and without distinction between crown and root, but is straight, and not gliriform. A resemblance to the superior incisor of *Ectoganus* can be observed in the deep emargination of the enamel to near the apex on the inner side, and the convexity of the opposite side.

A strong resemblance can be discovered between this genus and *Tomitherium*, which is described under the *Mesodonta*. The composition of the inferior molars in the latter is essentially the same in the two genera, but the anterior cusps and yokes are relatively less developed in *Tomitherium*. An obvious resemblance is seen in the last premolar, which is somewhat sectorial in the form of its anterior half in both genera. There is no enlarged external incisor in *Tomitherium*, but either arrangement is consistent with Mesodont affinities, and even incisors of Rodent-like character, in view of the structure of *Chiromys*, so that *Esthonyx* might perhaps be properly referred to that group. Its resemblances to *Erinaceus* are, however, so many, that I leave it here for the present.

Esthonyx bisulcatus, Cope.

Plate xl, figs. 27–33.

Esthonyx bisulcatus, Cope, Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 7; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 118; System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 24.

Esthonyx acer, Cope, Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 7; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 119.

Represented by parts of both mandibular rami, with molar and loose incisor teeth of one individual; a mandibular ramus, supporting the last four molars, of a second; a fragmentary ramus, with one molar in place; and some isolated molars, of a fourth individual.

The section near the apex of the crown of the ?superior incisor is lenticular, one side (?the inner) being interrupted by a low longitudinal ridge, from which the enamel is removed by attrition. The enamel is slightly and obsoletely striate. A section of the inferior incisor is oval, flattened on the inner side; the enamel is obsoletely rugose, and is slightly incurved on the upper surface near the apex.

The grinding-face of the molars and some of the premolars is ∽-shaped, but the anterior limb of the figure is much thickened on the inner face, so as to have a triangular form, the base being inward. This base is notched by a second groove of that side of the tooth, which interruption is obliterated by prolonged attrition. This portion of the crown is elevated above the posterior, in consequence of the more rapid removal of the latter by trituration. The large internal and external grooves continue nearly to the base of the crown, as in *Ectoganus*. The last inferior molar is longer than the others, and is three-lobed, forming by its base nearly an isosceles triangle. The heel is formed by the backward production of the posterior convexity of the ∽, the central line of the figure forming a diagonal ridge across the middle of the tooth.

The mandibular ramus is of a deep compressed form.

Measurements.

	M.
Length of three consecutive molars	0.0250
Length of the last two molars	0.0210
Length of the penultimate molar	0.0084
Width of the same	0.0062
Length of the last molar	0.0112
Width of the same	0.0070
Length of the incisor, second form	0.0250
Diameter of the same	0.0050
Diameter of the incisor, first form, transverse	0.0030
Diameter of the incisor, first form, antero-posterior	0.0070

A second specimen consists of a portion of the lower jaw, in which the last four molars remain. They resemble those of the specimen already described. The anterior one of the series assumes the form of a premolar, the posterior V becoming a curved median cutting-edge, and the anterior V opening into a crescentoid section; it rises to an acuminate apex, having thus a rather sectorial character. In the three true molars, there is a small tubercle at the inner base of the posterior limb of the anterior V. Posterior V much lower. Enamel smooth.

Measurements.

	M.
Length of the four last molars	0.035
Length of the three last molars	0.026
Length of the penultimate molar	0.008
Width of the same	0.005
Length of the last molar	0.011
Width of the same	0.005
Depth of the jaw at the last molar	0.020

This species is like the *E. burmeisterii;* but the mandibular ramus of that species is relatively deeper.

Esthonyx burmeisterii, Cope.

Plate xl, fig. 26.

Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 7; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 119.

A species nearly allied to the *E. bisulcatus*, the type of the genus, is represented by a portion of the right mandibular ramus, with the last molar tooth in perfect preservation. While the jaw is of a depth similar to that of the *E. bisulcatus*, it is more slender in its proportions. The molar, also, while of nearly the same length, is relatively narrower, especially in its anterior portion. The crown of this tooth is worn in the specimen, and the anterior portion is elevated above the posterior, and displays a trace of the notch of the inner margin already observed in the species last described. The composition of the tooth is similar in other respects. No cingula. Enamel smooth.

Measurements.

	M.
Length of the last lower molar	0.009
Length of the last lower molar from the anterior tubercles	0.0060
Width { anteriorly	0.0050
Width { posteriorly	0.0025
Depth of the ramus at the last molar	0.0240

This species is dedicated to Prof. Hermann Burmeister, director of the museum of Buenos Ayres, who has studied the *Mammalia* of the deposits of the Pampas, and given us an excellent account of their osteology.

TÆNIODONTA.

The characters of this group, already pointed out,* are most distinctly seen in the teeth which are supposed to be superior incisors. Unfortunately, they have not yet been found in place in the cranium; but their association with a Rodent type of inferior incisors, which have been found in place in the mandible, confines us to the alternative choice between superior incisors and canines. From the small size or absence of inferior canines, a similar character may be inferred for the superior dentition.

The superior incisors present two bands of enamel, an anterior and a posterior. They are compressed in form, the sides presenting a surface of dentine or cementum. Attrition produces a truncate or slightly concave extremity. The inferior incisors are Rodent-like.

Two families represented this suborder in the Eocene period in New Mexico. The first or *Ectoganidæ* possess molar teeth with several roots. In the *Calamodontidæ*, each molar has a simple conic fang. But one genus of each family is known. In *Calamodon*, the deficiency in enamel is supplied by a deposit of cementum.

The type of superior incisors characteristic of this division is unknown elsewhere among *Mammalia*. It is intermediate between the usual type and that of the *Rodentia*, but it is not, therefore, evident that it represents a stage in the process of differentiation of the latter order. This is rather seen in such incisor teeth as those of *Esthonyx*. The great reduction in the extent of the enamel investment is an interesting approximation to the *Edentata*, where this substance is altogether wanting. The reduction is greatest on the adjacent sides of the molars; it has a little greater extent on the inner side, while it extends as a band on the exterior side, so that in worn teeth this surface alone remains. In addition, there are a heavy cementum

* Proc. Acad. Phila., March, 1876.

investiture and undivided roots in the genus *Calamodon*, features essentially characteristic of the *Edentata.*

Thus we have in the *Tæniodonta* the first hint as to the relations of the *Edentata* in early Tertiary time.

ECTOGANUS, Cope.

Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 4; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 116; System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 6.

This genus rests on a number of remains of the crania of two species, including principally teeth, in a good state of preservation, all found in appropriate relations by the writer. The teeth include incisors, molars, and premolars, it is believed, of both superior and inferior series.

There are two types of gliriform incisor teeth, and of one of these, in the largest species, three sizes. In the inferior, the teeth are elongate, compressed, convex in both directions on the anterior face; and are convex or angulate in section at the posterior face; the enamel is confined to a band on the anterior face, extending more or less on one side or the other, the naked dentine extending prominently backward at the middle and basal portion of the shaft.

The teeth of the other type correspond with those referred to the upper jaw in the genus *Calamodon.* Like them, they are flattened, and have a convex, enamel-coated, anterior face, and a similarly coated posterior face, which converges toward the anterior, instead of being parallel with it, as is the case in *Calamodon.* In *E. gliriformis*, the unworn apex is partially preserved, and presents the peculiarity of having two distinct terminations, one for each enamel face. Between the two, there is a deep notch, which is oblique, and also extends up one side of the tooth for a greater or less distance, according to the species. The superior apex is entirely encased with enamel. The enamel bands are oblique in the transverse direction as in *Calamodon*, looking to the side which I suspect to be the external. The other side is flat. This peculiar form induced me to suppose at one time that this body consisted of two distinct teeth connected by the alveolar wall, a view which I subsequently corrected.

There are three molars of the superior, and several of the inferior series available for present determination. The superior are all remarkable for the great exposure of their external faces as compared with their internal, and the extension of the enamel on the outer face of the very thick external root, which is not distinguished from the crown. The premolars have two of the roots connate, forming a support to the greater part of the crown. The worn surface is in form something like the Greek ω, the deep emargination being internal. The inferior molars have greater antero-posterior than transverse diameters. The enamel is more extended on one side than the other, covering the exposed portions of the roots. The grinding-surface is plane, and has the form of a horizontal ω; the limbs being angulate, as in the Greek ω. The enamel of the oblique molars is quite thin. A portion of a large molar which I originally described as having three roots is of uncertain position, owing to a portion having been lost. Two sides of the crown stand on a single root of crescentic section which is abnormally divided by a fracture. There were three prominent tubercles on the circumference of the crown, but injuries it has sustained prevent the description of its true form.

This genus apparently occupies a position between the single-rooted and many-rooted genera of the group. It differs from *Anchippodus* and its immediate allies in the greater simplicity of the form of the inferior molars, which are composed in the latter of two V's, somewhat as in many *Insectivora.*

Ectoganus novomehicanus, Cope.

Plate xl, figs. 34–39.

Calamodon novomehicanus, Cope, Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 6; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 118.

This species is represented by a superior and perhaps an inferior incisor tooth. The former obviously belongs to a species of *Ectoganus*, but exhibits strong characteristic distinctions from the corresponding tooth of the *E. gliriformis*. It belongs to an individual of larger proportions than the type-specimen of the latter.

The superior incisor has the usual compressed form, and is concave on one side and convex on the other. The two enamel-covered edges are thick, and converge gently. The enamel bands themselves are extended chiefly on the convex face of the tooth, and not far from the grinding-face they unite, surrounding that side of the end of the crown. The enamel bands are also slightly incurved on the concave face, increasingly so near to the grinding-face, but they do not meet by a considerable interval. The masticating surface is therefore oblique, wearing faster on the side not protected by the enamel. On the opposite side, the enamel is thrown into an entering fold of little depth at the point to which the crown is worn in the specimen, which runs out a little above the grinding-face. There are some obsolete striæ on the enamel toward the decurved margin. The pulp-cavity is large at the fractured base of the tooth, and is surrounded by thick dentinal walls.

Measurements.

	M.
Length of the crown preserved	0.038
Depth of the crown at the broken base	0.018
Depth of the crown at the apex	0.011
Width of the crown at the broken base	0.008
Width of the crown at the apex	0.006
Width of the interruption in the enamel at the grinding-face	0.005

In comparison with the corresponding tooth of the *E. gliriformis*, the following peculiarities may be observed: the convergence of the enameled faces is much less rapid in *E. novomehicanus;* the flat side of the former is replaced by a concave side in the latter; the convex side of the *E. novomehicanus*, is in *E. gliriformis* grooved next the lower or posterior side, the enamel band standing out in a bead; this groove becomes deeper, and finally divides the apex into two; in *E. novomehicanus*, this groove is only apparent near the apex, and the enamel bands are continuous with the intervening surface except at that point; the anterior enamel band is more strongly incurved on the flat side near the apex in the *E. gliriformis.*

Ectoganus gliriformis, Cope.

Plate xli, figs. 1–12.

Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 5; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 116.

The teeth constitute the available representatives of this species; the cranial and other fragments found being useless for description.

The superior enamel face of the superior incisor has an open shallow groove near the supero-anterior margin. The face of the superior apex, which presents to the other apex, has a wide longitudinal groove. The inferior enamel band covers a prominent rib, which, near the apex, projects so as to be 0.66 of a cylinder; its enamel is not grooved, but has, like that of the superior band, an obsolete trace of wrinkling.

The large inferior incisors are beveled on their posterior edge far below the apex, so that the outlines of the teeth are not parallel, as in the species of *Calamodon*. In the similar incisors of the second size, the posterior bevel is much shorter and more abrupt, and the posterior border of the shaft is not quite concentric with the anterior, converging a little toward the apex. In the smallest teeth of this type, the two borders are nearly parallel. The section of the two larger kinds of teeth is diamond-shaped; that of the smallest, a narrow oval. The enamel band on the two larger kinds of teeth is quite protuberant, but in the least it is narrow and merely convex. The enamel band on the largest inferior incisors is slightly convex on one side; and, on the other side, where it is more extended backward, it exhibits a shallow longitudinal concavity. Both sides are obsoletely, but distinctly, longitudinally ribbed. The enamel of the teeth of the medium size is quite similar. The dentinal shaft of the largest is contracted to a narrow edge behind; that of the second size is more obtuse.

The enamel of all the molars is smooth, and without cingula. The transverse crests of the unworn true molars support two tubercles, and the inner extremities of the crests of the premolars are produced in accordance with the oblique wearing of the incurved crown in mastication.

Measurements.

	M.
Length of the inferior incisor, largest	0.043
Width of the same	0.013
Depth of the same	0.018
Length of the incisor, medium, type 1	0.034
Width of the same	0.006
Depth of the same	0.014
Depth of the incisor, least, type 1	0.009
Width of the same	0.004
Length of the superior incisor	0.031
Width of the same	0.021
Diameter of the crown of a premolar { longitudinal	0.010
Diameter of the crown of a premolar { transverse	0.010

Length of the enamel of the face externally	0.013
Length of the same posteriorly	0.005
Length of the crown of the posterior upper molar	0.016
Width of the same	0.012
Length of the crown of the posterior lower molar	0.012
Width of the same	0.009

Size about that of a fully-grown Peccary.

CALAMODON, Cope.

Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 5; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 117; System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 24.

This genus is characterized as follows, from the material which I have been able to procure: Lower jaw with one pair of large incisors growing from persistent pulps; each ramus with seven teeth following its incisor without interruption, the last within the base of the coronoid process. These teeth with simple roots, but not growing from pulps having a continued persistence. Crowns of the molars with a transverse depression, which separates some low tubercles. Superior molars not certainly known. The superior incisors of two kinds, both differing from the inferior in having a squarely truncate grinding-face, instead of an oblique one, in which they differ totally from those of *Rodentia.* The larger have two enamel bands, an anterior and a posterior, and one side is concave. The smaller incisors have the anterior enamel band only, in the specimens preserved.

A characteristic feature of the dentition in this genus is the thick coating of cementum which invests those portions of the molars and superior incisors which are not protected by enamel. In these teeth, it is thicker than the enamel, and forms thickened raised borders surrounding the latter, producing a characteristic appearance not known in the other genera. It is not observable in the large inferior incisors.

A part of the skeleton of one of the species is preserved It shows that the humerus was robust, and was pierced distally by a large arterial foramen. The condyles are not very convex, nor the internal epicondyle so prominent as in some of the *Creodonta.* The head of the radius is flat and incapable of rotation, and is rather slender, while the ulna is deep and thin. An ungual phalange is stout and compressed, and but little curved, and without the basal sheath seen in the *Carnivora* and some *Edentata.*

The exact homologies of the seven mandibular teeth are obscure, and it is uncertain to how many the expression molar should apply. The two immediately following the incisor differ in form from the last five.

The symphysis is solid and short; it projects wedge-like between the large incisors, whose anterior borders are closely approximated. There is a large mental foramen.

The typical species is the *C. arcamœnus.*

Calamodon arcamœnus, Cope.

Plates xli, figs. 13–17; xlii, figs. 1–5; xliv, fig. 1.

Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 6; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 117.

This species is represented primarily by a left mandibular ramus containing a part of the incisor tooth, with which were found portions of the other ramus, with fragments of incisors, and two molars with entire crowns. These remains were all found in immediate association, and evidently belong to a single individual. To this species, I refer inferior incisors, with a few associated bones, of three other individuals.

The mandibular ramus is stout in all its dimensions, and the symphysis is completely co-ossified. The base of the coronoid process is thickened anteriorly, and the ascending portion forms an ascending ridge, but the masseteric fossa is not defined below nor antero-inferiorly. The inferior border of the ramus is inflected neither inward nor outward, as far back as preserved, *i. e.*, the line of the condyle. The external face of the ramus is convex, and the thickness of the ramus diminishes very little anteriorly. It is fractured near the middle, but the alveoli for seven teeth behind the incisor are preserved. Of these, the last five are quite similar in proportions, while the first two are of characteristic forms. How many of them should be regarded as molars, and how many, if any, canine and incisors, the material is not sufficiently complete to enable me to determine. The posterior two alveoli are subquadrate, with rounded angles; the three preceding them are more nearly round in section. The second tooth is peculiar, and having its transverse diameter twice as great as the antero-posterior, its position in the jaw is thus transverse. The root is like that of the other teeth, simple, but is slightly constricted on both the wide faces at the middle; its position near the ascent of the large incisor causes it to be a little shorter than that of some of the others. The first mandibular tooth is small; its alveolus is triangular-oval in section, the longer and oblique side being internal, and extending alongside of the large incisor three-quarters of its length. It is possible that this tooth should be reckoned as an incisor.

A well-preserved molar contracts downward to the base of the root, which is not twice as long as the crown. The latter has perpendicular sides, and one of its diameters is a little longer than the other. The enamel investment of the crown is uninterrupted on the sides, but has an irregular line of contact with the superficial layer of the root. If the side where the enamel descends lowest, be, according to the analogy of other species, the external, the boundary on the inner side is a little higher and oblique; it is angulate on the narrower end, and deeply notched at the wider end. The former will be, according to the analogy of other species, the anterior. It supports a transverse yoke, partly divided into two tubercles, whose long axis is also transverse. The posterior end of the crown supports two much smaller tubercles, which form the central part of a crescentic elevation of the border of the crown. One apex of this crescent is separated from the anterior yoke by a deep fissure; the other apex is contracted within the border of the crown, and, descending, extends to the basis of the anterior yoke, resembling the oblique yoke of the inferior molars of *Ectoganus* and *Esthonyx*. Center of the crown concave; no cingula, except a trace at the middle base of the anterior yoke. Enamel smooth. Fragments of incisor teeth accompanying this jaw exhibit smooth enamel, without longitudinal grooves or striæ, and without transverse lines of growth or rugosities of any kind; the section of this face is uniformly convex. A portion of the middle of the incisor in the jaw shows a shallow longitudinal groove near the posterior external margin. The incisive alveolus extends to below the third molar from behind.

Measurements.

	M.
Length of the ramus to and including the last molar	0.128
Length of the same to the base of the coronoid	0.098
Length of the five molars alveoli	0.075
Length of the alveolus of the penultimate	0.013
Width of the same	0.013
Length of the alveoli of the first and second teeth	0.025
Length of the alveolus of the second tooth	0.010
Width of the same	0.023
Length of the alveolus of the first tooth	0.010
Width of the same	0.009
Width of the inner side of the incisive alveolus	0.023
Depth of the ramus at the antepenultimate molar	0.053
Depth of the same at the antepenultimate molar	0.030
Length of the crown of the inferior molar	0.015
Width of the same	0.013
Elevation of the same (greatest)	0.013

A nearly entire inferior incisor accompanying some bones of uncertain reference appears to belong to this species. It forms nearly a regular arc of 73° of a circle of $0^m.095$ in diameter, but is not in one vertical plane. The anterior face is turned somewhat outward; the external face of the tooth thus becoming oblique, while the other is nearly plane. The posterior border is rounded, and maintains a uniform thickness and a uniform distance from the anterior face to its distal termination. This termination is an abrupt truncation about an inch short of the apex, which is worn from a thin enameled edge backward and outward. The mark of attrition of the superior tooth is distinct three-quarters of an inch below the truncation, on the inner side. The sides of the tooth are shallowly concave, the outer most so. The enamel band extends a little farther back on the outer side, and its section is widely convex without any grooving, except a shallow concave line near the inner border. The apex is perfectly smooth; lower down there are faint longitudinal ribs.

Measurements.

	M.
Length of the incisor on the convexity	0.135
Antero-posterior diameter below the apex	0.030
Antero-posterior diameter at the base	0.031
Transverse diameter below the apex anteriorly	0.016
Transverse diameter below the apex posteriorly	0.010

An incisor of another individual displays the same characters; *i. e.*, the posterior truncation below the apex, the equal antero-posterior diameter, and the broadly convex ungrooved front. The size is a little smaller. A portion of a third individual is similar.

Calamodon simplex, Cope.

Plates xlii, figs. 6-8; xliii; xliv, figs. 2-5.

Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 5; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 117.

The remains of this species were found rather more abundantly than those of the *C. arcamœnus*, from which it differs but little in dimensions. It may be distinguished by the form of its inferior incisor teeth, which are more robust and more roughened by longitudinal striæ or grooves. The most marked of these is a shallow concavity near the external posterior border, which destroys the regular convexity seen in the *C. arcamœnus*. The median portion of the face is more protuberant, and the investiture of enamel extends more posteriorly on both sides, the external border lying along the summit of a low longitudinal rib of the dentine. The posterior border of the shaft contracts gradually to the trenchant apex in front, as in *Ectoganus gliriformis*, and is not truncate, as in *C. arcamœnus*.

The specimen of this species first described consists of portions of inferior incisors and a molar. The former are larger than those of the *C. arcamœnus*, and the enamel face is protuberant, having a greater posterior extent than in that species; one side is gently convex, and is marked with a number of obsolete longitudinal ribs; the opposite face is turned outward at its posterior border, forming an open concavity. This side also is marked by obscure longitudinal ribs. The enamel surface is obsoletely rugose, except near the apex, where it is smooth. The molar is elongate, simple, and gently curved. Its section is obtusely subquadrate, and the external face, which is convex longitudinally, is also more convex in cross-section than the other sides. The external face has an investiture of enamel to near the base, while the dentinal surface extends to near the triturating surface on the anterior and posterior faces. The enamel of the inner face descends to a pointed extremity which marks half the length of the external enamel face. The triturating surface is nearly round, excepting a small entering loop of enamel on the inner side. It is worn obliquely, an angle of the circumference projecting beyond the rest. The enamel is marked by obsolete longitudinal riblets. The root contracts downward.

Measurements.

		M.
Diameter of the enameled part of the incisor	transverse	0.019
	longitudinal	0.015
Diameter of the base of the crown of the molar	transverse	0.015
	longitudinal	0.015
Length of the crown of the molar on curve		0.041

The molar tooth of this specimen differs from the one described as belonging to the *C. arcamœnus*. It is more prismatic and curved, and the enamel is more unequally distributed on its sides. The crown is more contracted. These differences are important, and are not dependent on attrition, since the short-crowned molar, that of *C. arcamœnus*, is unworn, and the long-crowned one of *C. simplex* is considerably so.

Another individual is represented by more abundant remains. It includes inferior and superior incisors, a molar, and portions of the cranium and limbs, especially humerus, ulna, radius, magnum, unguis, scapula, etc.

The inferior incisors present the features already ascribed to the species. The superior incisor is a remarkable tooth, and has associated with it a smaller curved incisor, which appears to me to belong to the same jaw, although this point is uncertain. The large tooth is equal in antero-posterior diameter at the base and at the masticating face, and is gently curved. It is flattened in an antero-posterior plane, which is slightly twisted. The enamel faces are convex and oblique in reference to the cross-section, the supero-anterior one especially declining to one side. This side is excavated into a shallow channel from one end to the other. The opposite side of the tooth is nearly plane or slightly convex at the masticatory face, and a little more concave near the root. The triturating surface is truncate. The enamel is smooth, excepting minute transverse lines of growth. The small incisor differs from the large one in having, like the inferior, only one face, the convex, protected by enamel, which is a narrow strip. The shaft is curved, and is oval in section. The masticating surface is transverse. The cementum layer is very thick. The molar is much worn, and has a cyclo-tetragonal section. The triturating surface displays no irregularity of form. The inferior enamel border is deeply emarginate anteriorly, posteriorly, and interiorly.

The recognizable cranial fragments are few. The condyle of the lower jaw has considerable transverse extent, and fragments of the ramus show it to have been robust, and with the base of the coronoid process projecting laterally, and separated by a ledge from the posterior molars, which extend within it.

A large part of the shaft of the right humerus, with half or more of the condylar extremity, is preserved. The former presents a deep bicipital groove, with especially wide deltoid ridge. The latter is, in fact, two ridges, presenting in opposite directions, with a plane between. There is also a postero-external longitudinal angle. The proportions of the humerus were stout, but cannot be exactly determined, owing to the lack of a portion of the shaft. The inferior extremity is transversely expanded, displaying a moderate internal epicondyle. The arterial foramen is protected by a strong osseous bar, whose convex border projects a little farther than the internal tuberosity. The flange bordering the articular condyle within is obtuse and moderately prominent. The articular face is strongly concave transversely, but is incomplete in the specimen.

The *ulna* and *radius* are entirely distinct, and the former maintains its proportions toward the distal end. Both extremities are wanting in the specimen. The shaft is strongly compressed; the inferior margin is rounded, and becomes oblique and expanded at the olecranon. The latter is well produced, and has an oval triangular section near the end. The humeral cotylus is shallow, but well flared on both sides. The inferior border of the ulna describes a very gentle sigmoid in profile. The head of the radius is flattened-transverse, and is almost, occupied by a nearly uniform concavity. The shaft immediately contracts, and soon acquires a sub-triangular section, with the external face vertical. It expands again toward the distal extremity, which is lost.

The *os magnum* is deeper than long behind, and half as long again behind as before, where its length is exceeded by the width. The inferior face is convex transversely in front, concave in all directions behind the front. The two superior facets are distinct, and it is only one of them whose plane rises into the posterior elevation. On the side of this, the lateral facet is distinct to the front. An ungual phalange is preserved, but wants the inferior surface. It is compressed, its superior angular line obtuse, and but little curved antero-posteriorly. The apex is moderately fissured. The proximal articular face is composed of two vertical concavities separated by a well-marked vertical angle. Its superior border is produced backward. The sides of the phalange are pierced by numerous nutritive foramina.

Measurements.

	M.
Length preserved of the large superior incisor	0.045
Length preserved of the posterior enamel face	0.029
Antero-posterior diameter of the grinding-face of the same	0.019
Transverse diameter of the same	0.009
Transverse diameter of the same at the middle	0.008
Transverse diameter of the small incisor	0.005
Antero-posterior diameter of the same	0.009
Transverse diameter of the inferior incisor	0.015
Antero-posterior diameter of the enameled part of the same	0.014
Transverse diameter of the molar	0.018
Long diameter of the humerus at the deltoid ridge	0.035
Short diameter of the humerus at the deltoid ridge	0.025
Diameter of the shaft above the arterial foramen	0.034
Diameter of the arterial foramen	0.010
Extent of the projection of the inner tuberosity	0.016
Estimated extent of the distal end of the humerus	0.060
Depth of the ulna at the middle	0.029
Width of the ulna at the middle	0.011
Width of the ulna at the olecranon	0.024
Width of the head of the radius	0.032
Depth of the same	0.018
Depth of the shaft at the middle	0.012
Width of the shaft at the middle	0.014
Length of the cuboid in front	0.010
Length of the cuboid behind	0.016
Width of the cuboid in front	0.015
Length of the ungual phalange	0.030
Width posteriorly	0.013

In a third individual, the large lower incisor gives the following dimensions:

	M.
Antero-posterior diameter	0.030
Transverse diameter at the border of the enamel	0.018

Fragments of incisor teeth of several other individuals display similar proportions. The species was about the size of a Tapir.

RODENTIA.

Remains of Rodents are not abundant in the Eocene beds in that part of New Mexico examined by me. They represent but three species of the single genus *Plesiarctomys*, which is the characteristic form of the Bridger beds of Wyoming.

PLESIARCTOMYS, Bravard.

Plesiarctomys, Bravard, Ossemens fossiles de Desbruge, 1850, p. 5.—Gervais, Paléontologie française explic., tab. 36, p. 4.

?Paramys, Leidy, Report U. S. Geol. Surv. Terrs., 4 to 7 i, 1873, p. 109; Proc. Phila. Acad., 1870 (name only).

The inferior molars by which this genus has been generally known resemble much those of existing *Sciuridæ*, but there are cranial characters which distinguish it from the existing forms of that family.

The crowns of the inferior molars support four rather small and strictly marginal tubercles, which inclose a median valley. The anterior inner tubercle is more elevated than the others, and the posterior two tubercles are connected by a low ridge on the posterior border, which may be more or less tubercular on the last molar. In some of the species, the marginal tubercles are merely elevations of the margin, while, in others, the adjacent tubercles of a pair approximate, so as to form a pair of interrupted cross-crests. A maxillary bone supporting three molars displays characters of value. The details of the crowns of the superior molars are similar to those of the inferior series; except that, in the species examined, the inner tubercles are more unequal, the anterior occupying most of the border. There is a large round *foramen infraorbitale exterius*, like that of *Ischyromys* and *Fiber*, and entirely unlike that of *Gymnoptychus* and *Sciurus*, conforming in this respect to the forms of the extinct group of the *Protomyidæ* of Pomel. The incisor teeth are compressed, with narrow anterior face. The enamel is not grooved, and is little or not at all inflected on the inner side of the shaft, while it is extensively so on the external face.

No characters have yet been offered by which to distinguish the American species as representing a genus distinct from the *Plesiarctomys gervaisii* of the French Eocene. Bravard briefly distinguishes the genus as distinct from *Arctomys* in the greater thickness of the angles of the molars, which thus become tubercles. Only the mandible and mandibular teeth of the *P. gervaisii* are known. It has been found in the Upper Eocene of France, near Perreal, Apt.

Plesiarctomys buccatus, Cope.

Plate xliv, fig. 8.

This Rodent is represented in the collections of the Survey by a right maxillary bone with adjacent parts of the cranium of one individual. Three molar teeth are perfectly preserved. The proportions are less than those of the *P. delicatissimus*, but larger than those of the *P. undans*.

The malar process of the maxillary bone is largely extended in an antero-posterior direction as well as transversely, so that in the perfect skull it is probable that the orbit has a largely vertical direction. The malar process has a concave border, both anteriorly and posteriorly, being bounded by the orbit behind, and the large *foramen infraorbitale anterius* in front. Its inferior face is divided into two planes by an angle, which extends outward at right angles to the longitudinal axis of the skull.

The outlines of the triturating faces of the molars are between quadrate and circular. They support four low tubercles, two each on the external and internal borders. The posterior inner is much smaller than the anterior inner, and incloses with the two external a concavity. On the anterior and posterior borders of the crown there is a low cingulum, but none on the inner and outer borders. Enamel smooth.

Measurements.

	M.
Lengths of the crowns of the three molars	0.0080
Length of the crown of the third molar	0.0027
Width of the same	0.0030
Length of the crown of the first molar	0.0025
Width of the same	0.0030
Antero posterior width of the base of the malar process of the maxillary bone	0.0050
Horizontal diameter of the *foramen infraorbitale exterius*	0.0028

Plesiarctomys delicatissimus, Leidy.

Plate xliv, figs. 9 and 12.

Paramys delicatissimus, Leidy, Proc. Acad. Phila., 1871, p. 231; Report U. S. Geol. Surv. Terrs., i, p. 111, pl. vi, figs. 28–29.

I obtained a portion of a mandibular ramus of one individual, which agrees in measurements and other characters with the species above named. The jaw supports the second and third molars, and a considerable portion of the incisor. An isolated incisor of another animal of this species is figured on the same plate (*q. v.*).

The ramus is compressed, and not robust in its proportions, although deep in proportion to its length. The diastema is short, and the mental foramen is just below the anterior border of the first molar. The masseteric fossa extends to the line of the posterior border of the third molar. The four tubercles which distinguish the molars of this genus are here elevations of the border of the crown, and they inclose a large basin. The anterior inner is the highest.

Measurements.

		M.
Length of the three anterior molars		0.0100
Length of the third molar		0.0030
Width of the same		0.0020
Length of the first molar		0.0038
Width of the same		0.0026
Depth of the ramus at the second molar		0.0094
Diameter of the incisor	antero-posterior	0.0033
	transverse	0.0020

These measurements show the difference in size between this animal and the *P. buccatus.*

Plesiarctomys delicatior, Leidy.

Plate xliv, figs. 10–11.

Paramys delicatior, Leidy, Proc. Acad. Phila., 1871, 231; Leidy, Report U. S. Geol. Surv. Terrs., 1873, i, p. 110, pl. vi, 26, 27; pl. xxvii, 16, 18.

Two mandibular rami indicate that this species was a member of the Wasatch fauna of New Mexico. They are more robust than those of the *P. delicatissimus*, the incisor teeth are wider, and the tubercles of the molar teeth more strongly pronounced. The opposite pairs of tubercles are more or less connected by low ridges, a point especially marked in the anterior pair of the second molar, and the posterior pair of the third. The fourth molar is the largest, having an additional or fifth tubercle posteriorly, thus inclosing a longer basin than do the borders of the other molars. The inner anterior tubercle is the most elevated, and there are no cingula.

Measurements.

		M.
Length of the posterior three molars		0. 0112
Length of the posterior molar		0. 0042
Width of the same		0. 0032
Length of the second molar		0. 0035
Width of the same		0. 0027
Depth of the ramus at the second molar		0. 0104
Diameter of the incisor	antero-posterior	0. 0040
	transverse	0. 0027

GENERA INCERTÆ SEDIS.

PHENACODUS, Cope.

Phenacodus, Cope, Paleontological Bulletin, No. 17, p. 3, 1873; Report Vert. Foss. New Mexico, U. S Geog. Survs. W. of 100th M., 1874, p. 10; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 122.

A genus of Mammals whose affinities it is not yet possible to state with certainty, first discovered by myself in the Wasatch beds of Bear River, Wyoming, was found not uncommonly in the corresponding horizon in New Mexico.

There are three molars in each jaw, and the specimens include two premolars, which form a continuous series, as in *Achænodon.* There are four principal tubercles on the inferior molars, and sometimes a third small one between the posterior pair, always present on the last one, which is, however, not largely developed. The first inferior premolar presents a broad heel, a double median tubercle, and an anterior tubercle (in *P. primævus*). The crowns of the superior molars are low and broad, and support numerous tubercles; these are low and vary in number, but there are two near the external border which are quite constant. They have general resemblances to those of Hogs, Bears, and Monkeys. The first true molar is broader than long, and there are no diastemata between it and the premolars, or between the latter, which are irregularly quadricuspid and tricuspid respectively. The forms of these teeth are entirely different from those of the corresponding teeth in *Elotherium.*

The dentition of the anterior parts of the jaws of the species referred by me to *Phenacodus* is unknown, but the premolar and molar teeth are similar in character to those of the genus *Palæochœrus* of the French Eocene. The well-marked external crescents are, however, characteristic, and the details of structure of the molars so closely resemble those of *Opisthotomus* and *Tomitherium* that I entertain a suspicion that this genus is allied to them. If so, it includes the largest of the primitive Eocene Mesodonta, the *P. primævus* equaling the Orang in the size of its jaws. There are abundant specific peculiarities distinguishing the French and American species, the upper molars of the latter resembling in a greater degree the genus *Chœropotamus.*

Phenacodus primævus, Cope.

Plate xlv, figs. 1-5.

Cope, Paleontological Bulletin, No. 17, 1873, p. 3; Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 10; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 122.

This species was first recognized by the writer in a posterior inferior molar of a Mammal of about the size of a Peccary, of unknown affinities, which was named *P. primævus.* Specimens of the same species, embracing the dentition of both jaws, having been procured in the Eocene of New Mexico, I have been able to add to the characters of the genus. The remains certainly referable to it include only fragments of jaws with dentition of six individuals, the most perfect embracing five superior and four inferior molars, all found embedded in the rock in immediate juxtaposition. A detailed description of this specimen is given below.

The penultimate superior premolar, viewed from below, exhibits the outline of a right-angled triangle, with the short base anterior, and directed at a right angle to the exterior side. The outer portion of the crown consists of a rather low compressed cusp, marking the posterior third of the length. The edge which connects it with the anterior base, is interrupted at its middle by a low tubercle. The inner part of the crown is produced into a stout, prominent cusp, which is opposite to the anterior outer tubercle just described, and is separated from it by a wide longitudinal valley. There are no other tubercles, and no basal cingula, except a trace at the posterior exterior base. The narrowing of the posterior part of the crown of this tooth is a peculiar feature, reversing the proportions frequently seen in teeth in the same position. It corresponds in this respect with the last inferior premolar, and was found in place as described.

The last premolar is subround in the outline of the base of the crown. My notes, taken at the time of discovery, state that it supported four tubercles. A fragment has been lost from the anterior part of the crown, so that a tubercle may be missing; but the remaining and principal part of the crown now supports four tubercles of unequal sizes. There is, on the outer side, a prominent one over the posterior root, and a much smaller and lower one in front of it. On the inner part of the crown, there is a stout and prominent tubercle, opposite the notch between the two external ones, and separated from the latter by a deep longitudinal valley. At the posterior part of this valley, near the very convex posterior border of the crown, is a low tubercle. There is a trace of a cingulum on the external base of the crown, and a cingular tubercle at the posterior low tubercle just described.

The first true molar differs in its form from the second and third, which nearly resemble each other. The crowns of the latter consist of two external and two internal low, conic tubercles, which stand considerably within the base on both sides. A lower tubercle stands between each pair of the anterior, exterior, and posterior sides, but none between the interior. The crown of the first molar is considerably broader than long, and supports five low, conic tubercles. One of these is on the posterior external angle; one is within the inner extremity; two are on the anterior border, and one on the posterior border of the crown. Besides these, there is a strong cingulum round the inner extremity of the crown, which rises almost as high as the inner tubercle described. There is a tubercular cingulum along the posterior border, and one round the base of the outer anterior tubercle, but none on the external base of the crown.

Besides the characters already assigned to the last two molars, it may be added that they possess a basal ledge all round, which is in some places weak; in others, especially at the posterior outer angle, quite prominent. The enamel of all the molars is, where not worn by mastication, slightly wrinkled.

Measurements of superior molars.

	M.
Length of the last five molars	0.064
Length of the penultimate premolar	0.012
Width of the same	0.010
Height of the same	0.008
Length of the last premolar	0.013
Width of the same	0.013
Length of the first true molar	0.011
Width of the same	0.016
Height of the same	0.007
Length of the last true molar	0.015
Width of the same	0.015
Height of the same	0.006

The posterior inferior molar of the same side is wide in front, and regularly oval in posterior outline, and has two equal anterior and three unequal posterior tubercles. One of the posteriors is situated near the middle of the outer side, and is separated from the adjacent anterior by a deep groove. The corresponding inner tubercle is more posterior; anterior tubercles low, trihedral, and connected by a shelf-like cingulum across the front of the tooth; rudimental cingula on outer side of crown. The penultimate molar has three tubercles on the posterior border; and a deep fissure, corresponding to that of the last molar, separates one of them from the anterior tubercle. In all of the true molars, the posterior outer tubercle is connected with the anterior inner by a low oblique ridge, which forms the external border of a shallow basin-like concavity of the crown. The anterior inner tubercle is stouter than the anterior outer, especially in the first and second true molars; in the latter, it has a posterior enlargement, which is, in the former, separated from the anterior part by a fissure-like groove. The last premolar is longitudinally oval at the base, the anterior extremity the narrower. The crown supports two median tubercles, the outer the more elevated and anterior. There is an angular basal tuberosity in front, and a posterior heel-like portion. The external angle of this part is broken away, but it probably supported a tubercle, as an oblique ridge extends from its position inward and forward. No internal posterior tubercle.

The portion of the mandibular ramus preserved presents nothing remarkable. It is stout and convex on the external face. The coronoid process rises rather abruptly a short distance behind the last molar, and the inferior border of the jaw does not rise noticeably below the masseteric fossa.

Measurements of mandible and teeth.

	M.
Length of the last four molars	0.0575
Length of the last premolar	0.0135
Width of the same	0.0085
Height of the crown of the last premolar	0.0080
Length of the penultimate molar	0.0140
Width of the same	0.0125
Length of the last molar	0.0140
Width of the same	0.0100
Height of the crown of the last molar	0.0070
Depth of the ramus at the second true molar	0.0310
Thickness of the same	0.0170

Portions of both mandibular rami of another animal present some additional features. One of them contains the last three molars, which are more worn than those of the specimen previously described. The section of the tubercles given by the attrition is characteristic. Those of the internal and posterior ones are subcircular; those of the outer are subcrescentic, the anterior angle being produced forward and inward. The ramus is relatively shallower than in the specimen above described, as can be seen by the measurements appended. This is thought to be due to the fact that the jaw of the latter has been somewhat crushed by pressure on its sides, so that the measurement of depth exceeds the normal.

Measurements.

	M.
Length of the true molars	0.040
Length of the penultimate molar	0.013
Width of the same	0.012
Depth of the ramus at the penultimate molar	0.023
Thickness of the ramus at the penultimate molar	0.017

The measurements of a third individual are as follows:

Measurements.

	M.
Length of the last molar	0.015
Width { anteriorly	0.011
Width { between two posterior tubercles	0.005
Elevation of the anterior cusp from base	0.008
Width of the penultimate molar behind	0.010

The jaws and teeth of this species represent an animal of the average size of the White-lipped Peccary *Dicotyles labiatus.*

Phenacodus omnivorus, Cope.

Plate xlv, fig. 6.

Report Foss. Vert. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 11; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 122.

This quadruped is represented in the collections by a single superior molar tooth, which occupied either the last or penultimate position in the jaw. Besides being of much smaller size than the corresponding tooth in the *Phènacodus primævus*, it differs much in the composition of its parts. Thus, the anterior outer tubercle is obsolete, and the anterior inner is a part of the cingular development. The posterior inner is relatively twice as large as in *P. primævus*, where it equals the anterior inner. The intermediate tubercles (except the external), and the cingulum, are more largely developed than in the larger species.

Superior molar with low and broad tubercular crown, with outline of base parallelogrammic, with the external end oblique; the oblique end with two principal low tubercles, which form the extremities of two series of similar ones, some of which arise from the strong cingulum which forms part of the summit of the crown. Crown without cingulum on the outer side only; elsewhere very strong and crenate, at the inner anterior angle rising into a stout, low tubercle. The largest tubercle is near this, on the inner anterior summit of the crown, and is connected with the larger or anterior outer by a low, broad tubercle. A smaller one intervenes between the cingular tubercle and the smaller external. The outer tubercles low and broad, a smaller one opposite the internal between them in the position of a cingulum. Enamel coarsely rugose.

Measurements.

	M.
Transverse diameter	0.014
Longitudinal diameter	0.010
Distance between the apices of the inner and outer tubercles	0.007
Elevation of the cingulum	0.004
Elevation of the outer cusp	0.005

The tooth described is about the size of the posterior inferior molar of the Black Bear (*Ursus americanus*).

Phenacodus sulcatus, Cope.

Plate xlv, fig. 7.

Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 11; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1874, p. 123.

Represented especially by the molar tooth corresponding to that above described, under the head of *P. omnivorus*, in good preservation. It is a species considerably less than half the size of the one just named, and presents several important differences of structure. Of the two outer tubercles, one is very small, and there is a third adjacent to the larger, produced by the posterior enlargement of the cingulum. As in *P. omnivorus*, the cingulum extends entirely round the remainder of the crown, and is tubercular on the anterior side, or that of the least outer tubercle. The inner tubercle is connected with the larger outer by an intermediate one of elongate form, so that the series when worn down resembles the transverse ridge of the superior molar of *Hyracotherium*, and which is separated by a groove from the cingular ridge on each side.

Measurements.

	M.
Transverse diameter	0.008
Longitudinal diameter	0.006
Distance between the apices of the inner and the outer tubercles	0.004
Elevation of the cingulum	0.002
Elevation of the outer cusp	0.003

Size similar to that of the corresponding tooth of a *Coati*.

AMBLYPODA.

Cope, System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 28.

Mammalia with small (?smooth) cerebral hemispheres, which leave the olfactory lobes and the cerebellum exposed. The feet short and plantigrade, with numerous (in the known genera five) digits, terminating in flat hoof-bearing ungual phalanges. The seven bones of the carpus distinct; the unciform articulating with the lunar as well as with the cuneiform. The astragalus flat, without trochlear surface, and attached to the tibia with little freedom of movement; its distal extremity divided into two facets, one for the navicular, and more or less of the other for the cuboid bone. Molars invested with enamel, with wide crowns and transverse crests. A post-glenoid process.

The above characteristics are the only ones which can, in the author's estimation, be admitted into the ordinal category, for although the animals embraced in the *Amblypoda* present many other peculiarities, they are such as may readily vary within the limits of an order, and in fact do so in the families of many of the orders known to us. The above definition displays a double set of affinities, viz: those indicated by the structure of the feet, and those expressed by the type of the brain. The former exhibit the closest resemblance to the feet of the *Proboscidia*, the approach being greatest in the hind foot. The principal difference in this extremity is seen in the extension of the navicular articulation over the entire distal end of the astragalus in the *Proboscidia*, while in the *Amblypoda*, the navicular is shortened, thus permitting the cuboid to come in contact with the external part of the distal extremity of the astragalus. The cuboid is alike in the two orders, having considerable transverse extent, and supporting the external two metacarpals on its distal face. This lengthening of the navicular is a specialty of the *Proboscidia* among hoofed Mammals, the shorter form being characteristic of the lower types of both *Perissodactyla* and *Artiodactyla*, where the astragalus has two distal articulations. In the *Perissodactyla*, the extent of the navicular increases until the highest genus, the Horse, is reached, where it almost covers the entire end of the astragalus; but, in the *Artiodactyla*, the extension of the cuboid over the astragalus does not diminish. The nearest approach to the distal articulation of the astragalus of the *Amblypoda*, outside of the order, is seen in the Miocene Perissodactyle genus *Symborodon*. Here the cuboid and navicular facets are flat, and separated by an oblique line, so as to be similarly incapable of hinge-like movement. The resemblance to the lowest *Artiodactyla* (*e. g.*, *Oreodon*, *Hippopotamus*) is very remote, for there the two facets are parallel, offering a ginglymus to the articulating bones.

The difference between the fore foot of the *Amblypoda* and that of the *Proboscidia* consists in the alternating position of the elements of the two carpal rows. This is also a character of the two other living orders of hoofed Mammals, and maintains itself with great persistency in both of them. It is essentially a primitive character, the alternating position being usual in the cold-blooded *Vertebrata*, and is the persistence of the oblique relation of the original divergent branching rays, to which digits have been traced. In the *Proboscidia* and *Hyracoidea*, the elements of the two rows assume an opposite and longitudinal relation. The structure of the fore foot in the *Amblypoda* appears to be about equally related to that of the *Proboscidia*, the *Perissodactyla*, and the *Artiodactyla*.

In the cubito-carpal articulation, the resemblance is again to the *Proboscidia* in the relatively large proportion of it belonging to the ulna, and the consequent lateral position of the latter bone. In this respect, it differs much more from the other two living orders of hoofed Mammals, although here again the lower forms of both resemble the *Amblypoda* more than do the higher forms. As is well known, both of the hoofed orders display a constantly diminishing extent of the ulno-carpal articulation, and increase of the radio-carpal, until, in the Horse and Ox, the ulna becomes a mere splint attached to the radius.

The relationships indicated by the brain are to the lissencephalous orders *Chiroptera*, *Insectivora*, and *Edentata.* As an ungulate order, the *Amblypoda* are distinguished from the first two, were other characters wanting. We may here notice, however, some curious resemblances between the forms of the teeth and lower jaw of *Coryphodon* and some *Insectivora*, and the still more curious resemblance between the tibio-tarsal articulation in the order and that of the cotemporary Creodont allies of the *Insectivora.* Comparison with the ungulate forms of *Edentata* only is necessary, and from these the enamel sheathing of the teeth separates the *Amblypoda* at once. The small size of the brain doubtless relates these animals to the other Eocene *Ungulata*, described by Lartet, still more nearly than to existing *Lissencephala.* In the small size and smoothness of the hemispheres, and relatively large development of the optic and olfactory lobes, the brain of the *Amblypoda* more nearly resembles that of the *Creodonta* than that of any division of recent animals. The resemblance between the brains of *Amblypoda* and those of the Carnivorous *Oxyæna* and *Arctocyon* (*fide* Gervais), is so great as to testify to a similar degree of cerebral development in both the clawed and hoofed types of Eocene *Mammalia.*

As a *résumé* of the relations of the *Amblypoda,* it may be said that they are the most generalized order of hoofed *Mammalia,* being intermediate, in the structure of their limbs and feet, between the *Proboscidia,* the *Perissodactyla,* and the *Artiodactyla.* This fact, together with the small size of the brain, places them in antecedent relation to the latter, in a systematic sense, connecting them with the lower *Mammalia* with small and smooth brains, still in existence; and, in a phylogenetic sense, since they preceded the other orders in time, they stand in the relation of ancestors. It is doubtless true that the *Amblypoda* were the ancestors of all living Ungulates, although no genus of the latter can yet be traced to any known genus of the former, such genera remaining for future discovery.* Standing in this antecedent relation, comparison with other classes of *Vertebrata* is in place. The proportionate size of the brain is, as has been discovered by Marsh in the *Dinocerata,* more like that characteristic of many Reptiles than of Mammals, and I may add that the immovable tibio-tarsal articulation is a Reptilian feature as well. These are, however, but hints of a relationship doubtless very remote.

Before proceeding to a more detailed consideration of the genera of this order, I give the distinguishing characteristics of the two suborders into which they naturally fall:

I. A third trochanter of the femur, and fossa for the round ligament; no alisphenoid canal; superior incisors present.......................*Pantodonta.*
II. No third trochanter nor fossa for the round ligament; an alisphenoid canal; no superior incisors..*Dinocerata.*

The differences presented by these suborders are thus very decided, but they agree in some important points, not necessarily of ordinal value. Thus the *foramen ovale* is distinct from the *foramen lacerum anterius,* and the *meatus auditorius* is not closed inferiorly. In the first point, they agree with *Symborodon* and *Rhinocerus* more than with any *Proboscidia* or *Artio-*

* A discussion of these and other general relations of the *Amblypoda* may be found in a paper read by me before the American Association for the Advancement of Science, August, 1875, and published in the Penn Monthly Magazine, December, 1875.

dactyla. In the latter respect, they agree with the Tapirs, but not with other Ungulates, excepting a few *Rhinocerida*. The cervical vertebræ are short, and not united by ball-and-socket joint, and are intermediate in character between those of *Proboscidia* and other Ungulates. In both suborders, the scapula is acuminate at its superior border and expanded behind, as in *Proboscidia*, while the abrupt origin of its spine is a character of *Proboscidia*, *Artiodactyla*, and many other Mammals, but not of *Perissodactyla*. In the rudimental spine and crest of the tibia, we have again especially Proboscidian resemblances, which are confirmed by the shape of the ilium. This bone expands immediately from the acetabulum into a broad plate, which has a continuous convex crest, and is altogether different from the pedunculate ilium of the Rhinoceros and Hippopotamus.

As regards the points in which the suborders differ, it may be observed that the *Pantodonta* in their dentition and femur resemble the *Perissodactyla* more than do the *Dinocerata*, while the absence of alisphenoid canal in *Coryphodon* is a suilline character, and the only one which I find in the group. In the form of the femur, the *Dinocerata* resemble closely the *Proboscidia*, but in the presence of the alisphenoid canal they agree with both *Perissodactyla* and *Proboscidia*. It is not unlikely that, in future, genera will be found which connect both these orders more nearly with primitive types of *Artiodactyla*, but as yet we are not acquainted with them.

The order *Amblypoda* was first defined by the writer in the Systematic Catalogue of the Vertebrata of the Eocene of New Mexico, published in April, 1875. The two suborders *Pantodonta* and *Dinocerata* were originally defined by the writer in "The Short-footed Ungulata of Wyoming", published March, 1873, in the following language:

"No incisors; nasal bones elongate; astragalus articulating with both navicular and cuboid; no third trochanter........................ *Dinocerata*.

"Dentition complete, *i. e.*, incisors present; ? nasal bones; astragalus articulating with both navicular and cuboid; a rudimental third trochanter.. *Pantodonta*."

The name *Dinocerata* was then proposed as a correction of "*Dinocerea*," originally introduced by Professor Marsh* for the animals which it includes,

* Amer. Jour. Sci. and Arts, 1872, October, 1872 (separata September 27).

under the belief that it constituted a distinct order of *Mammalia*, which, however, he did not characterize. Shortly afterward (January, 1873*), I gave the first general synopsis of the characters of the species of the group then contained in my collection, in which they resemble the *Proboscidia*, as follows: "1. The shortness of the free portion of the nasal bones; 2. The malar bone is rod-like, and forms the middle element of the zygomatic arch; 3. The cervical vertebræ are exceedingly short and transverse; 4. The femur is without third trochanter; 5. Its condyles are contracted, and the narrow intercondylar fissure is prolonged far forward; 6. The spine of the tibia is wanting, and the glenoid cavities separated by a longitudinal keel; 7. The astragalus is not hourglass-shaped above, but with a uniform face; 8. The phalanges are short and stout, and represent several toes." To these may be added two external characters, which directly result from the osteological, viz: 9. The possession of a proboscis; this is proven by the extreme shortness and stoutness of the free portion of the nasal bones, by the very short cervical vertebræ, and by the fact that the nasal and premaxillary bones are deeply excavated at their extremities, with surrounding osseous eminences for the origin of the muscles of the trunk; 10. The extension of the femur below the body, so that the leg was extended with the knee below and free from the body, as in Elephants, Monkeys, and Men. Other characters common to the *Proboscidia* and some other Ungulates are: 11. The scapula acuminate above the spine with a very short coracoid; 12. Broad truncate occiput, with widely separated temporal fossæ; 13. The greatly expanded iliac bones."

These characters were adduced in support of the view that these animals should be referred to the *Proboscidia*. Although I have subsequently referred them to a new and special order, the above characters express the affinities which I claimed for the group, although several of them are found not to be common to all the species. Thus the characters of the malar bone and cervical vertebræ are not common to all of the *Dinocerata*, while these, with the characters of the femur, are not found in the *Pantodonta*. It was not, however, until a few weeks afterward that I

* The extra copies of this paper, which contained all except the character number "1", were published January 16.

discovered the near affinity between these suborders. As regards the possession of a proboscis, there is every reason to believe that some of the species possessed one, though it may have been short as in the Tapir, while it is possible that in others it was wanting, or not more developed than in the Hog.

The first attempt to define the *Dinocerata* as an order of *Mammalia* was made by Prof. O. C. Marsh, of New Haven, in a paper published some time subsequently* to my essay quoted above. The characters which he brought forward, and which had mostly already appeared in the descriptions of species published by him and by myself, are the following: "1. The absence of upper incisors; 2. The presence of canines; 3. The presence of horns; 4. The absence of large air-cavities in the skull; 5. The malar bone forms the anterior portion of the zygomatic arch; 6. The presence of large postglenoid processes; 7. The large perforated lachrymal forming the anterior portion of the orbit; 8. The small and horizontal nareal orifice; 9. The greatly elongated nasal bones; 10. The premaxillaries do not meet the frontals; 11. The lateral and posterior cranial crests; 12. The very small molar teeth and their vertical replacement; 13. The small lower jaw; 14. The articulation of the astragalus with the navicular and cuboid bones; 15. The absence of a true proboscis."

This heterogeneous list of characters could not define any natural group, as many of them are of not more than generic or family value.† Several of the most important are not shared by the genus *Coryphodon*, a form at that time apparently unknown to Professor Marsh, but which clearly belongs to the same order of *Mammalia*. My conclusion has been that the *Dinocerata* do not alone constitute an order of *Mammalia*, but that they form a division of an order which includes also *Coryphodon*, and doubtless many other little or unknown types, whose position is, as I first stated, between the *Proboscidia* and the *Perissodactyla*, but which has no affinities with the *Artiodactyla*, as has been asserted.

Full descriptions of the species and genera of this order first appeared in my essay, "On the Short-footed Ungulata of Wyoming", above quoted

* The extra copies of this paper bear date January 28, 1873.

† As I pointed out in an article in the American Naturalist, May, 1873.

(published March 14, 1873). I there described the existence of five toes in the pes of the genus *Eobasileus*, and the co-ordinal relations of *Coryphodon* (*Bathmodon*). In a note published by Professor Marsh, October, 1873, that author asserts that the *Dinocerata* have "but four toes in the pes"; but in a paper on *Uintatherium* (*Dinoceras*), which has recently appeared, he admits that that genus has five toes in the pes (Am. Jour. Sci. and Arts, Feb., 1876). We owe to later observations of Professor Marsh two of the most important points in the structure of the *Dinocerata*, viz, the superficial structure of the brain, and the arrangement of the bones of the carpus. He shows (*l. c.*, July, 1874, and February, 1876) that the cerebral hemispheres are so small as not to cover any part of the olfactory lobes and the cerebellum; and that their combined diameter was less than that of some parts of the neural canal of the vertebral column. This information is, however, accompanied by serious errors of determination. (See on the brain of *Coryphodon*, below.) The brain is relatively one of the smallest among known *Mammalia*, and resembles strongly that of the Creodont *Arctocyon* of the French Eocene, figured by Professor Gervais, in the "Archives du Muséum", 1870. I show in another place that the brain of *Coryphodon* presents similar characters, and discuss their significance further on in reviewing the characters of the Eocene fauna.

The structure of the carpus of *Uintatherium*, described by Marsh (*l. c.*, February, 1876), is essentially identical with that of *Coryphodon*, which I described in the Systematic Catalogue of the Vertebrata of the Eocene of New Mexico (April, 1875).

The *Pantodonta* are confined, so far as discoveries extend at present, to the Lower Eocene or Wasatch beds, in the Rocky Mountain region, while the *Dinocerata* are confined to the higher or Bridger Eocene strata. The former suborder includes two genera, *Coryphodon*, Owen, and *Metalophodon*, Cope; the *Dinocerata* also two, *Uintatherium*, Leidy, and *Loxolophodon*, Cope.

PANTODONTA.

CORYPHODON, Owen.

Coryphodon, Owen, History British Fossil Mammals, 1846, p. 299, figs. 103, 104.—Bronn, Lethæa Geognostica, 1856, p. 842.—Hébert, Annales des Sciences Naturelles, 1856, p. 87, plates.

Bathmodon, Cope, Proceed. Amer. Philos. Soc. 1872, Feb. 16, 1872; Ann. Rept. U. S. Geol. Survs. Terrs. 1872, p. 586 (1873); System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 24.

The remains of this genus have been preserved in greater abundance in the Wasatch beds of New Mexico than in any other known region of the world, so that a good opportunity is offered for an elucidation of the structure of its skeleton. The bones obtained include all parts of the skeleton and skull.

Cranium and dentition.—The skull is moderately elongate, the elongation being behind the orbits, since the muzzle is rather short. The free part of the nasal bones is short and narrow, and the bones are not co-ossified. The premaxillary region is expanded, so as to extend beyond the nares. The latter are thus directed obliquely upward. The face is greatly contracted immediately behind the canine teeth. The superciliary borders are not prominent, but immediately behind the orbits the superior margin of the temporal fossa expands and becomes an overhanging roof to its posterior border, which is beyond the vertical plane of the occipital condyles. The borders of opposite sides unite in a deep notch on the middle line above, and overhang the concave supraoccipital region. The zygomatic arch is considerably expanded laterally. The *foramen infraorbitale* is rather large, and issues not far in front of the orbit, and in the same horizontal line. The lachrymal canal passes through the inferior edge of the lachrymal bone just within the border of the orbit.

There is no postorbital process either of the frontal or malar bone. In adult animals, the sutures of the superior wall of the cranium are entirely obliterated, excepting in the anterior part of the nasal bones.

The *premaxillaries* are not coössified on the middle line, but are in contact. They send a slender process backward from the inner apex, inclosing the *foramen incisivum* on the inner side, whether completely or not is uncertain. The palate is rather narrow, and of moderate length; it is notched posteriorly by the posterior nares only a little anterior to the line of the posterior borders of the molar teeth. The palatine bone has a small antero-posterior extent. Its *processus pyramidalis*, with the pterygoid processes of the sphenoid, forms an elongate undivided *lamina lateralis* of the posterior nares, which presents an angle downward, from which the posterior border rises to the axis of the skull near the transverse line of the glenoid cavities. The *foramen ovale* perforates the base of a short descending process. The *foramen lacerum* is not large, and a small truncate styloid process is concealed on the side of the small petrous bone. The basioccipital is nearly flat on the median line below. The postglenoid processes are well developed. The paramastoid and mastoid processes are fused into a single descending mass of moderate length. The *meatus auditorius externus* is not inclosed below.

The form of the mandible is peculiar. The angle is not inflected, and is elevated above the usual position in consequence of an upward curvature of the inferior border of the ramus, commencing below the last molar tooth. The condyle is large, and has considerable transverse extent, and its articular surface is presented as much upward as backward. The coronoid process is elevated and stout; the rami are slender for the general robustness of the skeleton, and the symphysis is rather long and co-ossified. The form of the ramus is not a little like that of many *Insectivora.*

The brain-cavity is remarkable for its very small size as compared with that of the skull. In the antero-posterior direction, the cerebral hemispheres did not extend anterior to the glenoid surfaces, while in the American Tapir they reach as far as the posterior border of the last superior molar tooth. The olfactory cavities are much longer in the *Coryphodon*, but do not extend to the line of the last superior molar tooth. In vertical diameter, the brain-cavity is less than half that of the portion of the skull in which it is situated, a large space above it being occupied by pneumatic chambers, which perhaps represent the diploë of thinner-walled skulls. The external walls of these spaces are only moderately thick. There are two principal lateral cavities, which are separated by a thin antero-posterior septum. They widen posteriorly, and each is divided by partial septa, which extend inward from the cranial walls, as follows: one horizontal, from the supra-occipital wall; two transverse and vertical, descending from the superior wall, the posterior of which nearly reaches the brain-cavity.

The *dental formula* is $\frac{3}{3}\,\frac{1}{1}\,\frac{4}{4}\,\frac{3}{3}$. The incisors are not closely packed; the canines are of very large size, and are separated by a short diastema from the uninterrupted series of molars. The crowns of the incisors of both jaws are simple and spatuliform, somewhat expanded transversely at the base. The canines of the opposing series differ in form. Those of the upper jaw have the section of the crown triangular, in some species more, in others less, compressed, but with the shorter line (*i. e.*, narrower side) anterior. They become much worn on the anterior face by friction with the posterior face of the inferior canine, assuming a convex worn surface, which may become wider than the other faces. There is a considerable range of variation in the size of the canines of both jaws, especially in those of the inferior series, which I suspect to be due to difference of sex.

The premolars in both jaws differ much from the true molars. In the superior series they consist of an external and an internal V, the former so oblique in the transverse direction that its apex stands above the middle of the base of the crown, or still farther interiorly. The limbs of the inner V rise from the position of anterior and posterior basal cingula to the cusp at the apex, which stands at the interior extremity of the crown. The true molars differ in the presence of two external V's, and in the greater development of the anterior limb of the inner V. The apex of the latter stands as a trihedral antero-internal cusp, and the antero-external ridge extends from it to the outer side of the crown, where it turns obliquely downward. It forms a broad table-like ledge, as the anterior half of the surface of the crown. The two external V's are of very unequal size: on the first molar, the anterior is flat and angular, and not more than one-quarter as large as the posterior; while on the second it is a small cone at the anterior base of the posterior V. The third true molar differs materially from the others in having the posterior external angle of the base of the crown brought round to the middle of the posterior side. The result is that the two V's become a transverse crest parallel with the elevated ridge connecting the inner cusp with the anterior external angle. The tooth, therefore, presents two nearly parallel transverse crests, separated by a deep valley, which is represented on the two preceding molars by the anterior ledge. The posterior limb of the posterior V has disappeared, the anterior edge of the two V's being only represented in the posterior crest. In the species with which I am acquainted, there is, in addition, a strong anterior basal cingulum on the true molars.

The inferior true molars present us with two cross-crests, which are oblique to the direct axes of the crown, because they connect cusps which alternate in position. No oblique crest connects the alternating cusps across the valley thus created, although a rudiment of it appears; but a corresponding crest at the anterior extremity of the crown forms a V with the anterior cross-crest It, however, descends rapidly to the inner side, where it terminates at the base of the crown. There is no fifth lobe of the last molar, but frequently a cingulum-like heel. The premolars differ from the true molars in the absence of the posterior cross-crest, and the development of the anterior descending crest so as to be equal to the anterior cross-crest, thus forming a V with its back inward and apex outward, like the V of the superior premolars, but reversed in position. The base of the crown is continued a short distance behind the V, and bears a low longitudinal median crest, which represents the rudimental ridge which connects the cross-crests in the true molars.

The *milk dentition* is almost completely preserved in a right maxillary bone, which I discovered among a large number of other bones, including teeth of adult and young Coryphodons, and which I described in the Appendix FF, Annual Report of the Chief of Engineers, 1874, p. 597. The crown of the first premolar is injured, but its base has the form of that of the second, and it is probable that it had the construction of the latter. The crown of the second premolar is, like that of the adult, composed of one external and one internal V, but wider in the antero-posterior direction, so that the limbs spread more than in the adult. There is an external vertical ridge at the posterior part of the posterior limb of the V, which gives a small angle in the grinding-surface on attrition. The third molar is totally unlike the second, or the corresponding tooth of the permanent dentition. While it presents a single internal angular cusp, with angles extending anteriorly and posteriorly round the crown, forming an open V, the external part of the crown consists of two V's, as in *Palæotherium*, *Palæosyops*, etc. These V's are equal in size, and a small vertical ridge, which divides them, is evidently homologous with the little ridge just described as existing near the posterior outer angle of the second molar. This tooth was in functional use at the time of the death of the animal. Immediately behind it, the surface of the maxillary bone is penetrated by the crown of the first true molar of the functional series. This presents the characters above ascribed to it in the adult, leaving no doubt of the systematic position of the animal, and the true relations of the teeth.

The *homologies* of the different parts of the teeth are much elucidated by this specimen. It proves that the posterior principal, and anterior supplemental V's of the external portion of the crown of the superior permanent molars really represent the two external V's of the ordinary Perissodactyle dentition, and that the external V of the first and second temporary molars represent the anterior V of the two found in the third temporary molar. A consideration of the permanent molars shows that the posterior crest of the last true molar is homologous with the two external V's of the first and second; the external cusp of the former, which is sometimes separated by a cleft from the remaining portion, representing the rudimental anterior V of the latter. On comparing the premolars with the molars, the resemblance between the large posterior V of the true molars to the single V of the premolars is very apparent, but it is questionable whether this resemblance is a true homology. It is true that a small angle may be sometimes noticed at the anterior base of the V, which might be said to represent the anterior V of the true molars; but the homology indicated by the temporary premolars is unmistakable, and may apply to the permanent premolars as well.

A comparison of these teeth with those of other *Amblypoda*, and with those of *Perissodactyla*, throws light on questions of affinity, since they are structurally somewhat intermediate between the latter and *Loxolophodon* and its allies. Among American *Perissodactyla*, an approach is seen in the genus *Palæosyops*, the structure of which furnishes an explanation of the relations between the structure of the superior molars of this and the Palæotheriodont types. From this comparison it appears that in *Coryphodon* there are no cross-crests representative of those of *Hyrachyus* and *Rhinocerus*, the strong anterior crest which appears to be such being homologous with the anterior basal cingulum of *Hyrachyus* and *Palæosyops.* The last milk molar of *Coryphodon* resembles the fourth premolar of *Palæosyops*, and there can be no doubt of the homology of the single inner cusp of this tooth in the two genera. In *Palæosyops*, this represents the anterior cusp of the true molars where two are present, so that the same relation can be claimed for the same cusp in *Coryphodon.* As I have heretofore shown,* the crowns of the molars in *Loxolophodon* support two transverse crests, which unite or approach at their interior extremities, forming a V, near to the apex of which, posterior to it in the last true molar, is a tubercle. The anterior transverse crest appears to be homologous with that in the molars of *Coryphodon*, but the posterior cannot be homologized with the posterior transverse crest of the last molar of that genus, since the tubercle found in *Loxolophodon* behind this crest must be compared with that part in *Coryphodon*, or with the posterior inner tubercle of *Limnohyus.* It is thus probable that the posterior transverse crests in *Loxolophodon* must be compared with one of the two transverse crests in the Tapiroid genera and *Dinotherium.* The homologies of the inferior molars of *Coryphodon* are simple, as they resemble nearly the corresponding teeth in *Hyrachyus*, with an approach in the anterior V to *Palæosyops.*

Vertebræ, ribs, and sternum.—The least satisfactory part of the description of the skeleton is that relating to the vertebral column. The number of dorsal, lumbar, and sacral vertebræ remains unknown, and of the caudal vertebræ it can only be said that they were rather numerous, indicating a tail of medium proportions.

The cervical vertebræ resemble those of the *Carnivora* more than those of living *Perissodactyla*, but resemble most those of *Eobasileus.* The centra are short and wide, and usually depressed, and do not display the ball-and-socket articulation, nor are they absolutely flat, as in *Elephantidæ.* They are slightly concave behind and convex before, as in the *Carnivora* generally. The vertebral canal is present, including the axis. In the atlas, it pierces the transverse process on the superior surface close to the posterior

* Paleontological Bulletin, No. 7, August. 1872.

base, and issues near the middle of the inferior face. It does not return through the transverse process, as in the Tapir, but the latter is not expanded anteriorly, as in that animal. The *foramen atlantis*, by which the vertebral artery enters the *foramen magnum*, is well isolated by the osseous border, as in many other Mammals. The axis is distinguished for the length of its odontoid process, which is without groove superiorly.

The lumbar vertebræ exhibit the same depressed and moderately opisthocœlous centra, presented by the cervicals. They are longer than the latter, but not longer than wide, and are not keeled beneath, but are pierced with foramina. The neural canal is large. The anterior zygapophyses present their faces inward above and upward at the base, having a concave surface. The caudal vertebræ are characterized by the presence of two transverse processes, one obtuse, at the anterior articular face, the other flat, at the middle of the length. The terminal vertebræ are slender. There are no surfaces for chevron-bones, but angles corresponding to them.

The ribs are flattened, and have the usual capitular and tubercular faces. The hæmapophyses are ossified. The sternal segments differ in form in the different species, being more cylindric in some than in others. I have described* a manubrium as having a somewhat T-shaped form, with subcylindric body, in *Coryphodon radians*. Some loose segments in the New Mexican collection are longer than wide, but flattened, while others are plate-like and subquadrate. The last are supposed to belong to the *Coryphodon latidens*.

Scapular arch and anterior limb.—The scapula, in its general form, is more like that of the Proboscidians than any other order. Its superior border is produced into an angle beyond and in the line of the spine. The spine rises abruptly from the neck. All the New Mexican specimens have the coracoid broken off, but in some of those obtained by Dr. Hayden on Bear River, Wyoming, it is preserved.† I have described it as consisting of a prominent hook, which originates a little outside of the edge of the glenoid cavity, and incloses a groove between itself and a tuberosity on the edge of the latter. I have observed clavicles in a fragmentary skeleton described

* Ann. Rept. U. S. Geol. Surv. Terr., 1872, p. 586.

† Described in Ann. Rept. U. S. Geol. Surv. Terr., 1872, p. 586.

under the head of *Coryphodon*, of uncertain species No. III. They have slender, slightly curved, and compressed shafts, with clavate extremities, which are truncate at the ends.

The humerus is a stouter bone than the femur. The head is particularly large, and the greater tuberosity is large and hook-like, bounding a deep groove with the lesser tuberosity. The deltoid crest is prominent, and extends beyond the middle of the shaft, and terminates in a twist forward. The condyles have the usual anterior direction, and their surface is simply hourglass-shaped, without the carina or rib seen in *Tapirus*, *Hyracodon*, *Hyrachyus*, etc., showing its affinity to *Loxolophodon*. It resembles the latter, and differs from the former in the large size of its lateral tuberosities, which give the humerus a great distal width, approaching the corresponding bone in the *Creodonta* in this respect. The ulna and radius are entirely distinct, including their distal extremities. The ulna has a much larger share in the carpal articulation than in the *Perissodactyla*, and is in the same transverse plane as the radius at that point. As compared with the diameter of its shaft, the carpal extremity of the radius is narrowed. This relation is appropriate to the small size of the scaphoid and large size, especially the width, of the cuneiform, in the carpus. The proximal part of the ulna is compressed below, and the distal end depressed so as to be transverse, but it is not so expanded as in *Uintatherium*. The head of the radius is a transverse oval, with the articular face a gentle sigmoid in horizontal section. The articulation with the ulna is not interlocking, but nearly level.

Anterior foot.—Several anterior feet of Coryphodonts were procured, three of them nearly entire. These display well their extraordinary form in the shortness as compared with the width, in which they resemble those of the Elephants more than any other animals. There are five digits,* as I first pointed out, of which the second, third, and fourth do not differ much in length; the length of the third, with the carpus, being in one specimen equal to the width of the palm. The fifth digit is a little shorter than the fourth, while the first is the shortest.

The scaphoides is the most irregularly shaped of the carpals. It consists of an anterior intercalated portion and a posterior tuberosity, which is

* See System. Cat. Vert. Eocene N. Mex., U. S. Survs. W. of 100th M., 1875, p. 24.

the smaller of the two parts, and gives the antero-posterior as the greatest dimension. Viewed from the front, four articular facets are visible, one superior for the radius, one external for the lunar, and two inferior for the trapezoides and trapezium. The radial surface is the largest, but is smaller than those of the trapezium and trapezoides together; it is decurved anteriorly, leaving but a narrow external front surface, which is continued without widening along the entire internal (free) side. The lunar and trapezoid facets unite in front at an acute angle, but behind this angle they separate, leaving a triangular facet for the magnum. The facets for the trapezium and trapezoides are subequal, and related by an open angle. I fail to make an exact fit between these facets and the proximal ends of the two bones in question, which give three instead of two facets. I have therefore thought that a small bone present at this point in one of the unseparated carpi might be an *os intermedium.* My desire to retain the bones of this carpus in the relation in which I found them prevents me from settling this point. The small size of the bone in question is appropriate to the small interval unfilled by the scaphoid. The scaphoid is the smallest of the carpals of the proximal row, and presents the smallest facet for the bones of the forearm.

The lunar is a robust bone, its antero-posterior diameter somewhat greater than the transverse. Viewed from above, its form is that of a spherical equilateral triangle with rounded angles. Its anterior two-thirds above are occupied by the convex facet for the fore leg; its lower surface presents four longitudinal facets; the two lateral for the scaphoid and cuneiform subvertical. The median two apply to the unciform and magnum respectively. The anterior face is longer (longitudinally) than that of the scaphoid. The cuneiform is subtriangular and flat, and with a greater length than any other carpal (except the unciform), directed outward and backward. Having this oblique position, only a part of one of its long sides is presented anteriorly, and the articular face of the ulna extends obliquely across it. Behind the latter, the surface is beveled, forming a long subtransverse facet for the pisiform. The inferior face is convex obliquely, the convexity extending from the inner anterior to the external posterior angle. The distal end is narrowed and truncated, with a thick convex border. The pisiform is an L-shaped bone, the transverse limb proximal, and bearing the long facet for the cuneiform. The long limb equals the transverse, and has a neck and oblique tuberous head.

Of the second row of carpal bones, the unciform is much the largest, the magnum is next in size, the trapezium next, and the trapezoides the smallest. But, of the exposed anterior surfaces, the magnum displays the smallest, and the others in the order named. The unciform is subcrescentic in vertical section, and its transverse exceeds its antero-posterior diameter. It presents two superior facets, one interior terminal, and three inferior. Of the two superior, the inner is antero-posterior, being narrower than the other and elevated above it; it is applied to the lunar. The other superior facet is the largest in the carpus, is transverse and strongly concave. The three inferior facets apply to the external metacarpals, the inner to a portion only of the third, and is therefore narrower than the others. The median is largest, and the external is oblique. The magnum has very little transverse diameter, but the antero-posterior and vertical are considerable, and in some of the species subequal. It has but one superior facet, that for the lunar, and one of nearly the same width inferiorly, for the internal part of the third metacarpal. Alongside of this is a narrower facet, partly lateral, for a small part of the second metacarpal. The inferior posterior tuberosity of the magnum does not extend much beyond the inferior articular face, while a superior posterior tuberosity occupies a corresponding concavity of the lunar. From this, the superior facet descends steeply to the anterior face. The trapezoides is the smallest bone of the carpus. Its anterior face is a vertical wide rhomboid, and is rather shorter than the antero-posterior diameter. Each side is a facet, but the supero-exterior and intero-inferior angles are obtuse, while the opposite ones are acute. The proximal facet is narrower than the distal. The trapezoides is larger, and would present a quadrate anterior face but for the presence of two proximal facets, the internal narrower than the external. The external presents a median fossa; the distal face is truncate; the internal (free) face presents the usual rough surface.

The lengths of the metacarpals have been already stated. The proximal ends present faces which are a little convex antero-posteriorly.

The second and third are distinguished by the possession of two proximal or carpal facets each, while the first, fourth, and fifth have but one each, and the first is peculiar in being squarely truncate. The shafts are wide, and the distal articulations transverse, excepting a feeble carina on the under side. The phalanges are short; all except the first of the pollex wider than long. Those of the second place are very narrow, being mere transverse, openly angulate bands. The ungual phalanges are short, and expanded transversely by the horizontal production of the lateral distal angles.

The inferior surfaces of the digits are defended by numerous sesamoid bones, which are of subcrescentic section. They rest in pairs, one of them on each side of the distal extremity of the metacarpals and metatarsals.

Pelvic arch and hind limb.—The ilium is characterized by the width of its peduncle and the expanse of its plates. The crest has the regular convexity and the length seen in *Loxolophodon* and the *Proboscidia.* The anterior border is acute, and is convex at the anterior inferior spine. The ischium is wide and flattened to the base; its posterior border is convex, with superior tuberous surface. The pubis is rather narrow.

The femur has the shaft flattened in the species known to me, and the border of the great trochanter is but little reflected backward. In the American species, the third trochanter is very small; in the European species, figured by Hébert, it is larger. The trochlear patellar surface is moderately elevated, one bounding ridge a little more so than the other, but the condyles are not compressed, and the intercondylar fossa is of usual width. The tibia is not so much shortened as in *Loxolophodon,* but resembles it in the rudimental spine and low obtuse crest. The shaft becomes subcylindric toward the distal extremity, and then expands transversely to the astragalar articular face. This is, as already described, of remarkable character. It is transverse and flat, without either groove or keel; the posterior border is slightly oblique, rising to the outer side. The malleolus projects beyond it, and its inner convex face supports a continuation of the articular surface, which is applied to a concavity of the inner side of the astragalus. As the mechanical result of this arrangement, there was no flexion and extension of the foot on the leg; but it is possible that there was a small amount of rotation, the inner malleolus being the fixed point. The fibula is entirely distinct, and has an oblique proximal surface of attachment to the tibia. The shaft is rather slender, and the distal end is expanded in an antero-posterior direction, so as to support a large, subround, oblique, inward-looking face for the astragalus.

Posterior foot.—The posterior foot has, like the anterior, five toes, of which the second, third, and fourth do not differ much in length, while the hallux is about two-thirds as long as the third. The general form of the only complete hind foot which I obtained, is not so short in relation to its width as the fore feet, the width of the sole being but little greater than the length of the four bones of the third toe. The foot is completely plantigrade, and the heel very short. The free part of the calcaneum is not longer than the anterior width, and is depressed at the base. The astragalus is flat above, or slightly concave in both directions. Its anterior part has greater transverse extension than the posterior, being produced inward in a hook-like extension. The inner border is thus obliquely concave for the reception of the inner malleolus; the external border is gently convex, and occupied by a longitudinal facet for the fibula. There is a posterior tuberosity at the angle with the inner border. The distal end of the astragalus is divided by a low tuberosity; but while the internal and longer portion is entirely occupied by the navicular facet, the external half is only partly covered by an articular surface. Of the latter, the inner and larger part is for the ectocuneiform bone, while the outer is in contact with the cuboid. This articulation of the ectocuneiform with the astragalus is found in several and probably all of the species here described, and is one of the striking peculiarities of the foot of *Coryphodon.*

The cuboid bone is transverse, and has greater length internally than externally. Its two proximal facets present an angle to each other, while the two distal facets are in one plane. The navicular is an L-shaped bone, with the anterior limb transverse, and is very thin in the longitudinal direction. The posterior end of the longitudinal and exterior limb is a tuberosity. The distal extremity is divided into the three cuneiform facets, of which the median is largest. The ectocuneiform is the largest of its series. The phalanges are similar to those of the fore foot, but the metatarsals differ in that their proximal extremities present but a single facet, except a very small one at the exterior border of the second, which joins the ectocuneiform.

Brain.—I succeeded in obtaining a complete cast of the brain-cavity of the *Coryphodon elephantopus*. The hard sandstone matrix which filled it was removed with some difficulty, the more as its surfaces were indurated by a cement containing much iron oxide. The osseous walls were found in a good state of preservation. It was ascertained that there is a considerable *foramen lacerum posterius*, but which is not nearly of such proportionate size as that in the genus *Tapirus*.

The form of the brain is very remarkable. Its distinguishing peculiarities are (1) the small size of the cerebellum; (2) the large size of the region of the *corpora quadrigemina;* (3) the small size of the hemispheres; (4) the enormous size of the olfactory lobes.

There is in the cast a strong constriction in front of the *medulla oblongata* on one side, which does not exist on the other side. It is uncertain which represents the true form as regards the lateral portion; but that there was a step-like constriction across the base of the brain at this point there is no doubt. The medulla is very stout, and wider than the hemispheres; it is depressed, and a protuberance on the inferior part of each side has the appearance of the base of the eighth pair of nerves. The region of the cerebellum is depressed, and does not present in the cast a distinct line of demarkation from the medulla. An indication of the vermis is seen in a low, longitudinal, median protuberance. In front of this, a transverse, shallow depression separates it from the middle brain.

The region of the *corpora quadrigemina* is the most bulky portion of the brain. Superiorly it presents a large transverse tuberosity, with the lateral portions well defined, but not distinguished from the cast of the hemispheres on the median line. From its latero-superior prominences, it extends downward and forward on each side, expanding laterally, and narrowing as it approaches the inferior surface. Each lateral portion is separated from the hemisphere by a deep fissure, into which a prominent crest of the lateral cranial walls projects. This crest commences above, nearly at the plane of the superior wall, and curves downward and forward to below the middle of the cavity which contained the hemispheres. The inferior face of the middle region of the brain is bounded laterally by the projecting masses above described, posteriorly by the constriction in front of the medulla, and anteriorly by a slight contraction marking the boundary of the hemispheres. Its anterior lateral angles are continued into a fossa of the cranium, which I did not clear of the matrix, but which doubtless gives exit to the *foramina sphenoörbitale* and *rotundum.* The protuberance which occupies this fossa, then, includes the base of the trigeminus nerve. A short distance posterior to this position, on the inferior side of the lateral expansion of the middle brain, is the slight projection which covers the united cavities of the *foramen ovale* and the *foramen lacerum posterius.* Between these, on the middle line, is a longitudinal elevation divided by a median longitudinal depression. Posteriorly, it rises from the transverse constriction of the medulla; anteriorly, it terminates rather abruptly, the one half at a point anterior to the other. This asymmetry is found in the osseous basis cranii, and is not due to accident. This median ridge is separated by a wide shallow concavity from the lateral border on each side. A short distance anterior to each *foramen sphenoörbitale* is a small fossa which I have not explored, but which is the opening of the *foramen opticum.* They are of small size, indicating a corresponding character for the optic nerve.

The *cerebral hemispheres* are relatively and absolutely very small, their median long diameter being one-fifteenth the total length of the skull, or a little smaller than those of the *Uintatherium mirabile* according to the figures and description of Marsh. They are together about as wide as deep posteriorly, but both diameters diminish rapidly forward, the vertical the most rapidly. The profile slopes downward and forward to the base of the broad olfactory peduncles. There are no convolutions, nor any decided indication of the Sylvian fissure,* but there are surface-casts of the small arteries that ramified in the *dura mater.* Owing to the prominence forward of the inferior part of the middle brain, but a small part of the inferior surface of the hemispheres is visible. The olfactory lobes are the largest

* Professor Marsh (Amer. Journ. Sci. Arts, 1876, p. 166) states that both convolutions and a Sylvian fissure are present in *Uintatherium.* These assertions are not justified by his figures, nor by the probably similar brain of *Coryphodon.*

known among *Mammalia*, and greatly exceed those of *Uintatherium* as described by Marsh, and even those of *Oxyæna*. Their peduncle is transversely oval in section, and is directed horizontally forward for a distance about half as great as the length of the hemispheres without change of form. The mass then expands laterally and superiorly, rising upward on each side of an osseous septum, which does not divide the olfactory lobes to the inferior face. They are thus deeply grooved above, and finally become furcate near to the extremity. Posterior to this point, the inferior face rises, and the apices project laterally and forward from the superior part of the lobe. The olfactory lobes consist, then, of a massive peduncle supporting a grooved subconical enlargement, which is bifurcate at the apex.*

Since the internal walls of the skull show the foramina for the exits of the cranial nerves, we have a sufficient basis for the determination of the parts of the brain. In this attempt, we are met by the difficulties which are inherent in the use of a cast to represent a brain. Although the *foramina sphenoörbitale* and *rotundun* can be readily fixed, their position is such as to give the point of exit of the *nervus trigeminus* an unusually inferior position. This appears to be the case to a still greater extent in the *Uintatherium*,† where the lateral descending masses are at the same time not nearly so largely developed as in *Coryphodon*. The large inferior area inclosed between these boundaries is, then, homologous with the *pons varolii*, or that part of the encephalon which is covered by it. Its appearance in *Uintatherium* supports this identification, but its proportions and anterior position in *Coryphodon* depart more widely from the usual form. The two anterior submedian ridges of its surface faintly indicated in *Uintatherium*, are probably the homologues of the pronounced median ribs in *Coryphodon*, which resemble a continuation of the anterior pyramids of the *medulla oblongata*. As they are not very distinctly marked in the medulla of *Coryphodon*, their identification may be uncertain, but they look like that portion of the anterior pyramids which is continuous with the *crura cerebri*, and which are concealed in *Mammalia* by the *pons varolii*. Their prominence in *Coryphodon* indicates that the *pons* is wanting in this genus, as in

* Measurements of this brain are given in the article on *Coryphodon elephantopus*.
† See Amer. Journ. Sci. Arts, 1876, plate iv, p. 165.

the *Reptilia*. A shallow concavity of the sphenoid bone between the origins of the trigemini indicates the position of a pituitary body, or hypophysis.

In profile, the brain closely resembles in form that of a Lizard, *e. g.*, an *Amiva*, excepting that in the latter the cerebellum is more prominent. The extension downward and forward of the middle brain, with its projection below the hemispheres, is common to both; but the inferior portions, at least, do not appear to be homologous in the two. In the *Coryphodon*, the lateral projections correspond with the exits of the trigeminus from the skull; in the *Amiva*, this part terminates in the optic tracts. The superior portions of the middle brain correspond in appearance and relative size with that of the *Amiva*, but a plain difficulty in identifying them in the two types is derived from the difference in their inferior connections. One result of the examination is assured, viz, that this region is no part of the cerebral hemispheres, and that it is entirely uncovered by them. As it is not the cerebellum, it stands in the position of the *corpora quadrigemina*, or perhaps of the posterior pair more especially. As the homologies of this region in the vertebrate brain are not yet determined, further attempts to identify this part of it in the *Amblypoda* must be postponed for the present. The structure is in any event entirely different from that seen in any recent *Mammalia*, or in any Mammal of a period more modern than the Eocene period, and one that not only entitles these animals to a position in a peculiar order, but also in a special division of the class, equivalent to those based by Professor Owen on the modifications of the structure of the brain. The homologies of the olfactory lobes are simple; but their extent and form resemble nothing known among Mammals, even far exceeding in size those of *Uintatherium*. On the other hand, they resemble those of Reptiles, especially of the Lizards, but are less deeply bifurcate anteriorly than in them. In the *Coryphodon elephantopus*, they equal in length the middle brain and hemispheres together, and their bulb equals the hemispheres in transverse and vertical diameter.

The nearest approach to the form of the brain in the *Amblypoda* is seen in that of the *Arctocyon primævus*, a Creodont which represented the *Carnivora* in the same Lower Eocene fauna, and was actually associated with *Coryphodon* in France. This brain is described and figured by Professor

Gervais (Nouv. Archives du Muséum, vi, 1870, p. 150, plate 6, fig. 4), who notices the remarkable exposure of the middle brain, or *corpora quadrigemina*. Among *Mammalia* of later ages, some of the extinct South American *Edentata* present the greatest resemblances, although slight ones. Among these may be noticed the small and transverse cerebellum, and especially the lateral expansion of the region anterior to it. To what portion of the brain this expansion belongs, is not stated, but it is not unlike the lateral mass in *Coryphodon*, as *e. g.* in the *Eutatus seguinii*,* Gervais. There is, however, nothing exposed on the superior surface which appears to be the middle brain; hence the difference from the brain of the *Amblypoda* is very considerable.

Restoration.—The general appearance of the Coryphodons, as determined by the skeleton, probably resembled the Bears more than any living animals, with the important exception that in their feet they were much like the Elephant. To the general proportions of the Bears must be added a tail of medium length. Whether they were covered with hair or not is, of course, uncertain: of their nearest living allies, the Elephants, some were hairy, and others naked. The top of the head was doubtless naked posteriorly, and in old animals may have been only covered by a thin epidermis, as in the Crocodiles, thus presenting a rough, impenetrable front to antagonists.

The movements of the Coryphodons, doubtless, resembled those of the Elephant in its shuffling and ambling gait, and may have been even more awkward, from the inflexibility of the ankle. But, in compensation for the probable lack of speed, these animals were most formidably armed with tusks. These weapons, particularly those of the upper jaw, are more robust than those of the *Carnivora*, and generally more elongate, and attrition preserved rather than diminished their acuteness. The size of the species varied from that of a Tapir to that of an Ox.

There is no evidence that these animals possessed a proboscis, as was probably the case with some of the *Dinocerata*.

We must suppose that the Coryphodons were vegetable feeders, but not

* Figured in the important memoir of Gervais's, already quoted, Nouv. Arch du Mus., 1869, v, p. 42.

restricted to any particular class of food. They were doubtless, to a large extent, like the Hogs, omnivorous.

History.—The first piece recognized as belonging to a distinct genus, under the name of *Coryphodon*, was described by Professor Owen in 1846. This was a fragment of the mandible, supporting the last inferior molar. In describing it, Owen noticed the peculiar form of the posterior part of the ramus. He also referred to some superior molars, one of which is figured by Cuvier (Ossemens Fossiles, pl. 77, fig. 6) as probably belonging to the same genus. These were alluded to by the French anatomist as the *Lophiodon de Soissons* and the *Lophiodon de Lyonnais.* Owen named the species observed by him *Coryphodon eocænus,* and it is believed that the teeth described by Cuvier belong to another species, to which DeBlainville gave the name *Coryphodon anthracoideus.* Little, however, was known of this form until ten years later, when Professor Hébert, of Paris, obtained some additional material from Meudon near Paris, and other localities. In the Annales des Sciences Naturelles for 1856, he gave a full account of the characters of the dentition, and described the femur. He explained correctly the homologies of the dental structure, and added a species, *C. owenii,* which is of smaller size than the *C. eocænus.*

The first American species was made known by the writer in February, 1872, under the name of *Bathmodon radians,* and the description was at that time confined to the superior molars, the femur, and the humerus. In February, 1873, in "The Short-footed Ungulata of the Eocene of Wyoming", I described the characters of the scapula and astragalus and its connections, which furnished reasons for removing the genus from the *Perissodactyla* and placing it in the *Proboscidia,* under a subordinal division, which was named the *Pantodonta.* The same course was pursued in the Annual Report of the United States Geological Survey of the Territories for 1872 (1873), where a second American species, *B. latipes,* was added. The next additions to our knowledge of the osteology of *Coryphodon* are due to the exploration of the Eocene beds of New Mexico, conducted by the writer, in 1874, in connection with the United States Geographical Surveys West of the 100th Meridian. On November 28, 1874, in extracts from the Report of the Chief of Engineers, published in advance, I gave the general characters of the skull, and of the hind foot, determining the number of toes in the latter. The temporary dentition and three new species were also described. In some remarks before the Academy of Natural Sciences of Philadelphia, made March 9, 1875, I pointed out the near relation of these animals to the species of *Coryphodon*. In the "Systematic Catalogue of Vertebrata of the Eocene of Wyoming", April, 1875, the structure of the fore foot, including the number of digits, was pointed out, and the group *Pantodonta* removed, with the *Dinocerata*, to a new order, the *Amblypoda; Coryphodon* was referred to the *Pantodonta*, and two species were added. I announced the generic identity of the American and European forms in a communication before the Academy of Philadelphia, made April, 1876 (published April 26), pointing out the subordinate characters of the respective types.* The present work completes the description of the osteology, so far as accessible to me; and I may add that this is so far complete that there only remain unknown the number of the ribs and dorsal and lumbar vertebræ, and the structure of the hyoid apparatus.

Species.—Remains of more than one hundred and fifty individuals of this genus were procured by the expedition, and these indicate the existence of a number of species. Their characters may be observed in the teeth, the forms of the astragalus, calcaneum, and other bones. The precise definition of all of these species is a matter of some difficulty, as I have been compelled to rely chiefly on the mandibular teeth for the characters, owing to the more irregular occurrence of other elements; and the tubercles of the teeth are not always constant. The following key expresses the relations of these forms, most of which, perhaps all, are good species:

I. Posterior inferior molars with an accessory cusp or tubercle on the inner side between the crests (*Coryphodon*, Owen):

An internal conic cusp; posterior crest oblique; heel very small; size medium.................. .... *C. cuspidatus.*

An internal crest; posterior crest oblique; heel small; size medium.. *C. obliquus.*

An internal tubercle; posterior crest little oblique; heel large; size large .... *C. lobatus.*

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* A short time after this, O. C. Marsh asserted the identity of *Coryphodon* and *Bathmodon* in the Amer. Journ. Sci. and Arts.

II. Posterior inferior molars without internal accessory tubercle (*Bathmodon*, Cope):

a. Posterior inferior molars with small or no heel:

Large; inferior molars elongate; symphysis mandibuli produced and narrowed; premaxillary elongate .... *C. radians.*

Medium; inferior molars nearly as wide as long; premaxillary short .... *C. latidens.*

aa. Posterior inferior molars with prominent or wide heel:

Medium; inferior molars elongate; symphysis mandibuli broad and short; premaxillary elongate; tusk tribedral........ *C. elephantopus.*

Smaller; premaxillary bone short; tusk tribedral............ *C. simus.*

Medium; premaxillary elongate; tusk compressed and grooved. *C. molestus.*

The *C. eocænus*, Owen, belongs to Section I, and the *C. anthracoideus*, Blv., and *C. owenii*, Héb., from France, belong to Section II.

As compared with the synoptic table of species previously published (System. Cat. Eocene New Mexico, 1875, p 29), the present one differs in the change of position of the *C. elephantopus*, besides the addition of two species. Further investigation shows that some of the specimens without posterior heel of the lower molars, formerly referred to the *C. elephantopus*, belong to the *C. radians*, while the discovery of the corresponding teeth in the former shows that these teeth possess a distinct, though not large, heel.

Of the above species, I obtained in New Mexico five individuals of *C. radians*, six of *C. simus*, four of *C. molestus*, and one each of the remaining species. But there are various other specimens, probably referrible to a number of these species, from which some of the parts necessary to absolute identification are wanting. Astragali of the subquadrate form, characteristic of the *C. latipes*, Cope, are not uncommon in the collections; but whether they belong to that species, or to one of those here described, is yet uncertain.

The smallest of the American species, the *C. simus*, considerably exceeded in dimensions any of the existing Tapirs; while the largest species, the *C. lobatus* and *C. radians*, equaled in proportions the Indian Rhinoceros.

Coryphodon cuspidatus, Cope.

Plate xlvi, fig. 1.

Bathmodon cuspidatus, Cope, System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 30.

Represented by a portion of a mandibular ramus, which supports the last molar. The posterior transverse crest of this tooth is low, and sends a well-marked oblique ridge to the anterior crest. A cingulum projects from the posterior base of the crown, which is not prominent, and disappears at the base of the inner end of the transverse crest. Just external to and in front of this extremity, a prominent conic tubercle is directed upward and inward. This process is not seen in any other of the numerous jaws and teeth in my possession. Between it and the anterior crest is a low rugose tuberosity, representing a cingulum. There is also a cingulum between the crests on the external side of the crown. The posterior transverse crest is quite oblique, its inner end falling behind the line of the internal cusp. The enamel, where not worn by attrition, is marked by linear rugosities.

Measurements.

	M.
Width of the molar behind	0.023
Elevation of the cusp from base of the crown	0.010
Elevation of the posterior crest at the middle (half worn)	0.010

The *Coryphodon cuspidatus* was about the size of the *C. simus*. In its characters, it marks an extreme position in the genus, in its internal cusps and lateral cingula. Remote approximations to the former peculiarity are seen in the *C. obliquus* and *C. lobatus*, in the presence of a low crest or flat tubercle in the same situation. The *C. lobatus* differs especially in the absence of lateral cingula, large heel, and much larger size.

Coryphodon obliquus, Cope.

Plate xlvii, figs. 1-7.

This species is represented by the greater part of the left ramus of the mandible, and a portion of the right one, with the last two molars and a canine tooth. These pieces are of robust proportions, and present various specific characters.

The mandibular ramus is of small vertical and of considerable transverse diameter. It is deepest below the last molar, the depth gradually diminishing anteriorly, and more rapidly posterior to that point, where the inferior border is concave upward. This is quite different from the form of the ramus in *C. radians*, where the vertical diameter is greatest at the last premolar and least at the last true molar, and where the inferior border is not so incurved posteriorly. The external face of the ramus is convex, and the masseteric crest well developed; the inner face of the ramus is flat. The inferior molars are relatively wider than in any other species excepting the *C. latidens*, but the cusps, especially the anterior ones, are not so elevated as in that species. Both the crests are more oblique than in that species, and, indeed, more so than in any other of the genus. The posterior crest extends diagonally, so that the internal cusp overhangs the base of the crown, while the external extremity marks by its anterior border the middle of the length of the crown. A low cingulum or heel behind the latter gives the crown its oval outline, but the cingulum rises to the outer side of the inner cusp and disappears. As though in continuation of this ledge, a similar crest descends from the opposite or antero-internal side of the cusp, and disappears near the base of the anterior crest. From the width of the eroded surface of the anterior part of the tooth, the descending anterior cingulm is probably well developed.

The penultimate molar has a very narrow cingulum, and the internal lateral crest is not visible in the section produced by mastication. The unworn enamel surfaces are plicate-rugose. The inferior molar, like that of the type-specimen of the *C. radians*, is relatively rather small, on which account I have supposed the individuals to be females. The inner side is flat, and the section of the remaining portion of the crown forms a segment of a circle. Where it joins the inner face anteriorly, there is an obtuse ala, as in *B. radians;* at the corresponding position posteriorly, it exhibits the transverse concavity due to the attrition of the superior canine.

Measurements.		M.
Length of the bases of the true molars		0.080
Length of the base of the last true molar		0.032
Width of the base of the last true molar		0.023
Depth of the ramus at the last premolar		0.049
Width of the ramus at the last premolar		0.028
Depth of the ramus at the last true molar		0.058
Width of the ramus at the last true molar		0.031
Width of the base of the coronoid process		0.031
Diameter of the base of the crown of the canine	antero posteriorly	0.020
	transversely	0.021

The specimen described is the only one which I can refer to the species.

Coryphodon lobatus, Cope.

Plate xlvi, figs. 2-10.

This species rests on the remains of one individual, which I discovered together, and at a distance from those of any other animal. They consist of imperfect fragments of the cranium, with numerous more or less broken teeth, representing all positions in the jaws. These indicate the largest species of the genus.

The characteristic last inferior molar offers certain distinctive features, which indicate that this animal cannot be referred to the *C. radians*. The posterior crest is low, especially on the inner side, where it is highest in *C. radians, latidens, simus*, etc., and rises from a broad, horizontal heel, or cingulum, which does not rise to the inner extremity of the transverse crest. Anterior to the latter, a crest with angular profile, or compressed lobe, extends nearly to the base of the anterior transverse crest, and its external base supports rugosities which continue into the posterior cingulum. There is no cingulum on the external side of the crown. The anterior descending crest is well developed, the lower part being quite elevated. The basal portions of the crown exhibit a rather fine rugosity of the enamel. An inferior premolar has a quadrate outline, and presents neither external nor internal cingula, and a slight one in front. Its size is large. The canines are very thick, but the crowns are not so long as in specimens of *C. elephantopus* and *C. latidens*. The inferior canine has the flat inner side of considerable antero-posterior extent, with a small angular projection in front at its base. The remainder of the crown is convex in section, but the posterior face is deeply worn by the attrition of the corresponding tooth of the superior series.

The inner portion of the last superior true molar exhibits the usual characters, and is without a continuous cingulum at the middle. The penultimate superior molar has a continuous cingulum at the internal border and one across the external base of the posterior external crest, both of which are wanting in *B. elephantopus* and *B. simus*. Of the parts homologous with the two external crescents in *Perissodactyla*, the posterior V is remarkable for its small size, while the anterior is an elevated cone, compressed, and quite distinct from the former. The anterior cingulum is strong, and has been worn by attrition with an inferior molar. The fourth premolar is large in the transverse direction, and rather narrow. Its inner crescentic ridge is well developed, and the basal cingulum is strong, passing round the inner extremity. A second premolar is similar, excepting that the length is greater in relation to the width (transverse). The premolars are more rugose than the molars, and have an external basal cingular line of rugosities. The superior canines have huge roots and small crowns, of a subtriangular section. An incisor tooth is remarkable for its large size, and the transverse as compared with the vertical extent of its crown. The base of the crown exhibits a strong basal cingulum on the inner side, but none on the outer side.

All of the teeth, and especially the canines, show by their attrition that the animal described is adult.

Measurements.

		M.
Length of the crown of the posterior superior molar		0.038
Width of the posterior crescent of the penultimate superior molar		0.014
Elevation of the anterior cone of the penultimate superior molar from the base of the crown		0.018
Length of the fourth superior premolar		0.022
Width of the same		0.035
Width of the second superior premolar		0.029
Diameter of the root of the superior canine		0.034
Diameter of the base of the crown of the superior canine		0.030
Diameter of the crown of the incisor	longitudinal	0.016
	transverse	0.027
Length of the crown of the last inferior molar		0.046
Width of the crown of the last inferior molar		0.030
Elevation of the inner posterior cusp		0.015
Elevation of the inner anterior cusp		0.025
Width of the heel behind the posterior crest		0.0065
Length of an inferior premolar		0.022
Width of the same		0.022
Diameter of the base of the crown of the inferior canine	transverse	0.026
	antero-posterior	0.035
Length of the crown of the same		0.053

But one specimen of this species was found. The corresponding teeth of the six specimens of the *C. radians* from New Mexico and Wyoming which I have seen, differ uniformly from those of the *C. lobatus* in the very small heel of the inferior molars, the elevated cusps, absence of internal median tubercle, etc.

Coryphodon radians, Cope.

Bathmodon radians, Cope, Proc. Amer. Philos. Society, 1872, p. 418 (Feb. 16); U. S. Geol. Surv. of Montana, 1871, p. 350; Ann. Report U. S. Geol. Surv. of Wyoming, etc., 1872, p. 587 (1873).

Of this large species, the remains are rather abundant in the Eocene beds of New Mexico. The best-preserved skeleton is that from Bear River, Wyoming, which served as the type of the original description. This will be fully illustrated in the forthcoming volume III of the quarto reports of the United States Geological Survey of the Territories. Of the New Mexican specimens, the first includes fragments of the cranium, with teeth of all positions, in a separate condition. The second is similar in character, but lacks what the first includes—superior molars. The third includes a few of the teeth, superior and inferior molars, canine, and incisors, with many parts of the skeleton in a fragmentary condition. Two other specimens consist of a superior and inferior true molar and a superior true molar.

The inferior molars present the common characters of very small posterior cingula and elevated cross-crests; the canines are not compressed, and the superior has a triangular section of the crown. The last superior molar has a narrower outline than that of *C. elephantopus* and other species; the length of the crown being less in proportion to the width.

In the first specimen, it is to be observed that, in the last superior molar, the transverse crests are nearly parallel; the posterior divided as usual, the external portion of the crest being a flattened cone. A cingulum extends round the base of the crown, except externally; it is weak internally and posteriorly, and strong anteriorly. A ridge rises from the posterior base near the inner extremity, and passes obliquely upward to the interior extremity of the anterior crest. This ridge is wanting in the type-specimen of *B. simus*. The enamel is smooth. The crowns of the incisors are transversely expanded. The penultimate inferior molars of both sides and the anterior part of the last inferior molar of one side are preserved. The former are distinguished by the presence of only a rudiment of a heel, which is smaller than in the type-specimen from Wyoming. The cusps are elevated; there are no lateral cingula, and the enamel is entirely smooth.

The anterior descending crest is well developed. The enamel of the premolars of both jaws is smooth, and the same is true of the end of the crown of the canine, which is triangular and without grooves.

Measurements.

	M.
Length of the last superior molar	0.031
Width of the same	0.039
Width of the last inferior molar	0.026
Width of the penultimate inferior molar	0.026
Length of the same	0.038
Elevation of the inner posterior cusp	0.016
Elevation of the inner anterior cusp	0.025
Length of the inferior premolar	0.022
Width of the same	0.016
Width of the crown of an incisor	0.019

The second specimen includes the last inferior molar, the penultimate molar, some premolars, and the superior canine without its apex; also a portion of the zygomatic arch. The teeth present typical characters, including the smoothness of the enamel. The posterior heel is rather better developed than in the first-mentioned specimen, resembling in this respect the typical specimen from Wyoming. It is a narrow ledge, which rises very steeply to the outer base of the inner tubercle, and then, in the last molar, sends off a short rugose continuation inward, which does not extend beyond the posterior face. The posterior outer angle of the V of the inferior premolars is quite protuberant. The base of the crown of the superior canine is a spherical triangle in section. The teeth indicate a large animal.

Measurements.

		M.
Length of the last inferior molar		0.039
Width of the same		0.027
Elevation of the inner anterior cusp of the same		0.024
Elevation of the inner posterior cusp of the same		0.016
Elevation of an inferior premolar		0.021
Length of the same		0.023
Width of the same		0.018
Diameter of the base of the crown of the superior canine	greater	0.030
	lesser	0.025

The zygomatic process of the malar bone is rather flat and not stout;

the inferior anterior tuberosity is not prominent. Depth at that point, $0^{m}.045$. This specimen, like the last, was adult.

The remains of the third specimen were found strewn over a considerable extent of a slope of the bad-lands, where the waters of erosion had scattered them either directly or by the undermining of the bed in which they had lain. The little ravines, whose divergent courses mark the lines of drainage, abounded in the fragments, while a few yet remained projecting along the crests of the dividing ridges. The marl has at this spot a red color, and all the bones partake of it. A more remarkable example of breakage I have seldom seen. The long bones were broken into short sections as though sliced with a knife, and many of the fragments were fractured as though in cleavage-planes. The pieces, collected in packages as they were found lying, form a considerable bulk; but I have not had the success I had anticipated in reuniting them. It is, however, evident that two animals are mingled in this mass; the largest of which I refer to the *C. radians*, referring to the teeth, which I found in close juxtaposition, as the representative portions.

The teeth agree in technical characters very closely with those of the type, and the specimens above described, with one exception. The posterior cingulum, or heel, has the same reduced proportions and the crests the elevation. The anterior descending crest is strong, and there are no cingula; but, instead of the enamel being smooth, it is everywhere marked with delicate flame-like ridges. The animal is younger than those just described, but not more so than the type, the crests being worn, as in the latter, by attrition, which has just reached the dentine. A trace of the rugosity only exists in the type-specimen, so that it must be regarded as a strong individual peculiarity of the present animal. The inferior canine is a much larger weapon than that of the type, but not larger than that of a second specimen, also from Wyoming. The inner face is flat, and the remaining surface strongly convex. The antero-interior margin is produced into an aliform ridge; the postero-interior margin consists proximally of two angular ridges separated by a groove. This ridge is simple in the type of *C. latidens*. The crown is curved upward and a little outward. A superior first molar resembles strongly one from the locality of the Wyoming type, of uncertain reference. It differs in the absence of cingulum from the inner side of the base of the crown, which is strongly developed in the Wyoming specimen. The posterior V is narrow, and produced well inward, and a strong ridge passes within its inner base from the posterior cingulum to the anterior transverse crest. The anterior external crest is a small flattened cone, whose external face is half as wide as that of the posterior. Anterior cingulum strong. An incisor is large, and has the form of those of the type. Its crown is higher than wide and without basal cingula.

Measurements.

		M.
Width of the posterior molar (inferior)		0.028
Length of the penultimate molar		0.037
Width of the same		0.026
Diameter of the inferior canine	antero-posterior	0.030
	transverse	0.028
Diameter of the first upper true molar	antero-posterior	0.032
	transverse	0.032
Transverse extent of its posterior external crest		0.020
Antero-posterior extent of its posterior external crest		0.011
Height of the crown of the incisor		0.026
Width of the crown of the incisor		0.022

This animal I suppose to be a male.

The other individuals of *Coryphodon radians* do not exhibit any characters not already mentioned in preceding descriptions.

Coryphodon latidens, Cope.

Bathmodon latidens, Cope, System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 29.

Represented by both mandibular rami with dentition nearly complete, by the left premaxillary bone with its teeth, and by a right superior canine. These portions belong to a species of about the size of the *B. elephantopus*, but one of a shorter and more robust form of skull. It differs in the same way from *B. radians*, besides being of distinctly smaller size.

The rami are stout, especially below the last molars, and not shallow anteriorly. Posteriorly, below the last molar, the inferior border retreats upward, so that the angle of the jaw is opposite to the superior fourth of the vertical diameter of the ramus at the middle. The inferior border of the angle is slightly deflected. The condyle has great transverse extent, and presents upward externally and partly backward internally. The coronoid process rises from the plane of the condyle a little in advance of it, and is recurved at the apex; its anterior face is wide from the base to the summit. The profile of the symphysis descends at about an angle of 45°, and then curves backward in the plane of the rami. Its anterior face is rather flat, and its incisive border broadly convex, as in *C. elephantopus*, and not produced forward, as in *C. radians*.

The canines are large and acute, and are directed at an angle of 45° upward, and 90° outward, the apices turned backward; the crown is subtriangular, and has a slightly alate anterior angle. External face convex, and without angle. Each is in contact with the external incisor, but is separated from the first molar by a diastema. There are five premolars on each side in this specimen, of which the second is probably intercalated abnormally, as it is smaller than the others. The crowns of the premolars are elevated, and their posterior crests short. The true molars are characterized by their short antero-posterior diameter as compared with their transverse. The anterior descending crest is but little marked, and its termination at the inner extremity is not prominent as in other species. The anterior transverse crest is distinctly higher than the posterior, and its posterior face is scarcely marked by the connecting ridge. The latter is well marked on the front of the posterior crest, while a very narrow ledge represents the wide cingulum of such species as the *B. lomas.* Enamel generally rather finely rugose. The premaxillary bone is short and elevated, and its teeth are large and with a rudimental cingulum on the outer face. Superior canine with triangular section of the crown. It is directed slightly outward, and curved slightly backward. The anterior face, though not much worn, has lost its coat of enamel through attrition with the inferior canine; it is nearly as wide as the slightly convex postero-internal face. The external face is nearly as wide as the anterior, is slightly convex, and bears on the proximal half one-third the width from the posterior border, a straight ridge, which is parallel with the anterior border. This ridge is not present in the teeth of *C. elephantopus*, *C. lobatus*, etc., but is present and longer in *C. molestus.* The canines are particularly large and acute in the *C.*

latidens, and the superior exhibits a large pulp-cavity. The enamel-face extends high up on the posterior face.

Measurements.

	M.
Total length of the jaw from the angle to the incisive alveolar border	0.306
Depth of the ramus at the third premolar	0.063
Depth of the ramus just behind the last molar	0.035
Diameter of the ramus at the last molar	0.035
Elevation of the coronoid process	0.160
Width of the condyle	0.080
Length of the dental series	0.156
Length of the true molars	0.080
Length of the penultimate molar	0.030
Width of the same	0.027
Length of the last molar	0.0335
Width of the same	0.0260
Diameter of the canines at the base	0.032
Width between the bases of the canines	0.053
Length of the crown of the canines	0.063
Length of the superior canine preserved	0.135
Length of the crown of the superior canine	0.093
Long diameter of the crown at the base	0.031
Antero-posterior diameter of the crown at the base	0.024

The lower jaw and portion of the upper jaw above described were found in the normal immediate relation in the closed mouth. Immediately below the skull was found a humerus distorted by pressure, and, in close proximity, an atlas, parts of sternum, ribs, and other elements. The atlas, sternal segments, and ribs afford some distinctive characters.

The atlas is short, and the lateral facets for the axis are moderately oblique, with a backward slope. The anterior cotyli are deep, and with nearly vertical long axes. The inferior face is without tubercle, and its posterior border is convex, the anterior concave. The neurapophyses are steep, and there is a short, obtuse, neural spine. The antero-posterior extent of the transverse processes is small, as its anterior base is much behind the middle of the longitudinal diameter of the atlas. It is pierced by the vertebral foramen from behind, *above* the facet of the axis downward; the foramen issuing in the middle of the wide anterior face of the process. The usual foramen pierces the neural arch above and within the cotylus.

The ribs are compressed for a great part of their length. The hæmal segments are ossified as far as the sternum, and are less compressed. Two sternal segments are preserved, with three hæmal segments adhering to corresponding angles. The segments are flat and subquadrate, the lateral borders slightly concave, and thinned by a rounded bevel from one side only. Anterior and posterior margins thickened, with rib-articulations at the angles.

Measurements.

	M.
Transverse extent of the distal end of the humerus	0.100
Transverse extent of the atlas	0.170
Transverse extent of the neural arch of the atlas behind	0.094
Transverse extent of the axial facet of the atlas behind	0.043
Antero-posterior length of the atlas	0.060
Antero-posterior length of the base of the neural arch	0.045
Antero-posterior length of the base of the transverse process	0.025
Vertical diameter of the atlas behind	0.095
Width of a rib a little below the tubercle	0.023
Width of a rib of the hæmal portion	0.018
Width of a segment of the sternum	0.058
Length of a segment of the sternum	0.055
Thickness of a segment of the sternum in front	0.015

But one specimen has come under my observation which I can refer to this species. It is about as large as an Ox, of not more than medium proportions. The species is well distinguished from the others with superior canines with triangular section, by the short, wide crowns of the molar teeth, and the rudimental condition of the anterior and posterior cingula.

Coryphodon elephantopus, Cope.

Plates l, figs. 5–6; li, lii, liii, and liv, fig. 1.

Bathmodon elephantopus, Cope, Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 10; Id., Ann. Report U. S. Geog. Survs. W. of 100th M., 1875, p. 95, plates v, vi.

This species is the only one of the genus which is represented by a nearly perfect cranium, the corresponding parts in the *C. molestus* being injured by pressure. This cranium was found in the hard sandstone which divides the Eocene on the Gallinas into two nearly equal parts, and had thus escaped the distortion which the more numerous specimens of *C. latidens*, *C. molestus*, etc., had suffered in the softer argillaceous rock above the sandstone. The mandible is imperfect, wanting a large part of one ramus and the inferior portion of the other; all the teeth are preserved excepting the last molar. The dentition of the cranium is perfect, excepting one incisor. The cranium and mandible were found in different fragments of rock which had fallen from their position on one of the lower crests of the bad-land mass, figured in cut 15, page 91, Ann. Report U. S. Geog. Survs. W. of 100th M., 1875. The largest mass, which weighed perhaps two tons, contained the upper cranium and the femur; the other fragments were smaller, and lay in a ravine on the opposite side of the ridge, from the summit of which all the masses had fallen, and on part of which a portion of the sandstone bed still remains. In one block occurred the symphysis, with incisor and canine teeth, and parts of both rami; in another block, molars of both sides and a coronoid process were found in place. After much labor, the specimens were all removed from the matrix, and the surface cleaned for investigation. The cranium has been somewhat obliquely depressed. The well-worn condition of the molars shows the animal to have been adult, and the powerful canines render it probable that it belongs to the male sex.

Viewed from the side, with the molar grinding-surface horizontal, the profile displays a strong elevation and prolongation backward and depression and abbreviation forward, so far as the cranial roof is concerned. On the other hand, the premaxillary region is well produced anteriorly, thus giving the nareal opening a direction nearly as much upward as forward. This production is not so great as in the existing Tapirs, but the general effect of the profile is Tapiroid. The superior aspect of the cranium shows a great width of the frontal and parietal bones, which overhang the temporal fossæ, a strong contraction behind the canine teeth, and a rounded expansion of the premaxillary region. The zygomas have considerable lateral expansion, the malar bone projecting outward far beyond the plane of the maxillary. The latter therefore occupies a sunken position between the malar bone and the protuberant canine alveolar wall. The posterior surface of the cranium is rather narrowed and elevated, the general outline being subquadrate, interrupted on each side below by the large mastoid processes.

The supraoccipital region is deeply concave, owing to the production backward of the lateral and superior walls of the cranial chamber.

With the cranium in the position described, the occipital condyles present partly upward. The united mastoid and paramastoid processes present a wide posterior face, and descend to the line of the inferior face of the condyles. The postglenoid process is large, but not very wide, and descends a little below the mastoid. The zygomatic process of the squamosal expands abruptly outward at the glenoid cavity, and its superior border is continued posteriorly external to the line of the postglenoid process, thus roofing over the external auditory meatus. The external face of the zygomatic process is convex and incurved above. The malar portion of the zygoma, just after leaving the maxillary bone and opposite to the last molar tooth, presents downward a truncate tuberosity, which has considerable antero-posterior extent. The orbital space is contracted by an expansion of the cranial walls outward and upward in the position of the superciliary horn of the *Loxolophodon cornutus.* This must have caused the eye to protrude, if it were of ordinary proportions. A small rugose tuberosity projects outward on the lachrymal bone. The *foramen infraorbitale exterius* is of moderate proportions, and opens over the third premolar.

The superior walls of the skull are so coössified as to obliterate all sutures. Anteriorly, the surface is nearly smooth; toward the middle, it is marked with shallow impressed grooves and dots; while, in its posterior half, it is so roughened by shallow pits and wrinkles as to resemble corresponding parts in some Crocodiles and other Saurians. Doubtless in life this part of the skull was, as in Reptiles, only covered by a thin epidermis. The superior surface of the skull is, above the lateral contraction and in line with the canine alveolus, swollen into a convexity which represents the middle corneous process in *Uintatherium.* These are followed by a concavity, behind which rises on each side the supraorbital tuberosities already described, which are larger than the anterior ones, and are separated by a longitudinal concavity. These tuberosities are continued posteriorly as low ridges, which unite a little behind the position of the orbits into a central ridge. This is bounded on each side by a marked longitudinal concavity, which begins anteriorly at the margin above the posterior part of the orbit.

These shallow gutters converge posteriorly, unite at the abrupt termination of the median ridge, and continue into the deep notch of the posterior border of the skull. The lateral borders of the superior face of the skull overhanging the temporal fossæ, commence behind the orbits and slope obliquely upward and outward. The margin makes an open sigmoid flexure, having a long concavity behind the orbit, a convexity just above the glenoid cavity, and a slight contraction posterior to that point. They project as far backward as the line of the occipital condyles, each side forming a prominent angle, separated from the opposite one by an open notch. The edge is obtuse and rather thin. The nareal opening is wide, and subround in outline. The free portions of the nasal bones are wanting in the specimen; but their basis is small, and they were probably insignificant, as in *C. lomas.* The dentigerous portions of the premaxillary bones are obliquely oval in form, the long axis being at 45° inclination to the long axis of the skull. The ascending portion extends to the nasal bones, although in the specimen the distinguishing suture is invisible. On the middle line, they are in contact, but not united by suture; and each sends posteriorly a narrow process, which separates each incisive foramen from the median line for a distance at least.

The *palatal surface* is not narrowed as in *Loxolophodon cornutus*, nor very concave. Its widest portion is that between the external incisors; it is a little narrower between the canines, and narrower still between the molars, whose inner extremities form parallel borders of the palate. The contrast between the great contraction behind the canine and the expansion of the premaxillary region is striking, and results in a short spatulate outline. The posterior extremity of the maxillary bone does not project much beyond the posterior base of the zygoma, and is separated by a shallow groove from the *lamina pyramidalis* of the palatine bone. The palatal border of the nares is short, and extends forward as far as opposite the middle of the inner extremity of the posterior molar. The nareal trough is elongate and rather narrow. The pterygoid processes of the sphenoid bone commence a little behind the anterior borders of the glenoid surfaces and just in front of the *foramen ovale.* They descend with the posterior border directed obliquely forward, and meeting the palatine laminæ at an open angle, as in *Rhinocerus*. The bridge which separates the *foramen ovale* from the *foramen lacerum* is produced downward in a short, longitudinal, sharp-edged process. The basicranial axis is stout, and bears on each side a longitudinal oval facet, whose middle is opposite the postglenoid process. Between their anterior portions, the axis is grooved. The palato-pterygoid laminæ are nowhere perforate, but there is a basin-like concavity just above the inferior angle, at the external base.

The *incisor teeth* are separated by spaces as wide as the diameter of their roots. The external are a little the smallest, and the crowns the most oblique; the length of crown is greatest in the middle pair, where it equals the width. The anterior and posterior faces of the crown are both convex, the former much the more so. The inner base is marked by a low cingulum.

The *canine teeth* are very large, and are well worn on the anterior face by use. The section of the crown is triangular, forming nearly a spherical right-angle triangle. In the longitudinal direction, the posterior face is a little concave, the anterior a little convex. There is no secondary ridge on either of them. The diastema is short and concave.

The *molars* are in good preservation, but the first true molar is so worn by mastication as to obscure its structure. The form of the last molar is an irregular transverse oval, with the posterior border strongly convex or angular. This angulation is more pronounced than in *C. radians*. The posterior crest is also angulate, so that while the inner portion is parallel with the anterior crest, the outer portion converges toward it, but not so strongly as in *C. molestus*. The anterior fold sends a fold downward and backward at each end, the inner of which is continued as a basal cingulum as far as the posterior angle. The anterior cingulum is strong, but it does not pass round the external base of the tooth. There is an imperfect cingulum round the interior extremity of the last two molars, but none on either extremity of any of the other teeth. The posterior external V of the penultimate molar is wide from border to border; the representative of the anterior V is a protruding trihedral cone, quite distinct from the posterior. The anterior transverse crest sends downward posteriorly a fold at each end, the anterior of which continues as a basal cingulum to the postero-exterior angle of the tooth.

The crowns of the *premolars* consist of a large external and smaller internal V, the latter of which in the first is a mere internal cingulum. The external V is concave on its extero-inferior side or back, and has a strong convexity at the base of each border. It is nearly flat in the first premolar.

The portions of the *mandible* which, from the place of their discovery, might be supposed to pertain to the cranium described, are found to fit into their presumed positions. Thus the symphysis presents the wide and rather flat form of the premaxillary region, and the canines and incisors apply readily. So also do the premolars and molars, especially in a peculiarity of wear of the first premolars and the worn condition of the first true molar. The inferior incisors are nearly in contact by the lateral angles of their crowns. The external are smallest, and exhibit an obtuse vertical ridge just external to the middle of the interior face. The same ridge exists in the second incisors nearer the external border, with which it incloses a fossa. There is no diastema in front of the canine. The latter is robust and is turned outward, the apical portion being at right angles to the long axis of the skull. The interior face is flat, as in other species, and the exterior very convex. The posterior aspect is worn into a transverse face by the attrition of the superior canine. The antero-interior angle of the crown is prominent, but its apical portion is worn by the outer edge of the external superior incisor. The section of the crown is generally trihedral. The diastema is short. The incisive alveolar margin is a regular broad curve, and the floor of the mouth gradually deepens to between the diastemata. The premolars of the left ramus are so crowded as to strongly impress each other. The posterior median longitudinal crest is distinct but short in all; and, in the third and fourth, the posterior base of the internal V is protuberant upward. The first true molar is deeply impressed by the adjacent premolar. Its anterior descending cingulum is well developed, while the posterior cross-crest abuts immediately on the following molar. This, the penultimate, shows cross-crests, which, though worn, have never been so elevated as in *C. radians* and *C. latidens.* The anterior descending cingulum is strong; the posterior cingulum, or heel, is well developed, commencing at the base of the inner cusp. On the last molar, it was doubtless larger.

The enamel on all the molars, canines, and incisors, where not worn, is finely wrinkled.

The cranium of this species furnished the opportunity of obtaining a cast of the brain. This has been described in its principal features under the head of the genus, and is figured on Plate LI of the present work. The slight distortion of the skull consequent on pressure is also visible in the brain. The cast terminates at the *foramen magnum*, not extending posterior to the cerebellum; here its transverse diameter exceeds that at the cerebral hemispheres, but is not equal to that at the middle brain. In excavating the matrix from the olfactory chambers, some difficulty was experienced in attempting to lay bare the superior and inferior walls, which are doubtless of a spongy or cribriform character. On one side of the bulb, this boundary was probably passed through, giving a larger vertical diameter than the true one.

Measurements of the brain.

	M.
Total length	0.150
Length to the middle brain above	0.024
Length to the cerebrum above	0.052
Length to the base of the olfactory lobes	0.090
Vertical diameter at the cerebellum	0.034
Vertical diameter at the middle brain	0.041
Vertical diameter at the hemispheres	0.039
Vertical diameter of the olfactory peduncles	0.015
Width at the cerebellum	0.039
Width at the middle brain	0.053
Width at the hemispheres	0.042
Width at the olfactory peduncle	0.026
Width at the olfactory bulb	0.038
Length below to the transverse constriction	0.024
Length below to the hypophysis	0.062
Length below to the optic nerves	0.075
Length below to the base of the olfactobry bulb	0.106
Length below to the bifurcation of the bulb	0.135

Comparison with the skull of a young *Tapirus roulinii* of two-thirds the linear dimensions of the present one shows that the hemispheres are of disproportionately small size. In crania of such relative sizes, if the hemispheres preserved the same proportions, those of *T. roulinii* should present two-thirds the linear dimensions of those of the *C. elephantopus*. The actual measurements are twice those of the latter, linear; therefore three times as long and wide. This gives a proportion of bulk of twenty-seven to one.

Measurements.

	M.
Length of the cranium from the incisive border to the convexity of the occipital condyle	0.450
Width of the cranium at the posterior part of the zygomatic arch	0.290
Depth of the cranium at the last molar	0.145
Length from the incisive border to the posterior edge of the *foramen infraorbitale exterius*	0.130
Length from the incisive border to the tuberosity of the lachrymal bone	0.173
Width of the anterior nares	0.067
Width at the supraorbital tuberosities	0.160
Width behind the supraorbital tuberosities	0.135
Greatest width of the parietal bones	0.154
Expanse of the posterior angles of the parietal bones	0.138
Elevation of the occiput, including the condyles, at the middle	0.130
Elevation of the occiput at the sides	0.148
Length of the palatal surface	0.240
Length of the nareal trough to the *foramen ovale*	0.111
Length of the oval tuberosities of the basioccipital	0.022
Length (perpendicular) of the postglenoid processes	0.030
Width of the palate in front of the canines	0.112
Width of the palate at the canines	0.141
Width of the palate at the diastema	0.069
Width of the palate at the last molars (inclusive)	0.125
Width of the palate between the first premolars	0.045
Width of the palate between the last true molars	0.047
Width of the palatal notch	0.028
Width between the *foramina ovalia*	0.040
Width between the external borders of the postglenoid processes	0.155
Width between the external borders of the mastoid processes	0.175
Width of the basisphenoid axis	0.037
Width of the foramem magnum	0.034
Axial length to the line of the canine teeth	0.055
Axial length to the line of the premolar teeth	0.106
Length of the premolar series	0.073
Length of the molar series	0.085
Length of the first premolar	0.016
Width of the same	0.017
Length of the fourth premolar	0.021
Width of the same	0.027

Length of the third molar		0.031
Width of the same		0.040
Diameter of the base of the crown of the canine	antero posterior	0.025
	transverse	0.030
Length of the crown (worn)		0.053
Width of the crown of the second incisor		0.018
Elevation of the same (unworn)		0.018
Width of the crown of the second lower incisor		0.020
Elevation of the crown of the second lower incisor when unworn		0.018
Length of the crown of the inferior incisor		0.053
Width at the base	antero-posterior	0.025
	transverse	0.028
Length of the diastema		0.034
Length of the six anterior molars		0.122
Length of the premolars		0.064
Length of the penultimate molar		0.034
Width of the same		0.024

A considerable number of loose bones were found on the ground among the rocks containing the remains described, but I cannot refer them to the same animal with certainty.

Coryphodon simus, Cope.

Bathmodon simus, Cope, Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 8.

The specimen which first announced the existence of this Ungulate was found on a slope of a bad-land bluff. It consists of a fragmentary cranium, of which a considerable portion was discovered in place, but so cracked as to be only removable piece by piece. The reconstruction has given one premaxillary bone, with the apex missing; the left maxillary, supporting six molars, four in good condition; the right maxillary, supporting one molar; both mandibular rami, with all the molars excepting the first and second on one side, with a part of the symphysis; a superior canine, incisors and fragments of superior molars loose, and numerous portions of the skull, including the zygomata, etc.

The teeth of this specimen indicate a smaller animal than those which represent some of the other species, being less than those of the type of *C elephantopus.* The inferior molars, especially the posterior, are elongate, as compared with their width, and have a well-marked heel. The superior canine is small, and with trihedral crown.

The premaxillary bone is, like that of *C. latidens*, characterized by the steep descent of the ridge which continues the lateral border of the nares toward the alveolar margin, which it approaches much more closely than in *C. radians* and *C. elephantopus.* Although the premaxillaries of the two individuals of *C. simus* in possession of the expedition have lost their anterior apices, the principal portion remaining has such a similarity of form with that of the *C. latidens*, of which the type-specimen includes a perfect specimen, that there can be no doubt of their identity of character. The small diameter of the fractured base of the apex indicates that it had little extent, and that the muzzle was short at its most prominent portion, the upper lip. The premaxillary teeth preserved present no peculiarities. The superior canine accompanying the specimens is small and well worn. Its section is that of a subequilateral spherical triangle, with the posterior line slightly concave. The posterior face of the crown is quite concave in the longitudinal direction, and there is no accessory ridge along the externo-posterior angle. The superior premaxillary teeth do not present any peculiarities. The last and penultimate molars present the usual characters. The small external cone of the crown of the latter is quite distinct from the posterior external V, which is rather wide at the base, which has no cingulum. The posterior molar is not produced backward into an angle, and the posterior crest is nearly parallel with the anterior. This tooth differs from the corresponding one of all the other species where I have seen it, in the absence of the ridge that descends from the interior extremity of the anterior crest backward and downward to the basal cingulum. The corresponding ridge is well developed in the penultimate molar. Neither molars nor premolars have a basal cingulum on the inner extremity of the crown, nor any at the external base. The posterior cingulum of the last molar is small and not continued. The enamel of the superior canine and molars is nearly smooth.

The mandibular rami have a greater vertical diameter than most of the specimens that have come under my view, but a portion of it is plainly due to extension under pressure. The actual depth is, however, relatively greater at the posterior part than in other specimens. The premolar teeth do not display any peculiarities, the first having, like the others, the short median posterior cariniform heel. The descending anterior cingulum, or crest, is well developed on all of the true molars, and the heel on the last two. This is, on the last molar, uninterrupted, and descends from the inner to the outer side, commencing within, opposite the middle of the cusp. The crests had not, when unworn, the relative elevation seen in the *C. radians* and *C. latidens*; and the space between them is relatively greater. The entire crown is narrower posteriorly than anteriorly. The enamel is nearly smooth.

An obtusely truncate osseous fragment was found attached to the superior posterior angle of the cranium. I cannot now attach it in place, owing to the loss of intermediate fragments; but a sketch which I took on the spot indicates that it projected, like a free and flattened horn-core, backward in the position of the lateral occipital crest in the *C. elephantopus* and in *Loxolophodon*. It therefore projected in a vertical plane considerably beyond the line of the occipital condyles. Its free end is somewhat thickened.

Measurements.

	M.
Depth of the premaxillary bone at the second incisor tooth	0.032
Length of the premaxillary bone from the maxillary, including two alveoli	0.036
Diameter of the alveolus of the first incisor	0.015
Diameter of the base of the crown of the canine { antero-posterior	0.017
Diameter of the base of the crown of the canine { transverse	0.018
Length of the bases of the posterior six superior molars	0.126
Length of the bases of three premolars	0.051
Length of the penultimate molar	0.026
Width of the same	0.033
Length of the last molar	0.026
Width of the same	0.036
Length of seven inferior molars	0.154
Length of three inferior true molars	0.081
Length of the penultimate molar	0.026
Width of the same	0.018
Length of the last molar	0.034
Width of the same in front	0.021
Width of the same posteriorly	0.017
Elevation of the inner posterior cusp	0.014
Depth of the ramus at the last molar	0.068
Depth of the ramus at the last premolar	0.064
Vertical diameter of the lateral occipital protuberance	0.063
Transverse diameter	0.024

Another animal, obtained at another time and place, is represented by fragments of both mandibular rami, with molar teeth. The posterior molar closely resembles that of the preceding specimen. Accompanying these are the extremities of both of the tibiæ. These are very flat, and the obliquities of the anterior and posterior faces are nearly equal. The calcaneal articular facet is wide, and but little produced beyond the astragalar, and is separated by an oblique low crest, which only extends part way across the extremity of the bone.

Measurements.

	M.
Long diameter of the end of the tibia	0.067
Short diameter of the end of the tibia	0.043
Diameter of the shaft two inches above the astragalar facet	0.026

A considerable number of bones of a third individual were found near the locality of the one first described. The premaxillary, maxillary, and mandibular bones are included, the first two without teeth. The posterior mandibular tooth is also wanting, which circumstance renders the identification of the species less secure than is desirable. The forms of the remaining teeth, with the canine and premaxillary bone, are those regarded as characteristic of the *Coryphodon simus.* Numerous bones of the limbs accompany the cranial fragments, but they belong to more than one individual. The distal ends of the femora belong to a small and a large individual. Both agree in having a moderately-elevated patellar groove, with the inner edge slightly elevated, and a notch in the outer edge marking the commencement of the condylar surface. The humeral head and condyles are relatively large as compared with the femur, as is usual in the genus. The articular surface of the latter is shallowly hourglass-shaped, and without ridges. The greater tuberosity of the former is very large and incurved, and separated by a marked bicipital notch from the narrow, projecting, lesser tuberosity. The heads of the femora are round, with the fossa of the *ligamentum teres* forming a deep notch from the border.

The teeth found with these specimens are of the normal size of this species, and the enamel is nearly smooth.

Coryphodon molestus, Cope.

Bathmodon molestus, Cope, Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 9.
Bathmodon lomas, l. c., p. 9.

One of the bad-land buttes of the Gallinas exhibits a bone-bed composed of skeletons of Coryphodonts lying together and dislocated in various degrees. Several days were spent in excavations, and many bones were secured, which represent all portions of the skeleton of several individuals. The cranial fragments with dentition belong to two species, the *Coryphodon latidens* and the *C. molestus.* The bones found in immediate proximity to the jaws of the former have been described in connection with them, and the bones found in connection with the cranium of *C. molestus* are described here. It is extremely probable that the latter belong to the same animal.

The *C. molestus* is represented by a nearly entire cranium, including mandible obliquely distorted by pressure. Immediately associated were found fore and hind limbs with the feet, scapular and pelvic bones, with cervical vertebræ. Bones of two or three other skeletons were found in proximity to these. Most of them are distorted by pressure, the feet being in the best state of preservation. Fragmentary skulls of two other individuals found in remote localities present the characters of this species. One of them includes the grooved canine teeth.

The *C. molestus* is distinguished by the forms of its canine and molar teeth and its premaxillary bone. The superior canine is more compressed, and has a narrower section than that of any other species of the genus, approaching in this respect the *Metalophodon armatus.* The anterior face of the crown is the narrowest, and is concave in section, consisting of an open groove, which narrows toward the apex. The posterior face of the crown is the widest, and, like the exterior, slightly convex. The three angular margins are acute and trenchant, but not serrate. The inferior canine has a flat interior and convex exterior face, which are separated by anteriorly and posteriorly directed cutting-edges. They differ distinctly from those of the *C. elephantopus* and the *C. latidens,* where the section is triangular to the apex, the external angle being rounded. The size of these teeth is less than in other species, which is partly to be traced to the young age of the animal in the type, since the last molar tooth, both above and below, is but just protruded. But their peculiar form cannot be traced to this fact, since the apical portions of the canines of other species differ utterly from the corresponding portions in the *C. molestus*. The last inferior molar resembles that of the *C. simus* in having a strong cingular heel behind the posterior crest, and in lacking all tubercle or cingulum between the internal extremities of the cross-crests. The general form of the crown is elongate, and the anterior descending crest is large, and extended well anteriorly to the inner side. The premaxillary bone is produced forward, so that the alveolus of the first incisor tooth is entirely in the horizontal portion, which is about $0^{m}.02$ longer than the vertical portion to its extremity in contact with the nasal bone.

The cranium of the typical individual presents the strong supratemporal crests already described in the *C. elephantopus*. They extend from behind the orbits, and are produced so as to extend far behind the vertical plane of the occipital condyles, uniting in a deep notch on the middle line of the superior surface. Thus the supraoccipital region is deeply concave. The mastoid processes are stout, descending to a little below the line of the inferior borders of the occipital condyles. They present a deep fossa on the superior part of the external side, which doubtless marks the sutural separation of the paramastoid from the mastoid portions. The latter is continuous above with the prominent inferior border of the temporal fossa, which overarches the *meatus auditorius externus*. No tuberosities nor horn-cores appear on the superior surface of the skull. The superficial layer of bone on the posterior half has a fine reticulate rugosity. The nasal bones are narrow anteriorly, and their free distal portion is narrow, short, and rather stout, and acuminate in outline. They do not extend so far forward as the anterior margin of the palatal portion of the premaxillary bones, but reach about to the line of the point of the posterior divergence as defining the inferior border of the external nares. They are well distinguished by persistent suture. The ascending portions of the premaxillary bones are nearly vertical, and are narrow. The horizontal portions do not appear to be suturally united on the median line, but are in close contact.

A view of the skull from below shows that the condyloid surfaces are entirely distinct. A low ridge or angle extends forward from each of them, and unites with its fellow on the middle line opposite the auricular meatus. The median ridge thus formed disappears at the sphenoid cross-suture, and here there exists on each side a low tuberosity which is equally transversely divided by the suture. A little anterior to this point, the external inferior margin of the basisphenoid is produced downward and forward into a short longitudinal crest, whose anterior base is pierced by the *foramen ovale.*

The *mandibular rami* are preserved excepting the posterior portions, and support all the teeth. They are rather shallow, and exhibit the usual upward concavity of the inferior border at and behind the last molar tooth. The inner face is flat, the external convex. The symphysis is elongate, reaching to the posterior border of the second inferior premolar.

The teeth are all preserved, and in good condition. They are but little worn, and the last molars in both jaws have their posterior portions not fully protruded. The last superior molar has the usual strong anterior cingulum, but none on the external and internal borders of the crown. The anterior cross-crest is concave backward, and the posterior cross-crest is similarly concave. The anterior crest at its inner end sends a crest downward and backward, which becomes a posterior basal cingulum. This forms an angular protuberance opposite the middle of the posterior crest, and there terminates. This is different from the arrangement in *C. radians*, where this descending cingulum rises again, and is continued upward into the anterior extremity of the posterior crest. In the penultimate molar, the posterior V is large and wide, and without external basal cingulum; the anterior V is represented by a conic cusp, little distinct from the border of the posterior. The anterior cross-crest is very prominent, both externally and internally; its inner extremity rises into a broad obtuse cusp, which is also the termination of a strong cingulum from the posterior side of the crown. Besides this, there is a strong anterior basal cingulum, but none on the inner side. The antepenultimate molar is considerably smaller than the penultimate, but is generally like it except in the better development of the anterior external V, which is flat externally and convex internally. The premolars display the usual characteristic of a single external V rising to an acute apex, and an internal cusp rising from anterior and posterior basal cingula. No internal nor external basal cingula.

I have already given a general description of the superior canine. To this I add, that near the base the posterior cutting-edge is replaced by two ridges, which inclose a shallow groove between them. The anterior one disappears near the middle of the crown, and the posterior becomes the true edge.

The *superior incisors* are large, and the crowns have a longitudinally oval outline. They are marked with a ridge on the anterior internal aspect, which is so strong on the second and third as to give them a triangular section. They have no external basal cingulum. The crowns of the inferior incisors are not different in outline, but they lack the external longitudinal ridge, and have a weak internal basal cingulum.

The *inferior molars* present neither internal nor external cingula. The premolars are stout and elevated; the posterior heel is scarcely recognizable on the first, which is equal in transverse and longitudinal diameters. The posterior cingulum, or heel, is as well marked on the penultimate as on the last molar, and is distinct on all the true molars. Like the third, the first and second true molars are rather elongate, and have a well-developed descending anterior crest. The enamel of all the teeth is obsoletely rugose.

Measurements of the skull.

	M.
Length from the posterior nares to the premaxillary alveolar border	0.270
Length of the series of superior molars	0.148
Length of the superior true molars	0.085
Length of the horizontal portion of the premaxillary	0.065
Length from the foramen magnum to the foramen ovale	0.095
Length of the basioccipital bone to the sphenoid	0.045
Vertical length of the mastoid process	0.030
Width of the supraoccipital region	0.080
Width of the anterior nares	0.044
Width of the palate at the last molars	0.039
Depth of the mandible just behind the last inferior molar	0.055
Width of the mandible at the same point	0.034
Width of the free portion of the nasal bones at the base	0.024
Length of the last upper molar	0.030
Width of the same	0.037

Length of the penultimate molar	0.033
Width of the same	0.030
Length of the first true molar	0.026
Width of the same	0.028
Length of the last premolar	0.017
Width of the same	0.025
Length of the last inferior molar	0.037
Width of the same	0.023
Elevation of the posterior crest of the last inferior molar	0.015
Length of the first inferior true molar	0.025
Width of the same	0.017
Length of the free portion of the canine	0.045
Diameter of the same { antero-posterior	0.020
Diameter of the same { transverse	0.011

In association with this cranium were found various bones of the skeleton. First in order comes the *atlas*, of which the greater part was obtained. It is of moderate length, and has the condyloid cup well excavated. The transverse process is horizontal and flat, its transverse extent exceeding its longitudinal. The vertebral canal enters it behind just above the posterior margin, and issues on the inferior face a little behind the anterior margin, at a point which marks the middle of the long axis of the vertebra. The end of the transverse process is not widened, but is a little thickened. Neural arch destroyed. The *axis* is preserved with the loss of its neural arch. The body is flattened and subquadrate in outline, expanding to the faces for the atlas, and terminates anteriorly in a remarkably long odontoid process. It is not keeled on the middle line below. The posterior articular face is vertical, not oblique, and somewhat concave. The faces for the atlas slope well backward. The odontoid is two-fifths the length of the axis; its superior face descends obliquely to the inferior face near the end; the inferior articular surface extends its entire length.

Measurements.

	M.
Vertical diameter of the posterior face of the atlas	0.030
Length of the base of the transverse process of the atlas	0.037
Length of the transverse process of the atlas	0.036
Longitudinal width of the atlas near the end	0.028
Total length of the axis	0.091
Length of the odontoid process	0.038

Diameter of the posterior articular face	vertical	0. 035
	transverse	0. 050
Width of the expanse of the anterior faces		0. 084
Diameter of the odontoid at the base	vertical	0. 024
	transverse	0. 022

Three other cervical vertebræ in a fragmentary condition accompanied the above. The centra of two are nearly complete, and exhibit the principal characters. They are short and wide, and somewhat oblique. The articular faces are ovals extended in the transverse direction, and the posterior is moderately concave, and the anterior proportionately convex, but not so strongly so as in the Tapir. Though resembling the cervical vertebræ of the *Carnivora* rather than those of the Tapirs, they are shorter than in the Lion or the Bear, but not so short as in *Eobasileus pressicornis* and the Elephants.

Measurements.

	M.
Length of the centrum	0. 023
Width of the articular face	0. 055
Depth of the same	0. 022
Length of another	0. 023
Width of the neural canal	0. 027
Width of the articular face	0. 056
Depth of the same	0. 029

The general characters of the fore foot have been described under the head of the genus. The best-preserved one of the present series exhibits all the carpals with four metacarpals in a single mass, somewhat dislocated. The carpals are stout, those of both rows increasing in size from the inner to the outer sides of the palm. The second and fourth metacarpals are of equal length, while the third is a little longer; the fourth is much shorter, but of equal width. The relative proportions are seen in the following measurements. The phalanges are all wider than long. The unguals are transversely expanded with gently convex margin, which terminates in a free acumination on each side. The surface is quite rugose.

Measurements.

	M.
Width of the anterior face of the lunar	0. 038
Width of the anterior face of the cuneiform	0. 045
Width of the anterior face of the magnum	0. 020

Width of the anterior face of the unciform	0.049
Width of the anterior face of the third metacarpal	0.031
Antero-posterior width of the articular face of the scaphoid	0.031
Antero-posterior width of the articular face of the cuneiform	0.036
Antero-posterior width of the articular face of the unciform	0.034
Length of the anterior face of the lunar	0.018
Length of the anterior face of the cuneiform	0.018
Length of the anterior face of the magnum	0.014
Length of the anterior face of the unciform	0.022
Length of the second metacarpal	0.071
Length of the third metacarpal	0.076
Length of the fourth metacarpal	0.070
Length of the fifth metacarpal	0.058
Width of the distal end of the third metacarpal	0.030
Width of the distal end of the fourth metacarpal	0.029
Width of the distal end of the fifth metacarpal	0.030
Length of a proximal phalange	0.022
Width of the same	0.029
Length of an ungual phalange	0.014
Width of the same { proximally	0.016
Width of the same { distally	0.027
Depth of the same proximally	0.011

The distal portion of a radius of the same series is somewhat flattened by pressure. The shaft is wide, and presents a longitudinal angle of the superior surface near the inner margin. Beyond the expansion, the bone contracts considerably to the carpal articular face, which is small in both diameters in comparison with the size of the shaft. It is oblique, owing to the production of the extremity at the inner angle, and the superior border is recurved backward.

Measurements.

	M.
Greatest width of the shaft of the radius	0.057
Width of the distal end of the radius	0.045
Diameter of the carpal articular face { transverse	0.039
Diameter of the carpal articular face { vertical	0.018

A *femur* associated with the preceding bones is as large as that of a medium-sized horse. The shaft is not stout, and is compressed. The third trochanter is small, and marks one-third the length from the middle of the little trochanter to the condyles. The little trochanter is well marked, and the condyles are large. Head and great trochanter lost.

Measurements.

	M.
Length of the femur from the little trochanter	0. 320
Width at the little trochanter	0. 085
Width at the third trochanter	0. 067
Width below the third trochanter	0. 055
Width at the condyles	0. 092
Depth of the inner condyle (oblique)	0. 100

A *tibia* accompanying the femur presents the usual character of the distal extremity, the flat articular face, with descending internal malleolus. The shaft is quite slender, and is strikingly less robust than in the *Eobasileus pressicornis* and other species of that family. The corresponding bone of the other limb, together with the fibula, exhibits a length proportioned to that of the femur above described, and my notes state that I discovered the ilium, femur, tibia and fibula, and hind foot in their immediate normal relations. The head of the tibia presents the usual characters of the genus, one of which is the absence of prominent crest. The outer femoral face is smaller than the inner. The shaft is subround; the distal end a transverse oval in section, widest at the inner extremity. The fibula is entirely distinct from the tibia, and has a slender shaft of a broadly oval section placed transversely. The head is not much expanded, and its tibial face is very oblique. The distal end is expanded antero-posteriorly, but little externally; its astragalar face inclines at 45°, and is subround in form. The external border becomes angular below, and the angle divides a wider external from a narrow posterior distal face.

Measurements.

	M.
Length of the tibia	0. 295
Transverse diameter of the head	0. 090
Transverse distal diameter	0. 065
Antero-posterior distal diameter	0. 038
Antero-posterior diameter of the shaft	0. 030
Length of the fibula	0. 260
Antero-posterior diameter proximally	0. 025
Antero-posterior diameter distally	0. 039
Diameter of the shaft of the fibula at the middle	0. 021
Transverse diameter proximally	0. 037
Transverse diameter distally	0. 037

A second individual is represented in the collections by two fragmentary mandibular rami of a young animal, whose last molars are not yet protruded. The section of the superior canine tooth is precisely similar to that of the typical specimen, including the two ridges of the posterior cutting-edge. A penultimate superior molar displays a peculiarity in the distinctness of the cone which represents the anterior V, and is as well developed as the corresponding cusp in the first true molar in the specimen first described.

The last inferior molar tooth which furnished the description of the *Bathmodon lomas* does not differ in any important respect from the corresponding tooth in the cranium of the specimen here first described. The latter enables me to determine the identity of the *B. lomas* with the *C. molestus*. This tooth is characterized as follows: The anterior crest is much more elevated than the posterior, with its inner apex almost a cone, with anterior, thick, revolute border. The usual oblique cingulum descends from the outer apex forward. The longitudinal ridge connecting the crests is low but distinct, while the posterior cingular ridge is remarkably large. This, which constitutes one of the specific marks, is extended horizontally so as to form a broad ledge, whose border is a segment of a circle. Enamel roughened with fine ridges on all the external surfaces. Tooth well worn by prolonged use.

Measurements.

	M.
Length of the crown	0. 041
Width of the same anteriorly	0. 027
Width of the posterior crest	0. 022
Elevation of the same	0. 011
Elevation of the anterior crest	0. 024

Coryphodontes of uncertain species.

No. I.

Plate lvii, figs. 3–7; Plate lviii.

One of the most instructive series of specimens of this genus consists of the bones of one individual which were found by the writer lying exposed at the base of a low bad-land bluff, from which they had been weathered. They consist of limb- and foot-bones, and a few cervical vertebræ, and are in pretty good condition. They differ from most of the other specimens in their white color, a few only being stained. I do not describe all of these bones in detail, but figure a number of them, as I do not know which of the characters are specific in all of them.

The *atlas* is stout, and the vertebral canal is straight and horizontal. The superior base of the transverse process extends almost the entire length of the atlas, while the inferior base is shortened in front. Another cervical vertebra has the section of the centrum a transverse oval; its posterior articular face is concave, and is oblique to the horizontal axis.

The *ulna* is massive posteriorly, with a thick obliquely-truncated olecranon, which is vertical proximally and transverse at the end, but not so much expanded as in *Eobasileus.* The shaft is obliquely crossed by a flat plane, that of the radius, which thus articulates with the carpus alongside of and not behind it.

The *scapula* is thickened on its posterior edge, and at its produced and shortly truncate apex. The anterior margin just below the apex is notched, and two large nutritive foramina pierce the plate just behind the base of the spine, one opposite its proximal end, the other an inch higher up. The terminal part of the scapula is strongly rugose.

The head of the *humerus* is large, and the greater tuberosity well developed; it is injured, and the lesser tuberosity is broken off. The humeral crest is stout and twisted just at the distal end; below it, the section of the shaft is triangular. The distal end of the humerus has a massive, truncate, epicondyle, which is separated from the condyle by a rotular keel. The opposite end of the condyles is not bounded by a keel, nor is the surface anywhere angulate. The measurements indicate the characters of the carpals, which nearly resemble those of other species. The third and fourth metacarpals preserved are as stout as those described under *C. molestus*, but are shorter. They are dilated proximally, and deeply impressed by the ligamentous fossæ. The carina of the distal articular end is obsolete.

The head of the *femur* exhibits a deep *fossa ligamenti teris;* the shaft is flattened, and the third trochanter very low. The patella is remarkably elongate, the lower end being produced an inch beyond the articular faces, and there obliquely truncated. The inferior half of the bone is narrower and thinner than the superior half. Of the femoral surfaces, the interior is nearly twice as long as the external, which only covers the proximal two-fifths the length of the inner face, although it is the wider. The distal end of the tibia is massive, and exhibits the usual flat astragalar face. The distal end of the fibula is also unusually massive, presenting inward the usual extensive oblique area as broad as long, and divided into three facets, two proximal, one of which is the larger, and a distal for the calcaneum, which is the smallest. The astragalus is broader than long, and the superior face is slightly concave. The anterior and posterior inferior faces have planes nearly at right angles. The former is divided into the cuboid and navicular facets by a tuberous projection. The calcaneum is short and flat, with a slender posterior free portion of subround section. Its proximal portion below the articular faces is deeply excavated by ligamentous pits. The cuboid bone is wider than thick antero-posteriorly, and thicker than long. Its outer portion thins away to a longitudinal edge. The calcaneal facet is larger than the astragalar, and is transverse, while the latter is antero-posterior. These faces make a strong angle with each other, the astragalar being parallel with the metatarsal face of the bone. The latter is wider than deep, and forms one slightly concave plane, in which the two metatarsal facets are distinguishable. The inner of these is very large; the outer incloses about half its area. A portion only of the navicular is preserved. It is a thin bone with a sharp lateral margin, and the metatarsal facets well defined. The superior face is slightly concave.

Measurements.

	M.
Vertical diameter of the axial facet of the atlas	0.039
Length of the neural arch of the atlas	0.040
Length of the superior base of the transverse process of the atlas	0.037
Vertical diameter of the vertebral canal of the atlas	0.010
Vertical diameter of the centrum of a cervical vertebra	0.040
Transverse diameter of the centrum of the same	0.065
Length of the glenoid cavity of the scapula	0.075
Width of the glenoid cavity of the scapula	0.062
Distance from the glenoid cavity to the base of the spine	0.026
Width of the scapula at the superior end of the spine	0.115
Length of the scapula from the superior end of the spine to the apex	0.053
Width of the distal trochlear surface of the humerus	0.066
Transverse diameter of the internal tuberosity of the humerus	0.033
Short diameter of the head of the humerus	0.075
Long diameter of the shaft of the humerus at the inferior extremity of the crest	0.064
Short diameter of the shaft of the humerus at the same point	0.040
Diameter of the ulna beyond the middle of the shaft, transverse	0.045
Diameter of the ulna beyond the middle of the shaft, vertical	0.033

Diameter of the olecranon at the base	transverse	0.027
	vertical	0.060
Diameter of the olecranon at the end	transverse	0.050
	vertical	0.032
Diameter of the scaphoides	transverse	0.034
	antero-posterior	0.048
Diameter of the lunar	transverse	0.040
	antero-posterior	0.051
	longitudinal in front	0.037
Diameter of the cuneiform	transverse	0.037
	antero-posterior	0.057
	longitudinal in front	0.016
Diameter of the unciform	transverse	0.059
	antero-posterior	0.045
	longitudinal in front	0.023
Length of the third metacarpal		0.063
Width of the same distally		0.034
Length of the fourth metacarpal		0.063
Width of the same distally		0.0[illegible]3
Diameter of the head of the femur		0.066
Transverse diameter of the shaft of the femur at the third trochanter		0.071
Transverse diameter of the shaft of the femur below the same point		0.064
Antero-posterior diameter of the shaft of the femur at the latter point		0.037
Length of the patella		0.1[illegible]8
Width of the same		0.063
Diameter of the shaft of the tibia distally	transverse	0.045
	antero-posterior	0.035
Antero-posterior diameter of the astragalar face of the tibia		0.051
Greatest diameter of the shaft of the fibula distally		0.037
Antero-posterior diameter of the astragalar face of the fibula		0.060
Vertico-oblique diameter of the astragalar face of the fibula		0.050
Transverse diameter of the proximal end of the calcaneum		0.060
Transverse diameter of the distal end of the calcaneum		0.028
Vertical diameter of the distal end of the calcaneum		0.025
Vertical diameter of the cuboid facet of the calcaneum		0.023
Width of the astragalus		0.079
Depth at the outer border		0.018
Depth to the angle between the cuboid and the calcaneal faces		0.041
Transverse diameter of the cuboid face		0.029
Diameter of the cuboid	greatest longitudinal in front	0.024
	transverse	0.051
	antero-posterior	0.036
Diameter of the navicular	greatest longitudinal in front	0.012
	antero-posterior	0.035

Coryphodon No. II.

Plate lviii, fig. 9; Plate lix; Plate lx.

A number of elements of a skeleton of a *Coryphodon* were found in the bed from which the *C. latidens* and *C. molestus* were obtained. They were in immediate association with the bones of the latter, all having been taken out successively; those to be here described on the 16th and 17th of October, 1874, those of *C. molestus* on the 22d and 23d, and those of *C. latidens* on the 24th. All of these are of a reddish color, and are invested with a thin coating of the matrix, which can rarely be removed without taking with it a part of the superficial layer of the bone. It is not certain that some of these bones may not belong to the *C. molestus*, but the different proportions of the fore foot show that the individual, and probably the species, are different.

The remains in question include a left humerus, a left ulna and radius, and a left fore foot, which probably belong together; also a right femur and patella, a right tibia and fibula, and a right hind foot, which are parts of one limb; also a series of caudal vertebræ. The limb-bones are at some points distorted by pressure, but are elsewhere of normal form.

The *humerus* displays the large greater and lesser tuberosities separated by the deep bicipital groove. This groove is defined on the shaft in front by the crest, which is not very prominent. The shaft is rather slender, giving a much more elongate form than in the American Tapir. The inner distal tuberosity is not very prominent, and, on the posterior face, bounds the very deep olecranar fossa, which is not perforate.

The *ulna* is preserved in its proximal half, which displays a narrow inferior face, except below the olecranon, where it speads out. The coronoid process is the most elevated portion, and at its base the olecranon is compressed. Its superior surface rapidly descends to the transversely-expanded extremity. The outline of the extremity is obliquely rounded to the inner side. The radial facets are not separated by a notch.

The *fore foot* exhibits all the carpal and metacarpal bones, many of them adherent and but little dislocated, and a number of the phalanges, including an unguis. Their forms have been already described under the head of the genus, and the measurements express their specific proportions.

The anterior face of the magnum is the smallest in the front of the carpus, and is wider than long. That of the trapezoides is next largest, and is longer than wide. That of the trapezium is larger still, and is longer than wide; its distal end is transversely truncate, and the outer side is concave and the inner side is excavated by a fossa. The anterior face of the unciform is also concave. What I suppose to be the pisiform is an L-shaped bone, the long axis terminating in the free tuberous extremity, the transverse limb proximal, and supporting a long, narrow, and longitudinally slightly concave articular face for the cuneiform. The metacarpals are preserved, except perhaps the proximal part of the pollex. It is true that there is an undetermined proximal end of a metacarpus unreferred, but its tuberous extremity is so different from the truncate form seen in *C. molestus* and No. III, and the total length, when added to the distal portion, being greater than in No. III, I leave its position undetermined. The distal extremity shows the first metacarpus to be the smallest; the second and third are subequal and longest; the fourth is a little shorter; and the fifth just a little shorter than the fourth. Of the proximal ends, all are truncate laterally except the external sides of the No. V and supposed No. I, which are angulate externally, marking the extremity of the narrow margin of the shaft. The median inferior ribs of the distal ends of the metacarpals are obsolete. The phalanges are of the usual form. An unguis is very short, with truncate extremity and laterally-produced angles.

Measurements of the fore limb.

	M.
Total length of the humerus	0.310
Long diameter of the shaft at the middle	0.045
Long diameter of the condyles	0.055
Antero-posterior diameter of the condyles	0.058
Length of the ulna from the radial border to the end of the olecranon	0.128
Width at the radial facets	0.056
Depth at the radial facets	0.064
Depth of the olecranon in front	0.060
Depth of the olecranon at the end	0.027
Width of the olecranon at the end	0.040
Length of the proximal ends of five metacarpals in place (width of the palm)	0.110
Diameter of the lunar: antero-posterior	0.041
Diameter of the lunar: transverse	0.038
Diameter of the lunar: longitudinal in front	0.017

Diameter of the cuneiform	transverse	0.032
	longitudinal-oblique	0.050
	longitudinal in front	0.016
Diameter of the pisiform	transverse proximal	0.040
	longitudinal	0.042
	distal (longest)	0.022
Diameter of the trapezium	antero-posterior	0.023
	transverse	0.020
	longitudinal in front	0.022
Diameter of the trapezoides	antero-posterior	0.022
	transverse	0.016
	longitudinal in front	0.022
Diameter of the magnum	antero-posterior	0.036
	transverse	0.019
	longitudinal at the middle	0.033
	longitudinal in front	0.015
Diameter of the unciform	antero-posterior	0.030
	transverse	0.048
	longitudinal in front	0.019
Length of the second metacarpal		0.065
Length of the third metacarpal		0.065
Length of the fourth metacarpal		0.060
Length of the fifth metacarpal		0.058
Distal diameter of the first metacarpal		0.020
Distal diameter of the third metacarpal		0.027
Proximal diameter of the same		0.030
Distal diameter of the fifth metacarpal		0.025
Proximal diameter of the same		0.028
Length of a phalange		0.019
Width of the same		0.024
Length of the ungual phalange		0.013
Width of the same		0.023

The inner border of the trochlear groove of the *femur* is higher than the outer, and the condyles stand well apart. The patella is in place, and displays the same inferior prolongation beyond the articular faces already described. Both tibia and fibula are a little shorter than the corresponding bones of *C. molestus*, and are not in any respect more slender. The hind foot is the most complete which has ever been found, and has been represented in a diagrammatic sketch on page 28 of the Systematic Catalogue of the Vertebrata of the Eocene of New Mexico. All the tarsal bones are present, and all the metatarsals except the distal half of the fifth. All the phalanges of the third and fifth digits are present, and some of those of the second and fourth.

The *calcaneum* is somewhat flattened by pressure. It is as broad anteriorly as long, and the free portion is turned inward, with a concavity on the inner side. It is flat, and the inferior surface is roughened for ligamentous insertions. The inner anterior expansion has its astragalar facets in two (an anterior and a posterior) transverse planes, while the astragalar plane of the exterior part of the calcaneum is the anterior, though posterior in position. The astragalus is broader than long, presenting an anterior acumination inward. The tibial face is continuous and slightly concave in both directions. Of the two distal faces the navicular is the larger, extending to the internal apex, while the cunei-cuboid face does not extend to the external margin of the astragalus. While the astragalus is unaltered, the cuboid has been somewhat depressed, like the calcaneum. It does not, however, thin out to an acute border, as in the skeleton described just preceding the present one as No. I. It has a short, rounded, straight, external border, shorter than the internal. The calcaneal and astragalar facets make a strong angle with each other, while the two distal metacarpal facets are nearly continuous. The remaining bones of the foot have not been modified by pressure.

The *ectocuneiform* is the largest of the cuneiforms, and is chiefly in proximal contact with the astragalus. Its navicular and cuboid facets are subequal. Its anterior face is quinquelateral, and a little broader than long. The navicular is a flat thin bone of an L-shape, the antero-posterior limb being next to the ectopterygoid. The cuneiform faces are distinct, and the internal is large. The mesocuneiform is larger than the entocuneiform, and its anterior face is a little wider than long. The corresponding face of the entocuneiform is longer than wide. The last is a wedge-shaped bone with triangular horizontal section.

The proximal ends of the *metatarsals* are subtriangular in form excepting those of the first and fifth. That of the fifth is bilobate posteriorly; all are nearly truncate, the third only presenting some convexity to the ectocuneiform. The second and third are subequal, the third exceeding; the fourth is distinctly shorter; and the fifth is about half as long as the third. The distal inferior keel is obsolete. The phalanges are wider than long; those of the second place being merely transverse, very open V-shaped pieces. The ungual phalanges are, as usual, wider than long, with a narrow distal margin and produced lateral angles.

Measurements of hind limb.

		M.
Elevation of the inner side of the femoral condyles		0.088
Width of the femoral condyles		0.080
Length of the patella		0.110
Width of the same		0.054
Length of the tibia		0.284
Length of the internal malleolus		0.015
Width of the same		0.038
Length of the fibula		0.240
Width of the proximal face of the fibula		0.035
Width of the distal face of the fibula		0.040
Length of the calcaneum		0.081
Width at the base of the free portion		0.031
Width anteriorly		0.072
Width of the cuboid facet of the calcaneum		0.028
Diameter of the astragalus	transverse	0.075
	antero-posterior	0.050
	external longitudinal	0.020
	median longitudinal	0.036
Width of the cunei-cuboid facet of the astragalus		0.022
Width of the navicular facet of the astragalus		0.042
Length of the cuboid	inner border	0.020
	outer border	0.013
Width of the cuboid		0.040
Diameter of the ectocuneiform	antero-posterior	0.024
	transverse	0.025
	longitudinal in front	0.020
Diameter of the mesocuneiform	antero-posterior	0.028
	transverse	0.022
	longitudinal in front	0.016
Diameter of the entocuneiform	antero-posterior	0.021
	transverse	0.016
	longitudinal in front	0.025
Length of the navicular in front		0.012
Diameter of the navicular	transverse	0.047
	antero-posterior internal	0.044
	antero-posterior median	0.019
Length of the third metatarsus		0.065
Length of the fourth metatarsus		0.056
Length of the fifth metatarsus		0.035
Proximal transverse diameter of the first metatarsus		0.023

Proximal transverse diameter of the second metatarsus	0.021
Proximal transverse diameter of the third metatarsus	0.021
Proximal transverse diameter of the fourth metatarsus	0.027
Proximal transverse diameter of the fifth metatarsus	0.022
Distal diameter of the second metatarsus	0.026
Distal diameter of the third metatarsus	0.028
Distal diameter of the fourth metatarsus	0.028
Distal diameter of the fifth metatarsus	0.022
Length of the first phalange of the third digit	0.015
Length of the second phalange of the third digit	0.011
Length of the third phalange of the third digit	0.014
Length of the first phalange of the fifth digit	0.013
Length of the second phalange of the fifth digit (unguis)	0.013
Width of the second phalange of the fifth digit (unguis)	0.019

The *caudal vertebræ* indicate a well-developed tail of moderate length. Parts or wholes of nine vertebræ are preserved, all without neural arch. None of them present such elongate proportions as in the corresponding parts of the *Creodonta* or *Carnivora*, but the stoutest are longer than broad. The inferior face of the centrum is characterized by the presence of two lateral angles at the posterior extremity, which are connected by a plane which truncates the lower surface behind. This surface is concave antero-posteriorly. The centra of the larger vertebræ are especially characterized by the presence of a tuberous transverse process at the superior lateral angle of the anterior face, and a short flatter transverse process near the posterior extremity, and opposite the middle of the articular extremity. These processes are separated from each other by a deep notch. The anterior articular face is subtriangular; the posterior, subquadrate.

Measurements.

	M.
Length of the three median caudal vertebræ	0.071
Length of the first of the three	0.025
Diameter of the anterior articular face { transverse	0.023
Diameter of the anterior articular face { vertical	0.016
Diameter of the centrum at the lateral notches	0.013
Length of a more distal caudal	0.021
Diameter of the articular face of the same	0.012
Diameter of the articular face of a small distal vertebra	0.008

Coryphodon No. III.

Plate lxi.

The specimen referred to under this head was found at the same time and at the locality which furnished the *Coryphodon molestus*. It represents a different individual, and of smaller size than those previously described. The bones are moreover characterized by their black color, which, while not conclusive as an index of identity (or pertinence) to one individual, indicate a similarity of situation, which adds to the probability that such is the case. The bones are supposed clavicles, nearly all the elements of a right fore foot, broken scapulæ and femur, and three tarsal bones.

The *clavicles* are the only ones obtained in any species of *Coryphodon*. Each one is rather slender and slightly curved. The shaft is compressed, with one edge narrower, so as to give an ovoid section. The extremities are considerably enlarged into subglobular masses, with oval cross-section and truncate ends. Neither clavicle is preserved entire. The fore foot is represented by all the carpals, with the trapezium fortunately attached to the first metacarpal, and all the metacarpals with the pollex and third digit complete with other phalanges. The carpals present no peculiarities as compared with those of other species, excepting that the exposed anterior face of the magnum is more transverse. The digits display no marked peculiarities. The fifth metacarpal is about two-thirds as long as the third, which is nearly twice as long as the first. The basal facet of the first metacarpus is squarely truncate; the first phalange is relatively a little longer than the corresponding one of the other digits, and the ungual phalange is also a little longer; the entire pollex is turned outward, the inner side of the two phalanges being a little longer than the outer, the entire digit being two-thirds as long as the third, which is a little longer than the second.

Of the *hind foot*, only the calcaneum, astragalus, and navicular remain, of which the first two exhibit some peculiarities. The calcaneum is L-shaped, but the transverse anterior portion is shorter than the long axis of the bone. The posterior free portion is moreover not depressed, as in Nos. I and II, but is compressed, although short and swollen at the extremity. There is no horizontal surface on the external side for the extremity of the fibula. The astragalus is generally like those already described, but is longer, the antero-posterior diameter equaling the transverse. The two antero-inferior facets are very unequal, the navicular being the larger, and they are separated by a considerable tuberous angle.

Measurements.

		M.
Diameter of the shaft of the clavicle		0.015
Diameter of the articular extremity of the clavicle		0.025
Diameter of the glenoid cavity of the scapula		0.060
Long diameter of the scaphoid		0.040
Long diameter of the lunar		0.045
Width of the cuneiform		0.050
Diameter of the trapezoides	antero-posterior	0.025
	transverse	0.017
	longitudinal in front	0.022
Diameter of the trapezium	longitudinal in front	0.021
	transverse	0.020
Length of the first metatarsal		0.031
Length of the second metatarsal		0.059
Length of the third metatarsal		0.065
Length of the fifth metatarsal		0.050
Length of the first digit		0.060
Length of the third digit		0.107

It will be observed that this fore foot differs from that referred to the *Coryphodon molestus* in the less relative width of the fifth metacarpus, resembling closely in this respect the corresponding bone in the foot referred to No. II. The present animal, although of the same size as No. II, has the epiphyses of the metacarpals coössified, while in the latter they are separate.

Coryphodon No. IV.

Plate lxii; Plate lxiii, figs. 1–4.

This individual consists of loose pieces which I found lying together, December the 7th, 1874, and includes lumbar vertebræ, humerus, ilium, femur, fibula, and astragalus. The pieces are free from distortion, excepting the ilium and the proximal part of the humerus, and are worthy of notice on this account.

The *lumbar vertebræ* have the centra somewhat broader than long, and depressed so that the articular faces are transverse ovals. The posterior face is concave, the anterior slightly convex at the borders, and a little concave medially. The neurapophysis stands on the anterior two-thirds of the centrum, and its section is a stout oval; the neural arch is capacious.

The anterior zygapophysis does not project much beyond the centrum, and is concave on its inner face, so that its superior portion looks inward, and its inferior portion upward. The inferior surface of the centrum is penetrated by foramina, of which one on each side is conspicuous for its large size.

The *right humerus* exhibits a prominent twisted crest, which ceases opposite to the point of origin of the external marginal ala. The latter is also twisted forward to the external epicondyle, which is as prominent as the inner epicondyle, but less abruptly defined above and below. The latter is not so prominent as in most of the *Creodonta*, but both tuberosities are large. There is no arterial foramen. The olecranar fossa is wide and deep, but not perforate; the radial fossa is shallow. The condyles are hourglass-shaped and without ridges; the inner extremity is bounded by a prominent acute border; the external is obtusely rounded.

The *left ilium* has its thin borders broken away. It is characterized by the width of the peduncle and expanse of the crest. The anterior inferior spine is an acute crest, as in many existing Ungulates; and there is a low tuberosity on the inner side at the superior portion of the pectineal line. The groove for the attachment of the sacrum is elongate, and bounded by prominent ridges; its plane is not in that of the expansion of the ilium, as in many Ungulates, but is oblique to it, so that a section of the ilium through its middle is triangular, the line bounding the internal side being about six-tenths the length of that bounding the inner side. The rather slender pubis has an oval section.

The distal ends of the *femora* are undistorted. They show the usual smaller size of the outer condyle, and the equal width of the intercondylar fossa. The fibula, while of the same diameter as those already described, is shorter. The inner face of the shaft is flattened in the inferior two-thirds; the external margin is acute. The inferior extremity has the usual expansion, and is divided into two subequal faces externally by a longitudinal angle. The inner face is gently concave, and readily admits of a gliding movement on the external convex border of the astragalus, which fits it. The superior extremity of the fibula is less expanded. The astragalus presents no peculiarities not seen in the other species. Its superior surface is a little wider than long, and is very slightly concave.

Measurements.

		M.
Length of a lumbar centrum		0.045
Diameter of the same	transverse	0.068
	vertical	0.040
Diameter of the neural canal of the same		0.024
Diameter of the humerus at the tuberosities		0.110
Diameter of the humerus at the crest		0.055
Diameter of the condyles of the humerus	transverse	0.064
	antero-posterior	0.050
Transverse diameter of the acetabulum		0.065
Transverse diameter of the peduncle of the ilium		0.076
Transverse diameter of the sacral fossa		0.050
Transverse diameter of the base of the ischium		0.032
Length from the acetabulum to the sacral fossa		0.115
Diameter of the distal end of the femur	transverse	0.088
	antero-posterior	0.079
Diameter of the shaft inferiorly (transverse)		0.048
Length of the fibula		0.230
Transverse diameter of the distal facet of the same		0.038
Transverse diameter of the superior face of the astragalus		0.054
Antero-posterior diameter of the superior face of the astragalus		0.040
Vertical diameter of the external face of the astragalus		0.016

This animal was entirely adult. It is marked *Y* in the field-notes.

METALOPHODON, Cope.

Proceed. Amer. Philos. Soc., 1872, p. 542 (Sept. 20); Ann. Report U. S. Geol. Surv. Terrs., 1872, 589 (1873).

Metalophodon armatus, Cope.

Report, loc. cit., p. 543.

The only portion of a skeleton which I can refer to this genus is a fragment of a large superior canine tooth, which is not sufficiently characteristic to enable me to make a final specific determination. The crown is much compressed, so as to be lenticular in section near the apex, and the anterior and posterior edges are acute. A short distance above the apex on the exterior side, another ridge rises into prominence, and continues to near the base of the crown. It becomes as prominent as the inner or apical ridge, and incloses with it a wide and strongly concave groove. The inner face of the crown of the tooth is the widest, the outer the most convex. The enamel surface is longitudinally minutely ridged striate, the striæ turning outward to the cutting-edges. The tusk belonged to a rather larger animal than the type of *M. armatus*, and one probably equal to the *Coryphodon radians*. Its form approached that of the canines of the *Dinocerata* more nearly than do those of *Coryphodon*.

Measurements.

	M.
Long diameter of the tusk	0.026
Short diameter of the same	0.014
Diameter of the anterior groove	0.009

PERISSODACTYLA.

This, the second order of hoofed Mammals found in New Mexico during the Wasatch Eocene period, was represented by a moderate list of species, all of small size. Some of these were very numerous in individuals, so that their remains constitute, with those of Coryphodons, a characteristic feature of the collections made by the expedition.

MENISCOTHERIUM, Cope.

Report Vert. Foss. New Mexico, U. S. Geog. Survs. W. of 100th M., 1874, p. 8.

Char. gen.—Molars three, with two continuous external crescents and two internal tubercles, except on the posterior, where there is but one, the anterior conic tubercle. The posterior tubercles on the other molars crescentoid in section. A well-developed crescent between the anterior tubercle and anterior crescent, and an oblique crest extending from the latter to the adjacent horn of the posterior inner tubercle. Two external crescents on the last premolar.

This genus presents a curious combination in the structure of its molars of the character of *Palæosyops*, *Hyopotamus*, and *Hyracotherium*. It is exceptional among the Ungulates of the same fauna in the number of crescents of the molars, being the only genus of the American Eocene period yet discovered, which we know to possess the crescent between the inner and outer anterior tubercles of the superior molars. Such genera are numerous in the Eocene of Europe. It is to be regretted that nothing but the superior molar teeth of this genus is known.

Meniscotherium chamense, Cope

Plate lxvi, fig. 18.

Report, loc. cit., p. 8.

Char. specif.—Last molar with the oblique inner posterior crest terminating at the posterior margin of the crown. Prominent external ribs at the point of connection of the external crescents of the crown. No cingula; enamel entirely smooth.

Measurements.

	M.
Length (externally) of the last four molars	0.029
Length of the true molars	0.022
Length of the penultimate	0.009
Width of the same	0.010

This animal was about the size of the Raccoon, and probably had the habits of the Tapirs.

OROTHERIUM, Marsh.

Amer. Jour. Sci. and Arts, 1872 (*separata*, p. 26).

This genus has been heretofore known only from partial descriptions of the dentition of the inferior series. In these, it has been stated that the fourth premolar resembles the first molar in structure, and that the anterior inner cusp of the molars is slightly bifid. I have seen a number of specimens possessing one or the other of these characters, which are in other respects identical with the genus *Hyracotherium.* I find the resemblance of the fourth premolar to the first true molar to consist in the presence of two tubercles on the posterior part of the crown; in *Hyracotherium*, there is but a single one, which sends an angular crest forward. The bifid or double character of the inner anterior cusp is in some instances so little marked as to lead me to regard it as of secondary importance in the definition of this genus. In the *O. cristonense*, the cusps do not display this character. The genus *Oligotomus*, Cope, differs from *Orotherium* in the possession of one less inferior premolar, while in the details of the inferior molars they are alike.

In the *O. cristonense*, the two rami of the mandible display almost the entire dentition of those bones. The molars are 4–3, with considerable diastemata between the canine and first premolar, and the first and second premolars. The canines are large, divergent, and acute, leaving space between them for several small incisors, which are lost from the specimen. The symphysis is long and coössified. The first premolar possesses a simple crown and a single root; the other molars are two-rooted. The second premolar has a low acute heel, and no cusp accessory to the main one; the third has a more elevated acute heel, and an accessory anterior cusp. The fourth has two posterior cusps, the outer continued forward as a crest, and two anterior cusps much larger than the others. In the remaining molars, the cusps are subequal; the inner subconical, the outer sending a low oblique crest forward and inward. The last molar has a prominent heel.

A specimen of what I suppose to be the *O. vintanum* embraces the third, fifth, sixth, and seventh superior molars, the fifth, sixth, and seventh inferior molars, and numerous bones of the skeleton. The superior molars do not differ in their characters from those of *Hyracotherium.* The crown supports four principal conic cusps, of which the external are flattened and connected at the base. Between the posterior part of each of these and the corresponding inner cusp is a low tubercle, which is more or less united with the latter. There is a cingular cusp at the anterior base of the anterior outer cusp. The third premolar has two approximated outer crests, and an internal one with low connecting ridges. The palate is deeply excavated as in other *Perissodactyla.*

The humerus of this specimen is a slender bone, much more so than the femur, and has a smooth oval shaft. The head is large and much incurved; it possesses a prominent deltoid ridge and a wide bicipital groove. The condylar fossa is entirely perforate. The trochlear character of the condyles is well marked, there being an angular internal marginal crest, and a rounded one at the other end within the margin. This is the "trochlear crest" of the more specialized *Mammalia,* and it is important to note that this is the only genus of the New Mexican fauna in which I have observed its presence, although it doubtless exists in the three other genera of *Perissodactyla* here enumerated. The external epicondyle is not prominent. The head of the radius is a transverse oval without inferior angle, and, in accordance with the humeral condyles, the horizontal section of the articular face is an open sigmoid. The distal end of the radius is narrow, confirming the impression that the fore limb is lighter than the hinder; it displays a quite small face of contact with the ulna. The olecranon is much compressed.

The femur is moderately stout, and the trochlear groove for the patella is elevated, with the bounding crests subequal. The inner condyle is a little more produced than the outer. The external or third trochanter is well developed, as are the great and small trochanters. The distal end of the tibia has the usual Perissodactyle structure. It presents a well-marked inner astragalar groove, and the inner half of the still deeper external groove, which was completed by the lost fibula. The three angular tuberosities, external, anterior, and posterior, are well marked; on the inner side of the end of the tibia, just in front of the external tuberosity, there is a marked tendinous groove. The calcaneum has lost its cuboid facet, but the remainder of it nearly resembles the corresponding parts in the Tapir. The free shaft is rather elongated and compressed, and is not flattened on the inferior face. The inner superior facet stands on a transverse tuberosity, while the front of the tuberosity, which was applied to the astragalus behind, supports a facet.

The general structure is Tapiroid. The number of digits remains unknown.

Of the three species known to me, two are about the size of the Red Fox, while the third, *Orotherium lœvii*, is smaller.

Orotherium cristonense, Cope.

Plate lxv, figs. 13–14.

Orohippus major, Marsh, Cope, System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, pp. 20–21.

Both mandibular rami nearly complete, from the posterior end of the last molar to the end of the symphysis, represent this species. The portion of the jaw supporting the molars is of moderate stoutness, but the ramus contracts vertically in front of the second premolar, and is moderately concave transversely between the first premolar and the canine. The symphysis is shallow and posteriorly horizontal; its length is equal to that of the three true molars.

The canines are large and curved, and much produced upward and slightly outward from the alveolar border. The crown is subacute, with an oval section at the base, and smooth enamel. The first premolar is about equidistant between the base of the canine and that of the second premolar. Its crown is lenticular in section, with a cutting-edge fore and aft, and no tubercles or cingula. The second premolar possesses a rudimental anterior basal tubercle; it has no external basal cingulum. There is a rudimental cingulum on the outer side of the heel of the third premolar, and an interrupted one on the outside of the fourth. The true molars possess an uninterrupted basal cingulum on the outer side. The heel of the last molar is wide; the root supporting it is continuous with that which supports the middle of the crown. The enamel is everywhere smooth.

Measurements.

	M.
Length from the incisive border to the end of the last molar	0.075
Length from the incisive border to the first premolar	0.020
Distance between the first and second premolars	0.007
Length of six posterior molars	0.045
Length of three true molars	0.027
Diameter of the canine	0.005
Width of the fourth premolar posteriorly	0.005
Width of the second true molar	0.006
Length of the third true molar	0.0116
Width of the same	0.0055
Depth of the ramus in front of the first premolar	0.009
Depth of the ramus at the first true molar	0.015
Width of the symphysis at the front of the diastema	0.014

The simplicity of the anterior inner cone of the molar teeth distinguishes this species from the two that follow.

Orotherium vintanum, Marsh.

Plate lxv, figs. 1-12.

Amer. Jour. Sci. and Arts, 1872 (*separata*, p. 26).

In the specimen of this animal already alluded to in the description of the genus, the true molar teeth of both jaws with numerous bones of the skeleton are preserved. These I found lying together at the base of a bad-land bluff, and as there is no admixture of incompatible fragments, and every appropriateness in the association of the pieces, I conclude that they are portions of one and the same skeleton. The superior true molars and the third superior premolar are marked with a continuous cingulum on the front, inner, and posterior aspects of the base of the crown. There is a distinct cingulum on the external base also, but it is interrupted between the bases of the external cusps. The anterior ridge connecting the inner with the outer cusps in the third premolar is modified into a stout, low tubercle. In the inferior molars, the inner anterior tubercle is stouter and more elevated than the others, and is connected with the outer anterior by an elevated yoke. In this point it is quite different from the *O. cristonense.* In this specimen, the heel of the last inferior molar is unusually small. In the molars of both jaws, the enamel is rather rugose, except on prominent surfaces, where it is smooth.

In the femur, tibia, and humerus, the absence of lateral curvatures is a noteworthy feature.

Measurements.

	M.
Length of the superior true molars	0.023
Length of the last superior molar	0.007
Length of the penultimate molar	0.008
Width of the same	0.010
Elevation of the same	0.006
Length of the third premolar	0.0064
Width of the same	0.0070
Length of the penultimate lower molar	0.0084
Width of the same	0.0055
Length of the third lower molar	0.010
Width of the same	0.006
Length of the femur from the little trochanter	0.077
Antero-posterior diameter of the femur at the same	0.011
Transverse diameter at the middle of the shaft	0.010
Transverse diameter of the head	0.011
Transverse diameter at the condyles	0.021
Antero-posterior diameter at the condyles	0.023
Transverse diameter of the tibia at the middle	0.009
Transverse diameter of the humerus at the middle	0.008
Transverse diameter of the trochlear surface of the humerus	0.012
Transverse diameter of the head and deltoid crest of the humerus	0.021
Transverse diameter of the head of the radius	0.011
Transverse diameter of the distal end of the radius	0.010
Vertical diameter of the distal end of the radius	0.006
Transverse diameter of the distal end of the tibia	0.012
Antero-posterior diameter of the distal end of the tibia	0.009
Length of calcaneum from the front of the inner tuberosity	0.027
Depth of the shaft of the calcaneum	0.0085

A fragment of the left mandibular ramus of another individual supports the last two true molars. The last molar has a short heel with dentellated margin on the inner side, and oblique ridge connecting it with the external cusp adjacent to it. Both molars possess a well-marked external basal cingulum, and an oblique ledge descending inward from the external anterior cusp. The penultimate molar exhibits a posterior cingulum, which presents an angle upward. Enamel slightly wrinkled.

Measurements.

	M.
Length of the last inferior molar	0.0110
Width of the same in front	0.0055
Elevation of the same in front	0.0055
Length of the penultimate inferior molar	0.0080
Width of the same in front	0.0055
Depth of the ramus at the anterior part of the last molar	0.0170

Orotherium lœvii, Cope.

Plate lxv, figs. 15-17.

Represented by a portion of the left mandibular ramus supporting three premolars and two true molars, and probably by a similar portion of the right ramus which accompanied it, and a portion of the right maxillary bone, bearing the second and third premolars, also found with it. These fragments belonged to an adult animal of smaller size than either of the preceding. The crowns of the molars are so worn as to render it impossible to decide on the character of the inner anterior cusp, but the fourth premolar possesses the inner posterior cusp characteristic of the *O. cristonense.*

The fourth premolar has two subequal elevated anterior cusps, with a pronounced basal tubercle in front, and no external cingulum. The true molars have a well-marked anterior ledge, and posterior median tubercle. There is an external cingulum between the cusps, but whether completed round the bases of the cusps is not certain from the amount of attrition which they have undergone. No trace of cingulum on the inner side; enamel smooth.

The base of the first premolar is a wide triangle with the base posterior. It has an internal but no external cingulum; the crown consists of a single cusp with an obtuse posterior cutting-lobe. The second premolar possesses a greater transverse than longitudinal diameter, and exhibits two approximated external cusps. There is a single strong internal cusp, and a smaller cusp intervenes between it and the anterior external angle. The entire base of the crown is surrounded by a narrow cingulum. Enamel nearly smooth.

Measurements.

	M.
Length of the bases of the second, third, fourth, fifth, and sixth molars	0.0285
Length of the crown of the fourth premolar	0.0055
Width of the crown of the same	0.0035
Length of the crown of the penultimate molar	0.0065
Width of the crown of the same	0.0050
Depth of the ramus at the penultimate molar	0.0150
Depth of the ramus at the second premolar	0.0120
Length of the crown of the third superior premolar	0.0050
Width of the crown of the same	0.0060
Elevation of the crown of the same	0.0035

This species is dedicated to Oscar Loew, M. D., chemist and mineralogist of the United States Geographical Surveys West of the One hundredth Meridian.

HYRACOTHERIUM, Owen.

Hyracotherium, Owen, Transactions of the Geological Society of London, 1841, pp. 203–208; British Fossil Mammals, p. 419–423.—Gervais, Paléontologie Française.

Orohippus, Marsh, Amer. Jour. Sci. and Arts, 1874, p. 247 (with description); l. c., 1872 (name only).

This genus is a characteristic type of the Lower Eocene, and has many near allies. Such are *Rhagatherium*, Pict., *Lophiotherium*, Gerv., and others. Like the former, the first premolar is separated from the second by a diastema, but, in *Rhagatherium*, the second and third premolars of the lower jaw present three cusps in a single series, a character which distinguishes it at once. The mandibular teeth are identical in structure with those of *Lophiotherium*, with the exception that in that genus the first premolar is part of a continuous series, while, in *Hyracotherium*, it is separated by a diastema from the second premolar. In comparison with *Orotherium*, I find that the last premolar is different in structure from the first true molar, while they are alike in the last-named genus. The anterior inner tubercle of the molars is simple in *Hyracotherium*, double in *Orotherium*. The superior molars described by Leidy under the name of *Hipposyus* strongly resemble those of *Hyracotherium*, but belong, as I now believe, to another genus. The inner cones are always distinct in *Hyracotherium*, but confluent in *Hipposyus;* the latter also lacks the posterior median tubercle.

Two species of *Hyracotherium* have been described by Owen from the London clay, *H. leporinum* and *H. cuniculus*, and a third has been discovered in the siderolitic beds of Vaud, the *H. siderolithicum* of Pictet. The species of both continents differ among themselves in the relative degree of development of the median tubercles of the superior molars, being in some almost conical, in others subtransverse. The former character is seen in the *H. cuspidatum*, Cope, and, according to Professor Owen's figure, in the *H. leporinum*. Every intermediate form can be observed.

The affinities of this genus have been variously interpreted, but its original reference to the *Perissodactyla* by Owen is rendered certain by the discovery of the structure of the astragalus in the *H. tapirinum*, Cope, and of the limbs in the closely-allied genus *Orotherium* (see page 253). If, as I suspect, the *Orohippus* of Marsh is identical with *Hyracotherium*, the structure of the feet described by that writer as belonging to it is also conclusive evidence to the same effect.

As regards the closer affinities of *Hyracotherium*, Professor Owen remarks (Paleontology, p. 329, 1860), in describing the nearly-allied genus *Pliolophus:* "*Pliolophus* and *Hyracotherium* form a well-marked section in the Lophiodont family, which seems to have preceded the Palæotherian family in the order of appearance, and to have retained more of the general Ungulate type than that family. This is shown by the graduation of the Tapiroid modification of the molar teeth into one more nearly resembling that of the *Anthracotheria* and *Chœropotami;* by the absence of the postero-internal cone on the ultimate premolar, by which all the premolars are, as in Artiodactyles, less complex than the true molars; by the form and position of the nasal bones; and by the structure of the external nostril." Professor Owen expresses the opinion that *Pliolophus* has three digits on the hind foot.

In a paper "On the Primitive Types of the Orders of the Mammalia Educabilia",* the writer pointed out (p. 7) that the type of the inferior molar

* Proc. Amer. Philos. Soc., extras, May 6, 1873.

teeth of *Oligotomus* and *Orotherium*, two genera nearly allied to *Hyracotherium*, require but slight modification to present the forms of later Perissodactyle genera. These are, on the one hand, *Palæosyops* and *Palæotherium*, where the inferior molars present two V's, and on the other, *Hyrachyus* and *Tapirus*, where they present two cross-crests. In a diagrammatic scheme in this paper, I placed *Oligotomus*, Cope, in ancestral relation to the Equine Perissodactyles on the one hand, and the Artiodactyles on the other. I have since shown that it is probable that the ancestral type of the Artiodactyles must be looked for in a genus possessing a less specialized character than *Oligotomus*, of the order *Amblypoda*.*

The probable ancestral relation of *Hyracotherium* ("*Orohippus*") to *Anchitherium* and the Equine series was first asserted by the writer in a phylogenetic diagram published in the Annual Report of the United States Geological Survey of the Territories for 1872, issued early in 1873. In the text, the following language is used: "An interesting annectant form is seen in *Orohippus procyoninus*, where the two intermediate tubercles which separate the inner cones from the outer V's in *Limnohyus*, are so developed as to constitute parts of an incomplete pair of transverse ridges, which disappear in front of the bases of the outer V's. They represent the oblique crests of *Palæotherium* and *Anchitherium*, and thus the genus *Orohippus* (*Hyracotherium*) furnishes a station on the line from *Palæosyops* to the Horses." Near the same time, Professor Marsh observes, under the caption of "*Orohippus*": "Additional specimens of this genus fully justify its separation from *Anchitherium*, and likewise show that it holds a most interesting intermediate position between that genus and the less specialized Mammals of the *Palæotherium* type."†

Later,‡ the writer traced the modifications in the structure of the molar teeth necessary in the course of descent from *Hyracotherium* to *Equus*. After quoting my comparison of the former genus with *Anchitherium*, from the Annual Report above cited, I continue: "A greater longitudinal

*Types of Molar Teeth of Mammalia Educabilia, March, 1874, p. 21; Relation of Man to the Tertiary Mammalia, Penn Monthly, December, 1875.

†Amer. Journ. Sci. and Arts, May, 1873.

‡Homologies and Origin of the Molar Teeth in Mammalia Educabilia, March, 1874, p. 14.

extent of these ridges or longitudinal expansion of the tubercles in the molars in both jaws, the oblique connections being still retained, gives the type of *Equus*. The elevation of the tubercles and deepening of the valleys give us the Selenodont type of superior molars again in this genus; while the lower molars only differ from that type in having the crescents alternate instead of opposite, forming the Hippodont pattern. There can be little doubt that the line of the Horses comes through *Hipposyus* (*Hyracotherium*) from the Bunodonts, rather than through *Palæotherium*, as suggested by some writers," *e. g.*, Huxley and others.

I have not been able to ascertain the number of the digits from my specimens, but, according to Marsh, some of the species observed by him possess four on the anterior limb and three behind.* It has been shown by various authors that, as we extend our view backward in time, the number of digits in the series of Equine Perissodactyles increases; the modern one-toed *Equus* and Pliocene *Hippidium* having been preceded by the Pliocene *Hippotherium* and Miocene *Anchitherium*, each with three toes. Hence, Marsh has supposed* that the four-toed *Hyracotherium* (*Orohippus*) is the oldest ancestor of the line. This conclusion was published contemporaneously with my remarks quoted in the preceding paragraph, and is confirmatory of the position which I had taken the year previously. Finally, in Marsh's article, it is observed that "an earlier ancestor of this group, perhaps in the lowest Eocene, probably had four toes on this foot, and five in front. A still older ancestor, possibly in the Cretaceous, doubtless had five toes in each foot, the typical number in Mammals." In my essay "On the Homologies and Origin of the Molar Teeth, etc.", of the same date,† it is observed: "I trust that I have made it sufficiently obvious that the primitive genera of this division of Mammals [i. e., *Educabilia*] must have been Bunodonts with pentadactyle plantigrade feet."

In a former essay, I alluded to the New Mexican species of this genus, under the name of *Hipposyus*,‡ on account of the close resemblance between

* Amer. Journ. Sci. and Arts, March, 1874.

† March, 1874.

‡ Report on Vertebrate Fossils discovered in New Mexico, 1874, p. 4 (U. S. Geog. Survs. W. of 100th M.).

their superior molars and some of those called by the latter name by Dr. Leidy. As the teeth last described by Dr. Leidy under the name of *Hipposyus* probably do not belong to the animal first referred to by him (and therefore to be regarded as the type), but to the one afterward named by Marsh *Orohippus*, I subsequently described similar species under the latter head. But no characters have, as yet, been pointed out by which to distinguish the latter from the genus previously described by Owen, whose name I therefore adopt.

Next to the species of *Coryphodon*, those of *Hyracotherium* are most abundantly represented by individuals in the Wasatch beds of New Mexico. They were doubtless the predominant type of omnivores, and furnished food for the numerous cotemporary *Creodonta*. The jaws and teeth are far more frequently found than the bones of the other parts of the skeleton, and, as usual, the rami of the lower jaws are the most numerous. The characters observed in the latter indicate, seven species, which differ very materially in size and proportions, but agree closely in general characters. They may be distinguished as follows: first, by their mandibular bones and teeth; and, secondly, by their maxillary teeth.

Mandibles.

Largest; last molar, $0^m.014$ in length; ramus, $0^m.020$ in depth at the last premolar; molars with a produced ledge in front .... *tapirinum.*
Large; last molar, $0^m.012$; ramus, $0^m.020$; ledges not prominent....... *vasacciense.*
Last molar, $0^m.011$; first molar, $0^m.0087$; ramus, $0^m.0127$; second and third premolars, $0^m.0139$ .... *sylvaticum.*
First molar, $0^m.0065$; ramus, $0^m.0130$; second and third premolars, $0^m.0135$ .... *angustidens.*
First molar, $0^m.0059$; ramus,* $0^m.0115$; second and third premolars, $0^m.0080$ .... *index.*

Superior molars.

Neither external nor internal cingulum of the crown.................. *? species.*
Cingula weak, interrupted; a vertical crest between the external lobes. *procyoninum.*
External and internal cingula present, but the internal weak .... *angustidens.*
External and internal cingula very strong; enamel rough, *vasacciense.*
Larger; outer cusps flattened.. *agile.*
Least species; outer cusps conic and well separated .... *cuspidatum.*

* The measurement $0^m.020$ in the Systematic Catalogue of the Vertebrata of the Eocene of New Mexico, p. 20, is an error.

It is evident from the above tables that I am not certainly acquainted with the superior molars of *H. tapirinum*, *H. index*, and *H. sylvaticum*, nor, with the mandibular teeth of *H. procyoninum* and *H. cuspidatum*. I have however, numerous teeth, which are not associated with those of the opposing series, and which doubtless cover nearly the entire ground of comparisons.

It would have been desirable to have compared specimens of these species with the types of those described by Professor Marsh, which belong presumably to *Hyracotherium*. But I have been precluded from access to his collections by circumstances beyond my control. On application to Professor Leidy for similar facilities with his own types, permission was granted, with the accompanying information that the larger portion had been lent to Professor Marsh, so that they also have been inaccessible to me.

Hyracotherium tapirinum, Cope.

Plate lxvi, figs. 12-16.

Orohippus tapirinus, Cope, System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 20.

Represented by mandibles with teeth, of five individuals, which exceed in size those of the species heretofore known, being larger than the smaller *Hyrachyi*. The opposite cusps of the molars are not separated by so deep a notch as in some of the other species, while the oblique ridges extending forward from the outer tubercles are well developed; the same is true of the ridge which extends from the prominent heel of the last molar. The anterior ledge is horizontal, and is bounded by a ridge which descends from the anterior external tubercle and becomes transverse. It is less marked in all the other species. Enamel nearly smooth. The external cingulum is very faint on the last molar, but becomes more distinct on the anterior molars; none on the inner side.

Measurements.

	M.
Length of the bases of the last two molars (No. 1)	0.025
Length of the basis of the penultimate molar	0.011
Width of the basis of the penultimate molar	0.008
Depth of the jaw at the penultimate molar	0.022
Depth of the jaw at the last premolar (No. 2)	0.020

Hyracotherium vasacciense, Cope.

Plate lxvi, figs. 7-11.

Orohippus vasacciensis, Cope, System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 21.
Lophiotherium vasacciense, Proc. Amer. Philos. Soc., 1872, p. 474.

Ten individuals from our collections are referred to this species, some of which embrace portions of both jaws.

Selecting as type a left mandibular ramus which supports the five posterior molars (the last broken), it may be observed that the third premolar has a strong median cusp, with a small accessory one on its inner side, and a similar one immediately in front of it. The posterior base of the crown is expanded, and supports a single obtuse cutting-edge of little elevation. The only cingulum of the tooth bounds the outer and inner sides of this part of the crown. The fourth premolar is similar, except that the two median cusps are subequal, the anterior one much reduced, and the general form stouter. It differs from the first true molar in the presence of a single posterior low cusp, which connects with the anterior by an oblique ridge. The opposite cusps of the true molars are well separated by fissures, and the anterior ledges are but slightly developed. External cingula well marked; enamel wrinkled where not worn.

Measurements.

	M.
Length of the five posterior molars	0.044
Length of the last two premolars	0.013
Length of the last two molars	0.022
Length of the penultimate molar	0.0085
Width of the same	0.0070
Depth of the ramus at the last premolar	0.0200
Depth of the ramus at the last molar	0.0220

In a specimen with the last two superior molars, the rather coarse wrinkling of the enamel is visible on the external face, although the teeth are well worn. The external tubercles are compressed cones connected by a ridge at the base. The accessory anterior external cusp is moderately developed. The cingula are distinct, but not prominent, on both the inner and outer sides.

Measurements.

	M.
Length of the last two molars	0.0160
Length of the penultimate molar	0.0085
Width of the same	0.0100

This species resembles the *H. tapirinum* in the robustness of the jaws, but the teeth are materially smaller. I originally discovered it in the Wasatch beds of Bear River and Black Butte, Wyoming; the other species from the former horizon (*H. index*) has not yet been detected elsewhere.

Hyracotherium angustidens, Cope.

Plate lxvi, figs. 1-6.

Orohippus angustidens, Cope, System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 22.

A number of jaws were obtained which resemble in general proportions those of the *Hyracotherium index*, but differ in the greater length of the series of the premolars. These teeth are nearly as large as the corresponding ones in *H. sylvaticum*, but the other teeth and the ramus of the jaw belong evidently to a smaller species, and one near to the least forms of the genus.

Selecting for description a portion of a ramus which supports the last three molars, we observe the close resemblance between the latter and those of other species. The anterior ledge and posterior median tubercle are little developed; the oblique ridges are well developed, and the heel of the last molar elevated. The molars have a strong cingulum on the outer side, and the enamel is slightly rugose. The ramus is slender.

Measurements.

	M.
Length of the bases of three true molars	0.024
Length of the penultimate molar	0.007
Width of the same	0.005
Depth of the ramus at the last molar	0.0125

In another specimen of about the same size, the bases of three premolars are preserved, and measure $0^{m}.016$ in length. In another, which supports the crowns of the third and fourth premolars, the characters are well displayed. The third has a short cusp on the posterior heel, and a sharp cusp on the inner side of the principal one. There is a rudiment of an anterior basal cusp. The anterior cusps of the fourth premolar are equal, and the angle of the outer descends to form an anterior basal cingulum. There is no trace of the inner posterior cusp which is seen in the genus *Orotherium*. External cingulum scarcely a trace. Enamel nearly smooth.

The most instructive specimen includes both maxillary bones with six molars, and fragments of the mandibles with the posterior three molars. The second premolar has two external cusps, without ridges on the outer face, and the inner face slopes inward, without internal cusp or lobe; the base is a little longer than wide, that of the other molars wider than long. On the true molars, there is a strong continuous external cingulum, but that on the inner side is only present between the lobes and as a faint fold on the base of the anterior. The external cusps are strongly convex on their outer faces, but are not ridged, nor does any ridge interrupt the deep valley between them, as in the *H. procyoninum*. The intermediate cusps are distinct, but weak; the enamel is nearly smooth. The penultimate molar is the largest. In the lower molars, the external cingulum is well marked, and there is none on the inner side. The last molar is rather shorter, and the ramus a little deeper than in the specimen first described.

Measurements.

	M.
Length of the last three inferior molars	0.022
Length of the last inferior molar	0.009
Width of the last lower molar	0.0055
Depth of the ramus at the first molar	0.0155
Length of six superior molars	0.0380
Length of the second premolar	0.0055
Width of the same	0.0045
Length of the third premolar	0.0048
Width of the same	0.0065
Length of the penultimate molar	0.0071
Width of the same	0.0088
Length of the last molar	0.0070
Width of the same	0.0071

Some of the specimens now referred to this species I formerly supposed might belong to the *H. procyoninum*,* but the discovery of the superior molars of the *H. angustidens* has enabled me to make a direct comparison, which reveals marked distinctions.

* *Hyracotherium procyoninum*, Cope.—*Helotherium procyoninum*, Cope, Proc. Amer. Philos. Soc., 1872, p. 466 (August 3); ? *Orohippus pumilus*, Marsh, Amer. Journ. Sci. and Arts, 1872 (August 7).

This was evidently a very abundant animal during the Eocene period in New Mexico.

Hyracotherium agile, Marsh.

Orohippus agilis, Marsh, Amer. Journ. Sci. and Arts, 1873, p. 407.

Some superior molars agree in size and other characters with those noticed by Professor Marsh under the above name, so far as I can ascertain.

Hyracotherium cuspidatum, Cope.

Plate lxv, fig. 18.

Orohippus cuspidatus, Cope, System. Cat. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 22.

This is the least species of the genus known to me, and is known especially from a portion of the left maxillary bone, which supports the first and second true molars. Other separated molars of the same character are not uncommon, and probably belong to the same species.

The molars are characterized by their regularly quadrate form, the anterior external angle not being produced as in most of the species. The first is also as long as broad, and is not narrowed as in others. Both molars are entirely surrounded by a strong cingulum, which is not interrupted on the inner side of the crown, and rises into a low accessory cusp at the anterior external angle. The tubercles of the tooth are conical; the outer circular in section, and slightly connected by a ridge at the base. The median tubercles are well separated from the interior, and are conical, thus differing from other species. The enamel is coarsely rugose. The malar ridge overhangs the maxillary face in a marked manner.

The specimen described is a portion of an adult animal, and the crowns of the teeth are not much worn.

HYRACHYUS, Leidy.

Leidy, Report U. S. Geol. Surv. Terrs., i, p. 59.—Cope, Ann. Report U. S. Geol. Surv. Terrs., 1872, p. 594.

Hyrachyus singularis, Cope.

Plate lxvi, fig. 17.

System. Cat. Vert. Eocene New Mexico, U. S. Geog. Survs. W. of 100th M., 1875, p. 19.

Represented by the maxillary bones and teeth of two individuals, one of which includes those of both sides of the cranium, with the molars and last two premolars. In size, this species is less than the *H. nanus*, the smallest of the genus. The third and fourth premolars have two transverse crests each, of which the anterior forms the border of the crown, and the posterior marks its middle. The supernumerary cusp at the external anterior angle of the crown is well marked in both premolars and molars; the posterior transverse crest of the molars is less elevated than the anterior as it approaches the longitudinal cusps. The latter are well joined together, and are strengthened by an external vertical rib, which extends to the apex. There is a weak cingulum on the anterior base of the crown, which passes round the inner base of the anterior internal cone, but is wanting at the base of the posterior, and very weak on the posterior and exterior bases of the crown. Enamel smooth in young as in old teeth.

Measurements.

	M.
Length of five posterior molars	0.0330
Length of the third premolar	0 0054
Width of the same	0.0056
Length of the second true molar	0.0080
Width of the same	0.0100
Length of three true molars	0.0220

This species is, as observed in my preliminary report, the only representative of the numerous *Hyrachyi* of the beds of the Bridger formation. In my exploration of this horizon in Wyoming, I obtained remains of six species in great abundance, so that the existence of a single small species in few individuals, constitutes a marked feature of the New Mexican Eocene fauna. The absence of *Palæosyops*, a genus perhaps still more abundant than *Hyrachyus*, in Wyoming, adds to the evidence in favor of the belief that the difference between the faunæ of the respective localities is due to something more than the peculiarity of geographical distribution, but points to diversity of horizon or time, as is, indeed, sufficiently indicated by the study of the stratigraphy in Wyoming. There the Green River beds contain the same fauna as those under consideration, and underlie the Bridger formation.

REVIEW OF THE CHARACTERISTICS OF THE VERTEBRATE FAUNA OF THE WASATCH EOCENE OF NEW MEXICO.

In the preceding pages, the species described are related in the following manner:

MAMMALIA			54
Perissodactyla		10	
Amblypoda		8	
Pantodonta	8		
Incertæ sedis		3	
Bunotheria		30	
Creodonta	13		
Mesodonta	11		
? Insectivora	2		
Tæniodonta	4		
Rodentia		3	
AVES			1
REPTILIA			24
Crocodilia		6	
Testudinata		16	
Lacertilia		2	
PISCES			8
Ginglymodi		2	
Plagiostomi		6	

This total number of eighty-seven species may be considered in two aspects, viz, in regard to their geological position, and their anatomical structure.

I. *The geological horizon of the Wasatch beds.*—The record preserved in these beds is doubtless more imperfect than that found in many others, owing to various physical conditions. One of these is an evident disturbance of temperature and moisture, which they have sustained perhaps in connection with the volcanic phenomena which played so important a part in New Mexico during later Tertiary times. The fossils are generally found in a fragmentary condition, and often distorted by pressure. The fractures of the surface are often of such a kind as to indicate that the bones have been in a plastic state (see the figures of *Stypolophus hians**), during which the fissures thus created in them have in many instances been filled with a siliceous limestone. This material now presents a rough external surface of great hardness, and sometimes incrusts the teeth in such a way as to render it a difficult matter to expose them. Nodules of the same material abound on the bluffs (see the Geological Report). Not unfrequently the bones are covered with an incrustation highly charged with the red oxide of iron, and this substance gives its characteristic color to a large percentage of the fossils, the others being generally black or dark brown. The light colors of our Miocene beds are almost unknown, and the bones are always much harder than these, or even than the fossils of the Bridger group of Wyoming. These facts, in connection with the reduced number of exposures of the beds, account for the comparatively small number of species obtained, and the feeble representation of certain groups, *e. g.*, the Birds, Lizards, Rodents, etc.; nevertheless, a large number of individuals were obtained, and a considerable extent of country explored, and I believe that the synopsis above given is an approximation to the expression of the characteristics of the most abundant types, or the relative numerical representation in the fauna of the different genera, orders, etc.

Comparison with the established scale of geological horizons of Europe has established the fact that the beds in question belong to the Eocene category, as I have already shown† to be true of the longer-known Bridger beds of Wyoming. It remains to collate them with the numerous subdivisions of that period. The differences between the Wasatch and Bridger faunæ have been in part pointed out in my Report on the Vertebrate Fossils of New Mexico, 1874,‡ and may be more fully stated as follows:

1. Divisions found in the Wasatch beds, not yet reported from the Bridger beds: Aves, genus *Diatryma* (?allied to *Gastornis*); Mammalia, *Tæniodonta*, *Phenacodus*, *Pantodonta*, *Meniscotherium*, most species of *Hyracotherium*.

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* Plate xxxviii.

† Proc. Amer. Philos. Soc., 1872 (February, July).

‡ Annual Report of Chief of Engineers, 1874, ii, p. 592.

2. Divisions found in the Bridger beds, not yet found in the Wasatch: Fishes, *Amiidæ;* Reptiles, *Ophidia, Anostira;* Mammals, *Mesonychiidæ, Tillodonta, Achænodon, Dinocerata, Palæosyops,* most species of *Hyrachyus.*

The Wasatch horizon of Wyoming has not yet yielded so many species of *Vertebrata* as those of New Mexico, but the close resemblance of the two faunæ may be observed in the following list of forms which I obtained at several localities:* Fishes, *Siluroids;* Mammals, *Hyracotherium* (two species), *Phenacodus, Coryphodon* (two to three species). As is well known, the Wasatch beds underlie those of the Bridger group, and we therefore look for their European equivalent in the lower part of the series. It has been already pointed out† that the absence of *Hyopotamus* and *Anoplotherium* and allied genera from the Bridger horizon precludes an identification with the Upper Eocene of Europe. The comparison of the Wasatch fauna with that of the lowest of the three divisions into which Professor Gervais has arranged the European Eocene, shows a remarkably close correspondence. This epoch, the Suessonien of D'Orbigny (Orthrocene of Gervais) includes the marls of Rilly and lignites of Soissons, the Thanet sands, London clays, etc. Fossils from these beds appear to have been no better preserved than those of the Wasatch beds of the Rocky Mountains, yet some of the genera are identical, and others closely correspondent, as follows:

Wasatch.	Suessonien.
Ambloctonus.	*Palæonyctis.*
Hyracotherium.	*Hyracotherium.*
Coryphodon.	*Coryphodon.*
Diatryma.	*Gastornis.*
Lepidosteus.	*Lepidosteus.*

As a point of difference between the beds, there may be mentioned the absence of the *Tæniodonta* from the Suessonien,—a suborder not yet known out of North America. Nevertheless, the coincidence between the American and European horizons is so close that it may become necessary to include them under one name,—that is, if a fuller knowledge of their faunæ confirms the relations here presented.

This identification is of much importance to the geology of the North

* See Rept. U. S. Geol. Surv. Terrs., 4to, vol. ii, pp. 33–39.

†Ann. Rept. U. S. Geol. Surv. Terrs., 1873, (1874), p. 462.

American Tertiary formations, since it offers a point of departure for the estimation of the relations of the preceding and succeeding faunæ. It is additional evidence in favor of the Upper Cretaceous age of the strata, which, in Wyoming and elsewhere, immediately underlie them, viz, the Bitter Creek, or, what may be the same, the Fort Union Lignite beds. It appears also that the resemblance of the North American and European Vertebrate faunæ was closer during the Suessonian epoch than at any subsequent period of Tertiary time. A divergence took place, which is strongly marked in the Lower Miocene (White River) and Upper Miocene (Loup Fork) faunæ, especially in the former. See the report on the latter in the last chapter of this volume.

The Wasatch formation includes the Green River beds of Hayden, a name which I formerly applied to the entire series. It, however, applies properly to the fish-shales of Green River, containing *Asineops*, *Clupea*, *Osteoglossum*, etc., which are probably local in their character. Professor Lesquereux* remarks that "the remains of plants at Green River are found in laminated shales, with an abundance of skeletons of fishes". These plants he had already† assigned to the Miocene period, and in the former report to Dr. Hayden, says of the flora:‡ "If it had not so many typical representatives of the Miocene of Europe, and if, at the same time, it had some of our living species, it might be considered as Pliocene." Thus it appears that the testimony of the plants conflicts with that of the animals in the question of the age of this horizon, as it does in the case of the Fort Union (Lignitic) beds, and in the same direction. Thus what I call Cretaceous and Lower Eocene, Professor Lesquereux calls Eocene and Upper Miocene Tertiary respectively. The obvious conclusion is, what is indeed already well known, that the existing flora has a greater antiquity than the existing fauna, and that this has been the case throughout the later periods of geologic time. This is consistent with the discovery, by Dr. Hector, in New Zealand, that the existing flora of that island dates from the Jurassic period.

I may add, however, in reference to the age of the Suessonian formation, with which I have parallelized the Wasatch (and Green River) epoch,

* Ann. Rept. U. S. Geol. Surv. Terrs., 1873, p. 390.
† Loc. cit., 1872, pp. 410–416.
‡ Loc. cit., 1873, p. 390.

that Professor Lesquereux enumerates it among the "Paleocene" beds in his list* of horizons containing the European fossil Tertiary flora. Whether the distinction between Eocene and Paleocene be well marked in paleobotany I do not know; but the Suessonian and other Eocene beds are not very widely separated by their faunæ. Nevertheless, the Suessonian beds of Europe are placed by Professor Lesquereux in the Paleocene by their flora, while their horizontal parallels in North America are placed in the later Miocene. It would appear that there is another, perhaps geographical, discrepancy in this case.

The teeth of Sharks described in the preceding pages are of uncertain origin. They are associated with Oyster-shells, and both have the appearance of having been transpórted; nevertheless, some of the Mammalian teeth found associated with them have a similarly rolled appearance. It therefore remains uncertain whether the ocean had for a limited time access to the Eocene lake, or whether the Sharks' teeth and *Ostreæ* were derived from the Cretaceous beds which formed its shores. Similar, and in one instance the same, species of Sharks were found in both formations; the division of the Cretaceous being No. 4, or 3 of Hayden.

The same state of things exists in the siderolitic deposits of the canton of Vaud, Switzerland. Mingled with Mammalian remains are teeth of Sharks, of which M. La Harpe remarks that their appearance does not warrant the belief that they have been transported, or are not indigenous to the Eocene fauna.

In conclusion, the classification of the North American Eocene may be represented as follows:

Name.	Equivalent.	Locality.	Characteristic fossils.
Bridger formation	Middle Eocene..	Southwestern Wyoming	*Palæosyops.* *Tillodonta.* *Dinocerata.*
Wasatch formation ...	Lower Eocene ..	Northeastern New Mexico; Southwestern Wyoming..	*Pantodonta.* *Tæniodonta.* *Phenacodus.* *Diatryma.*

II. *The structural characteristics of the Wasatch fauna.*—The general statement of the character of this fauna is found in the classified list at the

* Ann. Rept. U. S. Geol. Surv. Terrs., 1874, p. 285.

head of this section. We observe that species of all the Vertebrate classes have been obtained, excepting the *Batrachia.** Of the Fishes and Reptiles, it may be summarily remarked that, with one exception, they do not present any marked difference from those at present inhabiting the warmer portions of the globe; six of the genera being still in existence. One only of the remaining genera belongs, so far as known, to an extinct family; most of them being nearly related to living genera.

The only species of Bird, the *Diatryma gigantea*, is too little known to furnish comparison with living types; but that little indicates considerable difference from any of the latter. The Mammalian fauna is much more readily understood, and its peculiarities are many.

The absence of the *Carnivora*, *Quadrumana*, *Proboscidea*, and *Ruminantia*, of the terrestrial *Mammalia* with large and convoluted brains, may be asserted. It is probable that no species of the order *Artiodactyla* has been found; it being exceedingly doubtful whether the only genus that bears a resemblance to the Hogs in its dentition (*Phenacodus*) has any relationship to those animals. Of small-brained Mammals, the orders *Edentata* and *Chiroptera* have not been obtained; in the case of the latter probably owing to the fragility of their remains. The distinction between the clawed and hoofed orders is generally well marked; three of the former and two of the latter being present. Some of the claws preserved present the subungulate character of certain existing *Rodentia*.

Of the five Mammalian orders above enumerated as present in this fauna, but one, the *Perissodactyla*, belongs to the large-brained series. This includes only ten species of the fifty-four. On the other hand, the remaining orders, both ungulate and unguiculate, agree in the very small size of the brain, in the relatively small size of the hemispheres to the whole, and in the absence or rudimental condition of the convolutions. I have verified this fact in the Creodont *Oxyæna* and the Amblypod *Coryphodon* in the preceding pages, and Professor Gervais has shown the same character in the Creodont *Arctocyon* of the French Suessonian.

So far as these observations have gone, they coincide with those made

***These have been discovered in beds of the Green River series in Wyoming by Hayden.**

eight years ago by Prof. Édouard Lartet, of Paris. He states* "that it is the result of a number of investigations undertaken in different horizons of the Tertiary strata, that the more we follow the *Mammalia* into the antiquity of geological time, the greater is the reduction of the volume of the brain in comparison with the size of the head and the total dimensions of the body. Cuvier observed the form of the brain of the *Anoplotherium* in a cast of marl, which was consolidated within the cavity of a skull of this animal, found in the gypsum of Montmartre. He says:* 'It has little volume, and is flattened horizontally; the hemispheres do not present convolutions, but we find only a shallow, longitudinal impression on each. All the laws of analogy authorize us to conclude that our animal was greatly deficient in intelligence.' In fact, the skull of the *Anoplotherium* is six times as long as the cast of its cerebral hemispheres, and this animal, whose dimensions Cuvier compared to those of a medium-sized Ass, had a brain smaller than that of the existing Roebuck.

"I owe to the kindness of Professor Noulet, of Toulouse, the possession of a fossil cranium, in which I have found the cast of a brain still more ancient than that of the *Anoplotherium* of Montmartre, since the fragment comes from the Eocene of the *Lophiodon* of Issel. In the brain of this animal (which I call provisionally *Brachyodon eocænus*, on account of the slight elevation of the crowns of the molar teeth), there are no longer any convolutions, but only certain irregularly-defined folds; the olfactory lobes are much prolonged in front, and the cerebellum is entirely separated from the hemispheres. This brain is smaller in all respects, and less complicated in its structure, than that of the *Cænotherium* described by Gratiolet; but it must not be forgotten that the latter animal is from a formation much more recent; that is, the Inferior Miocene of Allier.

"In proportion as we approach the present period, the differences between the fossil brains and those of living species become less marked, as has also been observed with reference to the elevation of the crowns of the molars. Thus the Deer and the Antelopes of the Middle Miocene of Sansan present many convolutions, while the cerebellum remains moderately uncovered, and the olfactory lobes are very prominent. In the Superior

*Comptes Rendus, June, 1868. *Ossemens Fossiles, iii, p. 44.

Miocene of Pikermi, the brain of the *Hippotherium* (*Hipparion*) shows itself a little less rich in convolutions than that of the existing Horse; and in a fragment of a skull of a Monkey, from the same locality, which I have been permitted to examine in the museum, the cerebellum is less completely covered by the hemispheres, and the median vermis is more prominent than in the living *Semnopitheci*, of the types most nearly related to those of Pikermi. But, in order to show more clearly this disproportion of the fossil brains in relation to those of living *Mammalia*, it is necessary that comparison should be made between species of the same family, or, better still, of the same genus. It has been possible for me to verify this point by the comparison of two carnivorous animals, the living *Viverra genetta* and the extinct *Viverra antiqua* of De Blainville from the Inferior Miocene of Allier. From this, it appears that, with a cranium one-third longer and one-fourth wider than the living *V. genetta*, the fossil *V. antiqua* has not a larger brain, and that this brain, more attenuated in its frontal convolutions, does not extend so far forward. According to Gratiolet, a great development of the olfactory lobes is a character of an inferior type. In fact, the more we ascend into paleontological antiquity, the more we find the olfactory lobes to display a great development in comparison with the cerebral hemispheres."

The Wasatch horizon is lower than the oldest above referred to by Professor Lartet, and it is interesting to observe how his generalization with reference to the characters of the Mammalian brain is confirmed. The *Oxyæna forcipata* approaches more nearly to the Viverrine type than to any other form of the *Carnivora*, although separated by a wide interval. I have been able to obtain a cast of the superior and anterior portions of its cranial chamber, from which it appears that the brain possesses characters of a much lower type than that observed in the *Viverra antiqua*. The olfactory lobes are enormously developed, rising higher than the hemispheres, from which they are not only entirely free, but are separated by a constriction of their basal portions. The hemispheres are not wider at the middle than the olfactory lobes, and have therefore elongate proportions. Their superior portion is without convolutions, although not a Marsupial. The general form in *Oxyæna* is more like that of the Opossum than that of any other living animal, but is still lower in character. Its inferiority is especially seen in its small size. The mandibular ramus of the *Oxyæna forcipata* is about the size of that of the Jaguar, but the brain, even with its large olfactory lobes, is only about two-thirds as long and one-third as wide.

I have already described the brain of *Coryphodon** as the lowest and most reptile-like Mammalian brain known, for the following reasons:—The diameter of the hemispheres does not exceed that of the medulla, which is as wide as the cerebellum. The latter is small and flat. The middle-brain is the largest division, much exceeding the hemispheres in size, being especially protuberant laterally. The hemispheres contract anteriorly into the very stout peduncles of the olfactory lobes. These continue undivided to an unusual length, and terminate in a large bulbus, which is at first grooved above and then bifurcate at the extremity. The length of the hemispheres is one-fifteenth that of the cranium, and their bulk one twenty-seventh that of the hemispheres of a Tapir of the same size. Their surface is not convoluted, and there is no trace of Sylvian fissure. The region of the *pons varolii* is very wide, and exhibits a continuation of the anterior pyramids. The large size of the middle brain and olfactory lobes gives the brain as much the appearance of that of a Lizard as of a Mammal.

The grade of a Mammalian genus is expressed in the skeleton by the structure of the limbs and that of the dentition. In the former, it is seen in the movable and in the fixed articulations, and the numbers of the digits. The movable articulations are those of the shoulder, elbow, wrist, hip, knee, and ankle. The fixed articulations are those of the ulna and radius. tibia and fibula, and those between the carpal and tarsal bones respectively. If we compare the limb-bones of the Reptiles with those of the Mammals, the characteristic peculiarity of the former is seen in the absence of the crests which, in the latter, bound or divide the articular surfaces, or condyles; thus giving the joint greater firmness, and the movement greater precision. There are great differences in the development of these characters in the *Mammalia*, and the facts presented by the types of the Eocene are of considerable interest.

In the *Mammalia* with most specialized limbs, the condyles† of the

* Vide supra, p. 199.

† In the present work, this term is used for the distal articular portions, not (as in anthropotomy) for the distal tuberosities, or epicondyles.

humerus are divided into two portions by a rib, which is nearer the external than the internal margin. One of these surfaces articulates with the ulna; the inner portion, or trochlea, chiefly with the radius. In the Mammals with the least specialized limbs, this rib, which is called the intertrochlear rib, is wanting, as in the reptiles. Another character of the Mammalian humerus is the flange with acute border, in which the condyles terminate at their inner extremity, and which is present in nearly all types, but differs greatly in the degree of its prominence. The intertrochlear ridge is present in *Artiodactyla*, *Perissodactyla*,* higher *Quadrumana*, and a few of the *Carnivora*. In the Bears and Cats, it is wanting, as also in the *Proboscidia* and in the lower *Mammalia* generally. If now we consider the species of the Wasatch beds, we observe that this character is present in the ten species referred to the *Perissodactyla*, while it is absent in the forty-four remaining species. This conclusion is based on observation in the case of the *Amblypoda*, *Mesodonta*, *Rodentia*, *Tæniodonta*, and *Creodonta*.

The differences in the cubito-carpal articulation are seen in the relative shares taken in it by the ulna and radius. In the lower terrestrial Vertebrates, these shares are more nearly equal than in the higher, and some range in this respect is observable in the types of the *Mammalia*. In the Wasatch genera, it has only been observed in the *Amblypoda*, *Creodonta*, and *Perissodactyla*, and the radio-carpal articulation found to be relatively wider in the last and highest order than in the two extinct groups first named. In the *Amblypoda*, the radial articulation is as large as the ulnar.

As regards the fixed articulation between the ulna and radius, the reduction of the former bone seen in the higher *Artiodactyla* and *Perissodactyla* is unknown in this fauna, and even the Wasatch *Perissodactyla* (*Orotherium*) do not display the interlocking articulation between the two, seen in the humeral cotylus, in nearly all the representatives of the two above-named orders of the later and present periods.

In the less specialized forms of femora, the distal ends are not distinctly divided into two condyles and a rotular surface, the three being more or less continuous. Such femora are not found among the genera of the fauna under consideration. Unspecialized character in the proximal end of the

* Not well marked in *Rhinoceridæ*.

tibia is seen in the simple and low spine and obtuse or low crest, characters which especially belong to the *Amblypoda* and *Creodonta*, and inferentially to the *Mesodonta*. Fragments of tibiæ of *Orotherium* indicate a well-developed tibial crest, as in other *Perissodactyla*.

The tibio-tarsal articulation in all *Mammalia*, including those of the Eocene period, is much the larger, the fibulo-tarsal being insignificant. In the *Reptilia*, it is a fixed articulation, and hence a flat one; in the *Mammalia*, it is the ankle-joint, and more or less ginglymoid. In most recent Mammals it forms a pulley-joint with flat sides, and in most of these its superior surface is grooved, generally deeply, to receive a corresponding angular rib of the tibia. The only existing order which exhibits a nearly flat tibial face of the astragalus is that of the *Proboscidia*, and the flatness is here transverse, the antero-posterior section being slightly convex. An approach to this structure is seen in a few *Insectivora*, where the groove is shallow. In the Wasatch fauna, the only species which are known to possess the specialized or interlocking ankle-joint are the ten referred to the *Perissodactyla*. Of the remaining forty-four species, twenty-two have an ungrooved astragalus, that of the *Amblypoda* being flat, and those of the *Creodonta* being more or less convex antero-posteriorly. Of the remainder, it is almost certain that the *Mesodonta* and *Tæniodonta*, fourteen species, present similar characters.

The number of the digits is an important index to the relative position of Mammalian genera. It is well known that specialization is exhibited in the orders *Perissodactyla*, *Artiodactyla*, *Carnivora*, *Insectivora*, *Rodentia*, and *Marsupialia* by the reduction of their number. This reduction is most strongly marked in the first two orders named, where but one or two toes remain. The condition of the Wasatch Mammals in this respect is as follows: The *Pantodonta* and *Creodonta* certainly, and the *Insectivora*, the *Rodentia* and *Mesodonta*, with great probability, possessed five digits on both pairs of feet. These groups include forty-one of the fifty-four species. Of the remainder, it is probable that the ten species of *Perissodactyla* presented a smaller number of toes, as four in front, and four, or probably three, behind, as in the case of several of the genera of the Bridger group.

In dental characters, many points of interest have been presented in the preceding pages. I will recapitulate them with reference to the principles laid down in my essay "On the Homologies of the Molar Teeth of the Mammalia Educabilia".*

The two striking features in the dental characters of the known members of this fauna are the absence of the two most specialized types of Mammalian dentition, the sectorial and the Selenodont. The simple or slightly-modified Bunodont type characterizes the *Rodentia, Mesodonta, Calamodon,* and the uncertain *Phenacodus,*—that is, eighteen species; the flesh-eating forms (*Creodonta*), thirteen species, present the strong modification of the Bunodont dentition, which I have called the tubercular sectorial. Two external crescents are only developed in the ten species of *Perissodactyla.* In nine of these, the inner primitive tubercles remain, constituting the lowest ("Symborodont") type in the order; while in one (*Hyrachyus singularis*), they are continued into transverse crests, forming the "Tapirodont", or second grade of dental complication in the order. The third, or "Selenodont", as already remarked, is wanting. Another Lophodont type is presented by *Coryphodon* (the "Bathmodont"), where only one outer crescent is developed, with one outer tubercle, and no inner ones remain. The history of this peculiar dentition is unknown, but it is not more specialized than the Tapirodont type.

It thus appears that of fifty-four species, thirty-five are Bunodont in their dentition and eighteen present a low and one a middle grade type of Lophodonts. This fauna presents rather more primitive characters than that of the Bridger beds, where Tapirodonts are very abundant (*Hyrachyus*). In the White River Miocene beds, the Selenodont and sectorial dentitions appear in strong force.

In reviewing the evidence brought together in the preceding pages of this chapter, the writer is of the opinion that the type of brain shown to exist in the *Amblypoda* and *Creodonta* is as distinct from those characterizing the primary divisions of the *Mammalia* as they are from each other; and that it necessitates the establishment of a special subclass for their reception, of equal rank with the groups *Gyrencephala, Lissencephala,* and *Lyencephala.*

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* Journ. Acad. Phila., 1874.

This I have called the *Protencephala*,* with the following definition:—Cerebral hemispheres smooth, small, leaving not only the cerebellum, but the middle brain, exposed behind, and contracting into the very large olfactory lobes in front. Cerebellum very small and flat; middle brain large. This character is sustained by that of the ankle-joint, which, existing in two such distinct divisions as the *Amblypoda* and *Creodonta*, may be found to characterize the entire subclass, but this is not yet certain. It is as follows:—Tibio-astragalar articulation flat and without groove or segment of pulley.

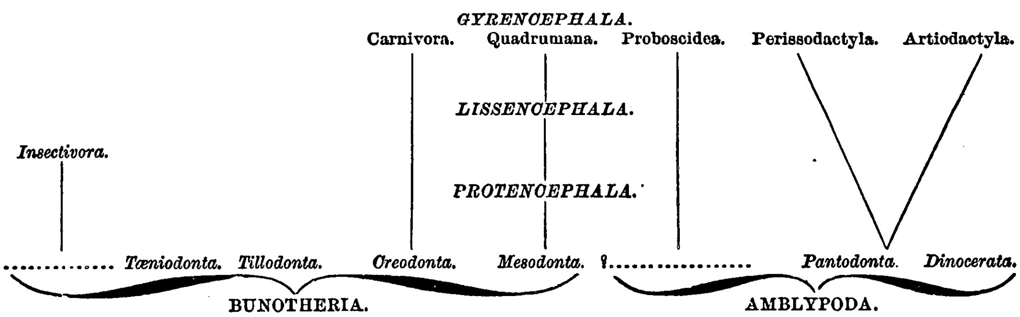
This subclass stands below the *Lyencephala* in its position, approximating the Reptiles in the points above mentioned more nearly than the latter do. It includes two orders, one Ungulate, the *Amblypoda*, the other Unguiculate, the *Bunotheria*. To the former belong the suborders *Pantodonta* and *Dinocerata;* to the latter, the *Creodonta*, and probably the *Tillodonta* and *Tæniodonta*. Whether the *Mesodonta* belong to it is not certainly ascertained, while the *Insectivora* do not belong to it, as they are rightly placed in the subclass *Lissencephala*.

The relation of these various characteristics to the question of descent is obvious, and it is believed that, through the study of this fauna, more intelligent phylogenies are possible than heretofore. In 1868, I wrote as follows† on the "law of homologous groups": "In the same manner, the development of the convolutions of the brain does not define groups of the highest rank, since it progresses chiefly during the later periods of embryonic life. . . . . Owen has endeavored to define the primary divisions of the *Mammalia* by the character of these convolutions, whereas they only define the subgroups of the orders; for we have lissencephalous (smooth-brained) Monkeys—certain Lemurs—and smooth-brained Ruminants [Artiodactyla], *i. e.*, the extinct *Brachyodon* and *Anoplotherium*, according to Lartet and Gratiolet. . . . . If now, through some topographical change, the whole series of *Mammalia* between the smooth-brained and convolute-brained were lost to us, as by the elevation of land and the absence of favorable localities or bodies of water for the preservation of their remains, we would have to study two homologous groups with the heterologous

* Proc. Amer. Philos. Soc., March, 1877.

† Origin of Genera, pp. 62, 63, 79.

terms of each corresponding with each other, as do now the genera of the *Clamatores* and *Oscines*, of the *Arcifera* and *Raniformia*, etc." The examination into the structure of the brains of the Eocene *Mammalia*, prosecuted since the above was written, has resulted in the discovery of the subclass *Protencephala*, which embraces a series of suborders which correspond in part to those now existing, which possess more fully-developed brains. The subclasses *Protencephala* and *Gyrencephala* are homologous groups in the true sense of the term. And I have shown that the imperfection of the tibio-tarsal articulation closely accompanies the undeveloped type of brain, the only order possessing the grooved astragalus being also the only one which presents the other general characters of an existing order, the *Perissodactyla*. The following table represents the ancestral relations of the *Amblypoda* and *Bunotheria* to the existing orders. As the *Perissodactyla* are the cotemporaries of these orders, I look for the discovery of the latter in still older beds, where they will appear as the ancestors of the former; and in this expectation I am encouraged by the reduction in numbers and variety of *Perissodactyla* in the older Wasatch, as compared with the newer Bridger beds. Moreover, the Wasatch *Amblypoda*, as ancestors of the existing *Ungulata*, present a type of dentition too complex to represent the direct ancestors of the Bunodont types, such as *Artiodactyla-omnivora* and *Proboscidea;* hence I look for the future discovery of *Amblypoda* with Bunodont dentition. The table is as follows, being in general features similar to one which I published in the Annual Report of the United States Geological Survey of the Territories for 1872, p. 648. It differs in the substitution of ordinal and subordinal names for those of genera, in accordance with the language used in the text accompanying it, l. c., p. 647.



CHAPTER XIII.

THE FOSSILS OF THE LOUP FORK EPOCH.

REPTILIA.

TESTUDINATA.

TESTUDO, Linn.

Testudo undata, Cope.

Plate lxvii, figs. 1–2.

Ann. Rept. Chief of Engineers, 1875, ii, p. 994.

Two species of Tortoises occur in association with the fauna described in the following pages, but their remains are mostly found in a fragmentary condition. Hence, although I procured nearly all portions of the skeleton, in no case do they belong to a single individual. None of the fragments belong to species of any other genus, unless it be *Stylemys*. I possess the caudal vertebræ and a metapodial bone of one of the species recognized, and the latter indicates in the clearest manner that it is a *Testudo*. It is wider than long, and totally different from the elongate metapodials of *Stylemys*. As already pointed out, these have the form characteristic of the *Emydidæ*, to which family the genus is to be probably referred. The caudal vertebræ are few and short, and have the procœlian character. They are without chevron-bones.

The greater part of a plastron was obtained, which I describe here, as it cannot be definitely referred to its proper species. It is quite thin medially, as in various Testudos, and is not much thickened within the fore border, as is the case in many species of that genus and of *Hadrianus*. The bridge is thin and the axillary borders are thickened, but not prominent inward. The end of a mesosternal bone is rather produced, and has not the lateral expansion seen in some Testudines and *Stylemys nebrascensis* and *S. niobrarensis*. A costal bone of uncertain specific reference, is abruptly expanded at the proximal end, indicating the narrowing of the adjacent one. Its proximal end is transversely truncate, and on the inferior side is a slightly elevated and compressed capitulum, whose long axis is in that of the costal bone. The costo-vertebral scutal suture at the intervertebral scutal suture is but little inflected; the intervertebral is straight.

A vertebral bone picked up alone, is wider than long; its form is subquadrate, with truncated angles and concave sides. The superior surface is smooth; on the middle line of the inferior is a longitudinal thin lamina, well produced downward, for suspension of the vertebra, resembling the arrangement I have shown to exist in *Stylemys*. This bone belonged to a tortoise of large size. It measures, length, $0^{m}.075$; width, $0^{m}.090$; thickness, $0^{m}.013$. In all the marginal bones preserved, they are seen to be united with the costals by a squamosal suture, and in no instance by gomphosis.

The specimen which furnishes the characters of the *Testudo undata* includes portions or wholes of eight marginal bones and one costal. The former display a strong recurvature outward, and their internal thickening is near their sutural union with the costals. The borders are acute and do not display any emargination at either the dermal or osseous sutures. The posterior part of the margin of the posterior marginals is very convex or flared upward, descending at or behind the osseous suture. Thus the fore edge has an undulating form. The caudal marginal bone is recurved, not prominent, and with a regular entire free margin. Its lateral sutures expand forward, so that its margin is narrower than its anterior portion. It is not divided by a dermal suture, consistently with the generic character. The surfaces of the bones are nearly smooth. The scutal sutures are wide, and have distinctly-defined borders. The marginal near the bridge is remarkably massive, the bridgeward suture being twice as thick as that joining the free marginal.

The size of the *Testudo undata* is as great as that of any of the species of Land-tortoises of our Tertiary formations.

Measurements.

	M.
Length of the free margin of three consecutive posterior marginal bones	0.310
Length of the last marginal bone	0.122
Width of the last marginal bone	0.135
Thickness at the middle	0.017
Thickness of the bridgeward suture of a lateral marginal	0.040
Thickness of the opposite suture of the same	0.015

Fragments of other specimens, probably of this species, present still larger proportions.

As compared with the two described species of *Stylemys*, this species differs in the strong flaring and recurvature of its marginal bones, and in the more wedge-shaped caudal marginal bone, as well as its much larger size.

Testudo klettiana, Cope.

Plate lxvii, fig. 3.

Ann. Rept. Chief of Engineers, 1875, ii, p. 995.

Indicated especially by a caudal marginal bone of a Tortoise of larger size than the one regarded as typical of the *T. undata*. It is, of course, probable that some of the fragments above described without especial reference, belong to it. The caudal bone differs from that of *T. undata* in being nearly plane, and thus wanting the recurvature or superior concavity of the corresponding bone of that species. Its form is also quite different. Its lateral sutures are nearly parallel instead of divergent anteriorly, and slightly concave; if a little expanded proximally, it contracts again to the suture for the pygal bone. This suture is a short squamosal on the outside of the caudal. The thickness of the bone is almost uniform to near the proximal suture; there an abrupt rabbet commences the plane of the thinner pygal.

Measurements.

	M.
Width, proximal	0.105
Width, distal	0.110
Length	0.110
Thickness	0.109

The free margin is slightly convex.

Dedicated to Francis Klett, of the United States Geographical Survey, to whose interest in paleontology we are largely indebted for the opportunity of studying the vertebrate fauna of the Loup Fork beds of New Mexico.

AVES.

Remains of four species of Birds were found by me in the sands north of Pojuaque. One of the species is represented by nearly all of the bones of the skeleton of one or both sides, but none of them in an unbroken condition. Another possesses the distal extremity of the humerus, proximal part of the ulna, distal end of radius, and other less characteristic pieces. The third is represented by a principal phalange.

The bones of the second species resemble very much the corresponding parts of the *Vultur umbrosus* below described. They have from three-fifths to two-thirds the linear dimensions of those of that species, and, like them, belonged to a rapacious bird. The distal extremity of the humerus differs in minor particulars from that of *V. umbrosus.* Thus the fossæ for muscular insertions on both the external and internal tuberosities are deeper, larger, and more sharply defined, as is also the case with the extensive concavity of the external face. The ulnar condyle is more globose. On the other hand, the ridges on the superior face of the proximal part of the ulna are not so strongly defined as in *V. umbrosus*, and the projecting lip next to the radius has a greater longitudinal extent. The distal end of the radius is relatively large, having three-quarters the diameter of that of the *V. umbrosus.* The marginal and middle distal internal tuberosities are less unequal in size than in that species.

The third species is represented by a first phalange. It is shorter and stouter than that of *V. umbrosus,* and was not coössified with the adjacent one. Its surface is rather coarsely striate internally and distally, and the general form is clumsy. It belonged, perhaps, to a large Gallinaceous bird and immature individual. The shaft narrows distally, and the inner side has a high, obtuse crest, which is highest near the proximal end. The distal end of the shaft is oblique inward.

Measurements.

	M.
Length	0.024
Proximal transverse diameter	0.0085
Antero-posterior diameter at the middle	0.009

RAPTORES.

VULTUR, Linn.

I have referred provisionally to this genus a rapacious Bird, in size intermediate between the Turkey Vulture (*Cathartes aura*) and the Golden Eagle (*Aquila chrysaëtos*). The beak is compressed, and the culmen, convex in the transverse direction, descends obliquely from above the middle of the tomia to the apex. The nareal openings are large, and are directed obliquely downward and forward, and are bounded within by a septum, which does not extend behind their posterior borders. They are bounded below and behind by a prominent flaring border. The symphysis of the lower jaw is straight, quite elongate, and regularly rounded in transverse section. The bones of the hind legs are less robust than those of the wings, but the tarso-metatarsus is not so slender as in the Polyborine division of the *Falconidæ*, but resemble in their robustness the true Vultures. The digits of the foot are more slender than those of the *Aquila chrysaëtos*: those of the external and middle digits are of the same length as in that species, while the inner free metatarsus is smaller in all dimensions.

Vultur umbrosus, Cope.

Plates lxvii, figs. 10–18, and lxviii.

Vultur umbrosus, Cope, Proc. Acad. Phila., 1875, p. 271; Ann. Rept. Chief of Engineers, 1875, ii, 993.

Cathartes umbrosus, Cope, Proc. Phila. Acad., 1874, p. 151; Ann. Rept. Chief of Engineers, 1874, 606.

The superior portion of the beak is contracted in line with the anterior border of the nares, showing the anterior limit of the cere. The surface anterior to this is marked with ramifying grooves for nutritive arteries. Between the nares, the superior face is but slightly convex. The nareal openings are large. The tomia of the beak are convex downward and backward from the anterior portion, which is in line with the inferior border of the nares. The posterior end of the mandibular symphysis is below a point which measures three-fifths the length from the apex of the beak to the anterior border of the nares. The apex of both jaws is broken off. As compared with the *Aquila chrysaëtos*, the symphyseal region differs, besides its greater length, in the less decurvature of the tomia anteriorly, and consequent deeper excavation to near the apex. The angular part of the mandible resembles that of the species mentioned, but has the inferior angular ridge prolonged to the angle, which it is not in the Eagle, and has a better-defined, delicately sharp masseteric ridge. The inferior part of the left quadrate bone is much like the corresponding part in *Aquila chrysaëtos.*

Measurements.

	M.
Length of the beak from the posterior border of the nares, restored	0.042
Length from the anterior border of the nares	0.029
Depth at the anterior border of the nares	0.020
Width at the anterior border of the nares	0.012
Width at the posterior border of the nares	0.018
Length of the symphysis, restored	0.016
Width at the posterior end of the symphysis	0.010
Width of the nares at the middle	0.007
Length of the mandible from the tomia to the angle	0.0150
Depth at the posterior end of the tomia	0.0095
Length of the external condyle (oblique)	0.0100
Width of the quadrate at the middle	0.0080
Depth (fore and aft) of the distal end	0.0060

Two cervical vertebræ are preserved from the middle of the series. They have no hypapophyses, and a small tubercle at the apex of the posterior emargination in the position of a neural spine. The neural canal is subcylindric, and the neural arch has two or three small acute tubercles on its external face. The arch inclosing the vertebral canal possesses the three external grooves well defined, better than in *Aquila chrysaëtos*, and the inferior is separated from the inferior face of the centrum by a small compressed tubercle. The ridges bounding the upper surface of the neural arch behind are stronger than in *A. chrysaëtos.*

An anterior dorsal vertebra has a wide, flat table, representing a hypapophysis, which is obliquely truncate on each side behind, and has no prominent apex. Between it and the anterior articular face of the centrum is a deep pit. There is a larger pneumatic pit on the posterior face on each side of the articular face, which does not penetrate the anterior wall. There is a very small capitular surface for a rib. It is probably the first dorsal vertebra. As compared with the corresponding one of the Golden Eagle, with which it agrees in size, it differs in the greater width of the hypapophysial table, and the entire absence of its median process. The two succeeding dorsal vertebræ are wanting, should the number have been the same as in the Golden Eagle,—seven. This is not certain; but the two which come next of those of the *V. umbrosus* which are preserved, present a disproportion in size, so like that seen in those occupying the same position, third and fourth from the sacrum, in the Golden Eagle, that the relations were probably the same in both species. Those preserved will then be the first, third, fourth, sixth, and seventh dorsals, with the dorso-sacral continuous with the sacrum. The third dorsal presents a hypapophysial table similar to that of the first, but differing in the more produced anterior lateral angles. Like it, it differs from the corresponding one of the Golden Eagle in its much greater horizontal extent, want of downward projection, and want of median spine. The large lateral pneumatic fossa is more median in position than in the first, and the rib-facet is higher up. The fourth vertebra is held in connection with the third by remaining portions of matrix, and differs from it in greater length of centrum and the compressed spine-like hypapophysis. The pneumatic foramen is median, and immediately at the base of the hypapophysis, lower down and smaller than in the third vertebra. The costal facet is higher up; the diapophysis is well developed, with an anterior and posterior fossa separating the wide superior and narrow inferior planes. The posterior articular face of the centrum is subtriangular in outline, with rounded angles and slightly concave sides. The sixth dorsal strongly resembles the fourth. Its anterior articular face is subquadrate in outline, a little broader than long, and differs much from that of the third in its greater vertical depth and much less excavation. The prezygapophyses have not a lateral external crest continued into the diapophyses, and the latter are more posterior in position. The hypapophysis is similarly compressed, and its basal pneumatic foramen is reduced in size. The seventh dorsal differs from the others in the absence of hypapophysis. Its inferior face is acutely carinate, and the pneumatic foramen is wanting. The diapophysis is much reduced, and there is a small pneumatic foramen at its base not found in the preceding vertebra. The posterior edge of the neural spine is grooved at the base.

The sacrum preserved includes the dorso-sacral vertebra, whose line of junction with the following ones is distinct, and the solid body formed by the coalescence of eight vertebræ, at the end of which it is broken off. The sacrum differs from that of the Golden Eagle in having six diapophyses given off behind the dorso-sacral, while only five are present in the latter. The dorso-sacral differs in shape; its centrum is compressed, and with an acute inferior angle, in which the next centrum resembles it. In the Golden Eagle, the centrum is wide, and without keel. The sacrum, though narrower, is longer than in that species, and maintains its width farther; thus it is widest at the ninth centrum, while it has already begun to contract in the Golden Eagle at the seventh. There are four consecutive caudal vertebræ and a plowshare-bone. The former are, as usual, wider than long, and have elevated neural spines notched at the extremity. They are, unlike those of *A. chrysaëtos*, without hypapophyses. The diapophyses are elongate and decurved, and have a flattened face on the upper side near the base. The plowshare-bone is remarkable for its small size as compared with the corresponding bone of the *Aquila chrysaëtos*. It is not coössified with the preceding vertebra, and the hypapophysial fissure is scarcely closed below by the opposite halves of that process. The posterior face is divided by a median vertical groove from top to bottom, and each half is flared outward, each lateral border being convex. The double hypapophysis projects downward in two straight processes, separated by a notch. A small foramen is present opposite the anterior articular face. The distal part of the superior ala is broken off.

Measurements of vertebræ.

	M.
Length of a cervical below	0.013
Length with the anterior articular face	0.014
Greatest width over the vertebral canal	0.0175
Width of the posterior articular facet	0.0065
Depth of the same	0.0045
Width at the base of the neural canal	0.0065
Length of the centrum of the first dorsal from the anterior concavity	0.0113
Width of the same below	0.0120
Depth of the neural canal posteriorly	0.006

Width of the same	0.008
Width of the centrum posteriorly	0.0045
Depth of the same	0.0055
Length of the centrum of the third dorsal from the fundus of the anterior facet	0.0130
Width of the same below	0.009
Width of the anterior facet	0.005
Vertical depth of the same	0.005
Length of the fourth vertebra	0.015
Depth of the posterior articular face	0.006
Width of the same	0.0075
Length of the seventh dorsal centrum	0.0180
Width of the same anteriorly	0.0080
Depth of the same anteriorly	0.0070
Diameter of the neural canal of the same { vertical	0.0045
Diameter of the neural canal of the same { transverse	0.0045
Length of the sacrum to the tenth centrum	0.0650
Width of the centrum of the first sacral posteriorly	0.0090
Width of the centrum of the ninth sacral posteriorly	0.0135
Combined lengths of the four anterior caudals	0.0200
Width of the centrum of the anterior	0.0060
Depth of the same	0.0035
Length of the plowshare-bone	0.0070
Width of the same anteriorly	0.0050
Width of the same posteriorly	0.0065
Depth of the hypapophysis	0.0050

Of the scapular arch, I have the proximal ends of both coracoid bones, and the distal end of one of them, and the proximal portion of the left limb of the furcula. The latter presents the coracoid facet and flat internal face, as in the Eagles, but the anterior border is less convexly arched than in the *A. chrysaëtos* and *A. bonellii.* The anterior extremity of the coracoid is as long as that of *A. chrysaëtos*, but narrower, while its humeral facet is as wide and longer. The scapular fossa is smaller and more oval. The inner angle of the distal extremity is produced, as in the Golden Eagle, but the fossa of articulation with the sternum, while as wide as that in the Golden Eagle, is only two-thirds as long. The proximal pneumatic foramina are large, and not concealed by overhanging borders.

Measurements of the scapular arch.

	M.
Length of the coracoid anterior to the humeral facet	0.0011
Length of the humeral facet	0.0150

Width of the same	0.0080
Length of the scapular facet	0.0060
Width of the same	0.0040
Transverse extent of the distal articular fossa of the coracoid	0.0150
Width of the same	0.0080
Transverse diameter of the shaft of the coracoid just above the posterior distal muscular area	0.0130
Length of the scapular facet of the furcula	0.0100
Width of the furcula at the lower end of the same	0.0140

Of the pelvic arch, only the ischia remain; that of the right side is the best preserved. It is smaller than that of the Golden Eagle, and but little less robust; it differs remarkably from that of that species, in that the sacro-ischiatic foramen extends a considerable distance posteriorly to the obturator foramen, while in the latter their posterior borders are in the same diagonal line. The ridge of origin of the ischio-femoral muscles is well developed, running parallel with the inferior border.

Measurements of the ischium.

	M.
Length	0.0410
Depth at the end of the obturator foramen	0.005
Depth at the end of the sacro-ischiatic foramen	0.009

Of the wing-parts, all the elements excepting the radius and some of the phalanges are present. The proximal end of the humerus is the largest of those of the long bones. It is slightly concave anteriorly, and the external crest is thick and recurved backward, and terminates in a hook-like truncate tuberosity directed backward and inward. The condyle or head is lenticular in section, with the anterior border flat, and the extremities acuminate, the outer separated from the external tuberosity by a deep notch. The proximal part of the shaft is convex behind, and has a shallow groove on the external side of the median ridge, between which and the external border the section is slightly concave. The distal end resembles the corresponding portion in the Golden Eagle, but the anterior supracondylar fossa is deeper and with better-defined lateral borders. On the anterior face, the muscular ridges are well defined as three longitudinal raised lines, while the surface is almost uniform in the *A. chrysaëtos*. Thus, there is a wide, open groove above the internal tuberosity in *V. umbrosus*, which is but little defined in the former species. The external tuberosity is more protuberant in the Golden Eagle, and less sharply defined anteriorly and posteriorly than in the *V. umbrosus*. The condyles are much alike in the two species, the radial projecting well inward and backward with acuminate apex; the ulnar having a greater transverse than antero-posterior diameter. The proximal end of the ulna is without olecranon, and presents the usual lip of the inner side well developed, with articular surface wider than long. The shaft is strongly grooved on the outer superior surface. Three-quarters of an inch from the proximal extremity, there commences on the external side of the shaft the ridge to which the secondary feathers were secured. The distal extremity of the coössified metacarpals is preserved, which supports the articular facet for the phalanges on the extremity of the anterior one. The distal part of the shaft of the latter presents a longitudinal groove on the external face. Altogether, the piece is exceedingly like that of the Golden Eagle. The first phalange is triangular in section near the base, being broad in front, but consisting mainly of an anterior rod and posterior ala. The anterior face becomes concave beyond the distal half. The distal articular extremity is flat and truncate; it is triangular, and has a narrow posterior ala.

Measurements of the wing-bones.

		M.
Transverse diameter of the proximal end of the humerus		0.032
Antero-posterior diameter of the head		0.010
Antero-posterior diameter at the tuberosity		0.013
Diameter of the shaft below the internal marginal crest	transverse	0.013
	antero-posterior	0.013
Transverse diameter of the distal end		0.028
Transverse diameter of the two condyles		0.020
Transverse diameter of the ulnar condyle		0.011
Antero-posterior diameter of the same		0.008
Width of the proximal articular extremity of the ulna		0.019
Diameter of the shaft of the ulna $0^{m}.04$ from the proximal end		0.011
Transverse diameter of the extremity of the coössified metacarpals		0.012
Length of the first phalange		0.037
Proximal diameter of the same		0.009
Distal diameter of the same		0.007

The femur presents no marked characters as compared with that of *Aquila chrysaëtos*, but is smaller on comparison than are some of the other bones, *e. g.*, vertebræ. The crests are all sharp. The same remarks apply to the tibia. The rough line of the external side is continued to the external distal tuberosity, which is not the case in the Golden Eagle. The distal external tubercles are less marked than in that bird, while the internal one is similar, but not so median, being near the posterior superior margin of the condyle. The anterior ligamentous bridge is similarly oblique, and spans a deep fossa. The inner plane of the distal end is not parallel to the exterior, diverging backward and inward. The condylar surface is uninterrupted. The proximal end of the fibula differs from that of the *A. chrysaëtos* in the greater transverse width and the obliquity of the articular face outward. The tarso-metatarsus presents a prominent ala along the interior margin, which is recurved posteriorly, as is also the posterior margin of the flat external side. Of the three distal condyles, the internal has less transverse extent than the corresponding one in the *A. chrysaëtos*, being but little wider than the median condyle. It terminates in the usual posterior acumination. The internal free metatarsus is like that of the species just mentioned, but is one-third smaller. The proximal phalange of the third digit is a little longer than the corresponding one in the Golden Eagle, and much more slender; the penultimate phalange is more slender and is shorter. Of the fourth digit, the first phalange is a little longer, and much more slender; the second is relatively longer than the first, while the third is of the same length as in the Golden Eagle, but not more than half the diameter. The lateral condylar fossæ are not strong, excepting in the second and third phalanges of the fourth digit. The proximal end of the first of these presents the usual oblique articular face.

Measurements of the posterior limb.

			M.
Diameter of the proximal end of the femur	transverse		0. 021
	antero-posterior		0. 017
Transverse diameter of the shaft of the femur $0^{m}.045$ from the distal extremity			0. 010
Antero-posterior diameter of the shaft of the femur at the same point			0. 011
Diameter of the distal end	transverse		0. 022
	antero-posterior	internal	0. 014
		external	0. 020
Diameter of the proximal end of the tibia	transverse		0. 020
	antero-posterior		0. 017
Transverse diameter of the shaft $0^{m}.04$ from the proximal end			0. 012
Antero-posterior diameter of the shaft at the same point			0. 007

Diameter of the distal end of the tibia — transverse	0.016
Diameter of the distal end of the tibia — antero-posterior — external	0.012
Diameter of the distal end of the tibia — antero-posterior — internal	0.013
Long diameter of the proximal end of the fibula	0.011
Transverse diameter of the middle of the shaft of the tarso-metatarsus	0.010
Antero-posterior diameter of the external side of the tarso-metatarsus	0.009
Transverse diameter of the distal extremity of the distal end of the tarso-metatarsus	0.019
Antero-posterior diameter of the median condyle of the tarso-metatarsus	0.010
Length of the inner metatarsus	0.017
Distal width of the same	0.011
Length of the proximal phalange of the third digit	0.029
Proximal diameter of the same	0.009
Distal width of the same	0.0066
Length of the penultimate phalange of the third digit, below	0.022
Length of the basal phalange of the fourth digit	0.015
Distal width of the same	0.005
Length of the second phalange of the fourth digit	0.007
Distal width of the same	0.005
Length of the penultimate phalange of the fourth digit, below	0.020
Distal width of the same	0.0038

The remains above described were found by the writer lying together on the surface of the friable sandstone from which they had weathered, and without admixture of fragments of any other animal.

MAMMALIA.

RODENTIA.

PANOLAX, Cope.

Proc. Acad. Phila., 1874, p. 151; Ann. Rept. Chief of Engineers, 1874, ii, p. 605.

Family *Leporidæ*. Superior molars prismatic, transverse, with a deep inflection of enamel on the inner side, except in the first and last. The first divided by an inflection on the anterior face; the last composed of two columns, an internal and an external, which are distinct to the base.

This genus reposes on a number of superior molar teeth, which I found lying together, but separated. I have arranged them in the order indicated by the corresponding series in *Palæolagus*. The first molar resembles that of that genus, and of *Lepus*, where it consists of a transverse shaft, with a more or less well-defined anterior groove, forming a loop on the grinding-face of the crown. The last molar is the smallest, as in those genera, but, being composed of two distinct columns, is quite different from that of the two genera named, where it consists of a single simple shaft.

The only species of this genus yet known differs in various respects, perhaps specific only, from those of *Palæolagus.* One of these is the presence of a band of cementum on the inner side of the tooth, which fills the groove. On the first molar, this band is on the anterior face, a fact which caused me to view it as the inner side in my original description, so that the crown was regarded as longitudinal, instead of transverse, which is its true position. The number of molar teeth is unknown, but, by analogy with the allied genera, should be $\frac{6}{5}$.

Panolax sanctæfidæi, Cope.

Plate lxix, figs. 16–22.

Loc. cit., p. 151; Ann. Rept. Chief of Engineers, 1874, ii, p. 605.

The crowns of the superior molars are strongly curved outward; in the intermediate molars, the outer edge is subacute, on account of a bevel of the outer part of the anterior face, which is slightly concave. In these teeth, enamel is present only on the anterior and interior aspects of the shaft, being concealed in the latter position by a narrow, but rather thick, band of cementum. The posterior face is naked. The first molar is smaller than the others, and is slightly curved backward as well as outward. Its outer border is obtuse, but narrower than the inner. The enamel covers only the internal and half of the anterior faces; in the former position, its margin at the groove is concealed by the cementum band. The last molar is equal in its transverse and antero-posterior diameters, and is strongly curved outward. The exterior column is the smaller, and is subround in section; the interior is oval and antero-posterior. Both anterior and posterior faces are grooved, but the posterior is the only enameled face, and is divided also by a band of cementum.

A penultimate molar in a fragment of the jaw is transverse in position, as in the true Rabbits.

Measurements.

	M.
Transverse diameter of an intermediate molar	0.0055
Antero-posterior diameter of the same	0.0025
Transverse diameter of the first molar	0.0035
Antero-posterior diameter of the first molar	0.0020
Transverse diameter of the last molar	0.0025
Antero-posterior diameter of the last molar	0.0022

This Rabbit was about the size of the Northern Hare.

STENEOFIBER, Et. Geoffr.

Pomel, Cat. Méth. Vert. Foss. Bassin de la Loire, etc., 1853, p. 20.

Molars $\frac{4}{4}$, prismatic; the shaft with one deep inflection of enamel on each side, and the crown furnished with a few fossettes anterior and posterior to the inflections. In the superior series, the internal inflection is the most extended in the length of the shaft; the external inflection is the most prolonged in the inferior molars. Incisors not compressed nor grooved. Frontal region contracted, as in *Fiber*.

Three species of this genus are enumerated by Pomel as having been found in the Miocene formations of France and of the Rhine, of which the longest known is the *S. viciacensis*. He points out that *Steneofiber* differs from *Chalicomys*, Kaup, in the structure of the molar teeth. In the latter, there are two external and one internal enamel inflections in the superior molars, and one external and three internal inflections in the inferior molars.

Two species of *Steneofiber* have been described from North America, viz, the *S. nebrascensis*, Leidy, from Miocene beds of Nebraska, and the *S. pansus*, Cope, from the Santa Fé marls. These species agree with the European ones in dental, and, in the case of the former, in cranial characters, differing in subordinate details, which I can only view as specific. Each of them has, like its European congeners, but a single inflection of the enamel on each side.

Steneofiber pansus, Cope.

Plate lxix, figs. 4–14.

Proc. Phila. Acad., 1874, p. 222; Ann. Rept. Chief of Engineers, 1875, ii, p. 993.

Of this Rodent, I found the right mandibular and maxillary bones with all their molars, an incisor and a first superior molar of the left side, and various bones, of one individual; also the inferior molar series of a second individual not fully adult.

The superior molar teeth diminish in size from before backward. The first is the largest, the second and third are equal, and the fourth is the smallest. In all, the postero-external angle is right, the outer and posterior sides being flat, while the antero-internal angle is rounded off by the uninterrupted curve from the front backward and outward to the internal enamel fold. In the stage of wear of the specimen, the external inflection has become isolated from the border into a narrow fossette, which is strongly curved posteriorly. In all of the teeth, there is a single narrow fossette behind it. There is a narrow transverse fossette at the anterior part of the crown closely adjoining, or, in the second and third molars, continuous with the internal enamel inflection. The worn surface of the crown of the first molar is nearly twice the extent of that of the fourth. Its shaft is curved moderately inward and backward.

The inferior molars present the same relations of size as the superior. The first is half as long again antero-posteriorly as any of the others, while the second and third are equal. The inner enamel inflection overlaps the external in front of it, and is preceded in all the crowns by one transverse fossette, except in the last, where there are two. These fossettes become smaller on attrition; that of the first molar is a crescent with the horns forward. There is one transverse fossette behind the external inflection. In form, the inferior molars are less triangular than the superior; the first and last differ from the others in presenting a strong antero-internal angle.

The mandibular ramus is robust, and the coronoid process originates opposite the line of contact of the second and third inferior molars. The diastema is abruptly concave, and the mental foramen is below its fundus. The inferior border below the molars is nearly straight. The molars terminate in short roots at the base of the long prismatic crown. The inferior incisor is almost quadrate in section, the two posterior angles being rounded. The enamel does not extend on either side, and is smooth; its transverse section is slightly convex. The surface of the dentine is polished, and is marked with faint, transverse, undulating lines. The transverse maxillo-palatine suture is opposite the posterior part of the second superior molar; it passes through the single lateral palatine foramen, which is preceded by a groove of the maxillary bone. The auditory bullæ are very large; they are subsemiglobular and compressed. The humerus preserved lacks epiphyses; its sections are triangular, owing to the presence of aliform angles. One proximal directed inward and backward is much more prominent than the deltoid crest opposite to it. The ulna is compressed posteriorly, and the olecranon is short.

Measurements.

	M.
Length of the superior molar series	0.0150
Length of the first superior molar	0.0050
Length of the fourth superior molar	0.0038
Length of the crowns of the inferior molars	0.0160
Length of the first inferior molar	0.0050
Width of the same	0.0040
Width of the last inferior molar	0.0035
Transverse diameter of the inferior incisor	0.0040
Depth of the ramus at the first molar	0.0140
Width of the ramus at the last molar	0.0080
Horizontal diameter of the auditory bulla	0.0150

The younger specimen is instructive, as showing the primitive condition of the fossettes and inflections of the mature dentition. The first molar is unworn, the fourth but little, and the second and third a little more worn. In the crown of the first, the outer inflection is seen to be continuous with the posterior transverse fossette, which notches the internal and posterior borders also. The anterior crescent-like fossette notches the antero-lateral borders. In the following two teeth, the posterior fossette is distinct from the outer inflection, but is a second or posterior internal inflection, soon becoming isolated on attrition. The anterior transverse fossette is isolated in these specimens. In the fourth molar, both the anterior and posterior fossettes are inflections from the inner side, thus giving three for that side, as in *Chalicomys.* Thus it is evident that in its immature state the dentition of this species approaches much more nearly that assigned by Pomel to *Chalicomys* than it does at maturity; for that a little attrition would soon produce the pattern seen in the specimen first described is entirely obvious.

A comparison of this species with the *S. nebrascensis*, Leidy, reveals a number of differences. In that species, the first and second molars in both jaws are nearly or quite equal; in the *S. pansus*, the first of both series is conspicuously the largest. The second and third present a difference in proportions in *S. nebrascensis*, while they are equal in the *S. pansus*. In the same way, the transition in size from the third to the fourth is abrupt in *S. nebrascensis* and very slight in *S. pansus*. The superior molars are represented as more quadrate in the *S. nebrascensis*, and there are two fossettes behind the external inflection. This cannot be due to attrition alone, as they are related antero-posteriorly, and are therefore not divisions of a single transverse fossette. As compared with the *S. pansus*, the *S. viciacensis* has a still smaller posterior upper molar, which often lacks the internal enamel inflection; and the fossettes are one more in each crown, as in *S. nebrascensis*.* The enamel inflections of the inferior molars are said to be opposed, and not alternating, as in both the American species.

The *Steneofiber pansus* was about as large as Prairie Dog (*Cynomys ludovicianus*), but more robust.

EUMYS, Cope.

Cope, Ann. Rept. U. S. Geol. Surv. Terrs., 1873, (1874), p. 474.—Leidy, Ext. Mamm. Fauna Dak. and Nebr., 1869, p. 342 (name only).

The characters of this genus as pointed out in the article above cited cannot be verified on the species below described, as the mandibular ramus with dentition is the only part preserved. The characters of the molar teeth are identical in character with those of the *Eumys elegans*, and it is therefore provisionally referred to the same genus. They also resemble those of the genus *Hesperomys*, to which I originally referred it.

Eumys loxodon, Cope.

Plate lxix, fig. 15.

Hesperomys loxodon, Cope, Proc. Acad., Phila., 1874, 150; Ann. Rept. Chief of Engineers, 1874, ii, 605.
Eumys loxodon, loc. cit., 1875, p. 993.

A nearly entire mandibular ramus, with all the teeth preserved, was found in the same deposits as the preceding species. Molars subequal,

* This species is stated by Leidy, on the authority of Hayden, to have been derived from the White River Miocene; it will be necessary to verify this statement, as the *S. pansus* is a Loup Fork species.

short-crowned; triturating-surface sigmoid. The apices of the sigma on the inner side tubercular, and anterior to the outer apices. First molar with an additional transverse crest in front. Incisor compressed; outer angle of enamel face rounded, smooth. Molars series oblique, rising anteriorly.

Measurements.

	M.
Length of the molar series	0.0050
Length of the first molar	0.0018
Depth below the last molar (inner side)	0.0030
Depth below the first molar	0.0045
Depth of the incisor	0.0015
Depth at the diastema	0.0027

This Mouse is only two-thirds the size of the *E. elegans*, and of more slender proportions.

The superior incisor tooth of a fourth species of Rodent was obtained. It is compressed, resembling those of the *Muridæ*, and particularly those of the *Eumys elegans*. It is twice as large as that of the *E. loxodon.*

CARNIVORA.

CANIS, Linn.

I procured remains of four species of Dogs in the Santa Fé marls each one represented by a single mandibular ramus. Only one of these is identifiable with species of the Loup Fork beds of Colorado and Nebraska, and I cannot distinguish its lower jaw from that of the existing Wolf, although it must be added that my specimen is imperfect. Eleven species of the genus *Canis* are now known from the North American Tertiaries, which range from the size of a Weasel to that of a Bear. I enumerate them in the order of size, adding also their stratigraphical position.

C. osorum, Cope, White River horizon, Colorado.
C. gregarius, Cope, White River horizon, Colorado.
C. lippincottianus, Cope, White River horizon, Colorado.
C. vafer, Leidy, Loup Fork beds, Nebraska.
C. temerarius, Leidy, Loup Fork beds, Nebraska.
C. hartshornianus, Cope, White River beds, Colorado.
C. lupus, L. (*C. sævus*, Leidy), Loup Fork beds, Nebraska, Colorado, and New Mexico.
C. wheelerianus, Cope, Loup Fork beds, New Mexico.
C. dirus, Leidy, Quaternary, Mississippi Valley and ? California.
C. ursinus, Cope, Loup Fork, New Mexico and ? Colorado.
C. haydenii, Leidy, Loup Fork, Nebraska.

It is to be observed that six of the species have been derived from the Loup Fork beds and only four from the Lower Miocene or White River beds, where they are associated with two species which have been referred to *Amphicyon*, Lart.

Canis ? ——.

Canis vafer, Leidy, Cope, Ann. Rept. Chief of Engineers, 1875, ii, p. 988.

Represented by an under jaw without teeth, which is scarcely sufficiently preserved to admit of certain determination.

Canis lupus, Linn.

Canis sævus, Leidy, Extinct Fauna Nebraska and Dakota, 1869, p. 28.—Cope, Ann. Rept. Chief of Engineers, 1875, ii, p. 988.

Represented by a portion of the left mandibular ramus, which contains the alveoli, or fragments, of the molars in front of the tubercular. This fragment agrees nearly with the corresponding part of *C. lupus* from Kansas, except in the nearer approximation of the canine to the first premolar. This character is seen in some of the domestic varieties of *C. lupus*. The ramus is a little more slender than in the specimen of the *C. sævus*, figured by Dr. Leidy.

Measurements.

	M.
Length of the premolar series	0.045
Probable length of the sectorial molar	0.024
Depth of the ramus at the sectorial molar	0.026
Depth of the ramus at the second premolar	0.024
Width of the ramus below the fourth premolar	0.011

Canis wheelerianus, Cope.

Plate lxix, fig. 2.

A left ramus of the mandible, lacking the portions below the condyle and in front of the canine tooth, furnishes the characters of this species of Wolf. The length of the dental series is identical with that of the *Canis lupus* from Kansas; and the ramus is a little deeper, especially behind, and a great deal thicker. This increase in thickness is especially visible on the external side, which has two planes, a superior and an inferior; the dividing convexity between them extending from the anterior angle of the masseteric fossa to below the posterior mental foramen. The same aspect of the ramus in the Wolf is plane from the alveolar to the inferior border. The inner face of the ramus is plane at the tubercular teeth, but the dental series is strongly curved outward in front of these; the sectorial tooth being oblique in position. Hence, the inner face is convex at the sectorial, and slopes obliquely outward from the thickening of the lower border at the symphysis upward. The anterior mental foramen is below the anterior part of the second premolar, and the second foramen is below the posterior border of the third premolar. In the specimens of *Canis lupus*, both wild and domesticated, I find the posterior mental foramen to be below the anterior part of the third molar when present. The external face of the ramus below the tuberculars is quite concave. The anterior border of the masseteric fossa is below the second tubercular molar.

The diastema is very short, and all the teeth of the molar series are closely placed, presenting a strong contrast to the appearance presented by the *C. ursinus*. The crowns of the teeth are so broken as to render it impossible to state the details of their structure. The posterior tubercular is quite small and is one-rooted. The sectorial is as long as the two preceding molars, and is considerably longer than the two tuberculars together.

Measurements.

	M.
Length of the piece preserved	0.132
Length of the molar series	0.095
Length of the first tubercular molar	0.012
Width of the same	0.009
Length of the sectorial molar	0.028
Width of the same	0.011
Length of the second premolar	0.012
Depth of the ramus below the first tubercular molar	0.035
Greatest thickness of the same at the same point	0.017
Depth of the ramus below the third molar	0.031
Greatest thickness of the same at the same point	0.018

The distinctness of this species may be estimated by comparing, from below, the mandibles of *C. lupus* recent, and *C. lupus* and *C. ursinus* extinct from the same formation. The ramus of the *C. wheelerianus* is seen to have the transverse diameter twice as great as in either of the latter.

Canis ursinus, Cope.

Plate lxix, fig. 1.

Proc. Phila. Acad., 1875, 256; Ann. Rept. Chief of Engineers, 1875, ii, p. 988.

This curious species is the largest carnivorous animal detected in the Santa Fé marl, the lower jaw having about the size of that of the Black Bear. The outline of the mandible is peculiar in its greater depth posteriorly as compared with the Wolf, which is occasioned by the gradual elevation of the alveolar border and the very slight upward bend of the inferior border until it has passed the line of the first tubercular molar. The interior face of the ramus is plane, while the exterior is deeply concave from below the anterior margin of the sectorial tooth to the line of the posterior border of the second tubercular, where the ramus is broken off. The excavation is below the extremities of the roots of the molars, and is bounded below by the everted lower border of the jaw. This border is narrow, but thickens forward so as to be massive at the symphysis. The anterior mental foramen issues below the middle of the second premolar, and the second foramen is below the posterior root of the third premolar. The external face, immediately below the tubercular molars, is convex, instead of concave as in *C. wheelerianus* and *C. lupus*.

The crown of the canine tooth is broken off; its root is oval in section, and is of large size absolutely and relatively as compared with the *C. lupus* and other Dogs. The alveolus of one and perhaps the base of that of a second incisor remain. The premolar teeth are quite small, and are separated from each other by short diastemata. The first is one-rooted; the fourth is in contact with the sectorial. The latter is a large tooth, exceeding in antero-posterior diameter that of both tuberculars together. It has a wide posterior heel, but the anterior sectorial part of the crown is broken away. The first tubercular is a large tooth, with the crown oblong in section, considerably exceeding the last premolar in size. The crown is worn by use. The alveolus of the second tubercular remains. It is single, but large and compressed, and a keel on its external side shows that the root is grooved. Its long axis is directed inward and forward, and is three-fourths as long as that of the fourth premolar.

Measurements.

	M.
Length of the molar series from the canine	0.121
Length from the same to the sectorial molar	0.061
Length of the sectorial molar	0.031
Width of the same	0.015
Length of the first tubercular molar	0.020
Width of the crown of the same	0.012
Depth of the ramus at the posterior border of the same	0.055
Depth of the ramus at the anterior border of the sectorial	0.049
Depth of the ramus at the first premolar	0.038
Long diameter of the canine tooth	0.023

The disproportion in the size of the premolar and tubercular teeth strikingly distinguishes this species from those of the type of *C. lupus*. From *C. haydenii*, which is probably more nearly allied, it differs widely in the absence of the upward direction of the alveolar border, the excavation of the external face of the ramus, the one-rooted second tubercular molar, etc. It is not unlikely that when the superior molar dentition of *C. haydenii* is known, it will prove to be an *Amphicyon*.

PUTORIUS, Cuv.

Putorius nambianus, Cope.

Plate lxix, fig. 3.

Martes nambianus, Cope, Proc. Acad. Phila., 1874, p. 147.
Mustela nambiana, Cope, Ann. Rept. Chief of Engineers, 1875, ii, p. 988.

Represented by a left mandibular ramus, which supported the molars to and including the anterior blade of the sectorial tooth. The premolars number three, and the first is one-rooted. The crowns of the second and third are simple, that is, without posterior lobe; but they possess well-defined anterior and posterior basal lobes, but no lateral cingula. The anterior lobe of the sectorial is elongate and rather low; its edge is worn by long use, indicating the adult age of the animal. Enamel smooth. A delicate *foramen mentale* perforates the ramus below the second premolar, and another enters below the third. The ramus is shallow and moderately compressed.

Measurements.

	M.
Length of the base of the premolars	0.0062
Length of the anterior lobe of the sectorial	0.0027
Elevation of the crown of the third premolar	0.0020
Depth of the ramus at the third premolar	0.0027
Width of the ramus at the third premolar	0.0020

This species is provisionally referred to *Putorius* (*Mustela*, auct.) on account of the empirical character of the absence of posterior lobes of the third premolar, which is present in the type of *Mustela* (*Martes*, Cuv.). The reference is not final, because the specimen does not display the posterior part of the crown, the inner tubercle, nor the tubercular molar. It is less than half the size of the *Mustela parviloba*, Cope (*Martes mustelinus*, Cope), of the Loup Fork beds of Eastern Colorado

PROBOSCIDEA.

MASTODON, Cuvier.

Mastodon, sect. *Trilophodon*, Falconer, Quart. Journ. Geol. Soc. London, April, 1857.
Tetracaulodon, Godman.

Mastodon productus, Cope.

Plates lxx, lxxi, and lxxii.

Proc. Acad. Phila., 1874, p. 221; Ann. Rept. Chief of Engineers, 1875, ii, p. 992.

This Proboscidian is represented in the collections of the Survey by portions of a number of individuals. The specimen on which the first determination was based is a mandible, which lacks only the coronoid processes and angles from both sides. Its symphysis is entire, containing two tusks. Each ramus supports two teeth, the fifth and sixth molars, which are more or less injured; the sixth of the left side being nearly perfect. A second and young individual is represented by the nearly complete dentition of the maxillary bones at the time of its death, viz, three premolars (the first wanting from one side), and the first true molar of both sides, not quite protruded. A third and a fourth specimen include three-crested third molars; a fifth is a fourth or fifth three-crested molar, much worn, and the sixth and seventh are inferior sixth molars, one of them nearly perfect. In addition, there are bones of different individuals from many regions of the skeleton, but nothing approaching completeness.

This species belongs to the genus defined by Dr. Falconer as possessing three crests to the third, fourth, and fifth, or intermediate molars, which also includes the *M. ohioticus* and *M. angustidens*, on which the genus was originally established, and for which the name *Mastodon* should therefore be retained. It is much more nearly related to the latter than to the former of these species.

The mandibular ramus is not elevated, but it is more so just behind the symphysis than at the origin of the coronoid process. At the latter point, its transverse exceeds its vertical diameter. This form is due to the external convexity at this point, which is, at the middle of the ramus, but little marked. The inner wall slopes very obliquely inward and upward at the last molar tooth, approximating the inner alveolar borders. These are nowhere widely separated, and in the specimen are continued on each side in front of the fifth (anterior) molar, one-fourth its length, as an acute ridge. The symphysis is produced as a beak with subparallel borders, and is deflected at an angle of 35° with the long axis of the ramus. Its inferior border is continuous with that of each ramus without interruption. On the superior face, the alveolar ridges converge, inclosing a narrow gutter, narrower than the inferior face, and then diverge and disappear before reaching the end of the beak. Thus the superior surface, from being grooved, becomes flat or slightly concave. The inferior surface displays a slight longitudinal concavity, which occupies the space between the alveolar ridges of the inclosed tusks. The rather large dental foramen is situated below the angle formed by the deflection of the alveolar ridge at the base of the beak. Its distance anterior to the anterior (fifth) molar exceeds the length of the latter.

The symphyseal tusks are depressed or transversely oval in section; their adjacent sides being flattened. Their length is slightly unequal, and they are worn obliquely posteriorly from the inner to the outer side. The dentine is longitudinally, weakly, closely striate. It is usually covered by a thin layer of cementum. The anterior or fifth molar of the inferior series is much worn by use, and in a bad state of preservation on each side of the jaw. Its crests have become confluent by attrition, both lengthwise and crosswise, leaving entering bays of enamel to mark the valleys. These indicate the borders of three crests. The last or sixth molar is just protruded, and the anterior two crests are the only ones worn. It was fractured in transportation, so that the anterior and posterior heels are incomplete; but a sketch, which I made from it when perfect, and before I removed it from the matrix, supplies this deficiency. The crown in its perfect state presented four transverse crests, a strong heel, and a small anterior cingulum. The crests are constituted of two principal obtusely conic tubercles, separated by a deep fissure. Those of the external series are attended by others, and those of the inner side are more simple. The last of the inner row is entirely simple; the penultimate has a trace of division at its apex. The second has a decided fissure, separating a lower division next to the median line, which is more strongly developed in the first. At the base of the second in front is a low tubercle, which corresponds to the cingulum in front of the first. The external cones present two accessory tubercles in front and one behind; the inner one of the former is wedged between the principal cones, while the more anterior one is in contact with the posterior one of the preceding series, thus completely dividing the transverse valleys into two unequal parts. The posterior tubercle is the largest, and has a convex posterior border, which is divided into three or four lobes by transverse grooves, forming a step-like outline in profile, all of which disappears on attrition. The principal lobes are opposite to each other, and the transverse series are convex forward. The enamel, even in the young tooth, is nearly smooth, and the basal cingulum very little marked.

Measurements of the mandible.

	M.
Total length from the apex of the tusks to the posterior border of the molar	0.750
Length of the superior oblique border of the spout	0.240
Length of the symphysis without the tusks	0.260
Length of the exposed part of the tusks	0.100
Diameter of the same at the base { transverse	0.040
Diameter of the same at the base { vertical	0.032
Width of the spout at the base	0.110
Width of the same between the superior ridges	0.040
Length from the symphysis to the base of the fifth molar tooth	0.100
Depth of the ramus at the fifth molar	0.127
Depth of the ramus at the sixth molar	0.118
Diameter of the ramus at the same point	0.150

Length of the fifth molar	0.113
Width of the same	0.072
Length of the sixth molar	0.158
Width of the same in front	0.070
Width of the same behind	0.060
Elevation of the anterior cone of the same	0.060

The superior series of molar teeth was found in place, and I took them from the matrix attached to the maxillary bone. The fourth molars, or first true molars, of both sides, were found inclosed within the jaw. The first premolar is smaller than the second; it was broken off, but the relation to the second here described is probably the true one. It presents a prominent anterior transverse crest, and a low posterior one, with a small external tubercle representing a heel. The anterior crest is continuous, and is three-lobed; the second consists of two well-separated low tubercles. The second molar is also furnished with two crests, which are subequal in elevation. Each one is divided by a median notch and fissure, of which the posterior is the more open. The anterior internal and posterior external tubercles are simple, the latter transverse from compression. The antero-external and postero-internal are lobate, the former with two lobes, the latter, which is the least elevated of all, with four lobes. There is a weak basal cingulum on each side and behind, but none in front.

The third premolar, which, according to Owen, belongs to the milk series, is furnished with three transverse crests, of which the posterior is the least elevated. Each of these is divided by a deep fissure, since it consists of two appressed cones. The cones of the outer side are simple and transversely oval in section; the inner ones possess each an accessory tubercle in front and one behind at their inner border. The accessory tubercles of adjacent crests are in close contact, thus blocking up the intervening valleys at their middles. The inner cone of the posterior pair has no posterior accessory tubercle on one side, but there is a strong posterior cingulum. The lateral cingula are only developed between the bases of the cones. Anterior cingulum narrow but uninterrupted. The first true molar is half as long again as the last premolar, and, like it, has three crests. As they are unworn in this individual, they have the following characters. The principal cones of opposite sides are opposite to each other and separated by an open emargination. Those of the outer side are extended transversely and have no accessory tubercles, but their crests are lobate; *i. e.*, divided by two or three grooves extending transversely to them. The anterior of the three is convex in front and subconcave behind. The tubercles of the inner side have two accessories, one anterior and one posterior, so that a section is trifoliate. In addition to these, there is a median tubercle at the anterior base of the anterior crest, and a median tubercle on the posterior side of the posterior crest. There is a low heel at the base of the latter, and a basal cingulum on each side of the anterior extremity of the crown.

Measurements of the superior molars.

	M.
Length of the three premolars in place	0.171
Length of the first premolar	0.038
Width of the same	0.026
Length of the second premolar	0.042
Width of the same	0.042
Length of the third premolar	0.078
Width of the same	0.055
Elevation of the same	0.034
Length of the first true molar	0.120
Width of the same	0.067
Elevation of the crown of the same	0.052

The external face of the maxillary bone is preserved in a damaged condition. The large *foramen infraorbitale exterius* looks forward and a little outward, and the position of the incisive alveolus is protuberant laterally. The alveolus contains the root of a small tusk, much decayed. The depth from the orbit to the alveolor border measures $0^m.090$, and the transverse diameter of the *foramen infraorbitale* is $0^m.020$.

There is a deposit of cementum in the valleys of both the inferior and superior molars, which does not appear in a few specimens.

Of two separate third molars, already mentioned, one is more tubercular than the other. In both, there is a cingulum between the bases of the cones on one side, which is lobed in the one, which also presents low tubercles above it in the valleys. In this tooth, no cementum is present. The other is without the tubercles, and cementum is present. Both are well worn. The more tubercular measures $0^m.073$ in length and $0^m.048$ in width. A large sixth molar is similar to that already described from the lower jaw, excepting that the cones of the more simple side of the crown are more distinctly divided into an inner and an outer, and that the posterior one is wanting from the penultimate cone of the opposite side. There are also other smaller tubercles on the sides of the valleys. Length, $0^m.140$; width, $0^m.082$.

Fragments of various sizes of the tusks of this animal are common in the Santa Fé marl, but, owing to their great fragility, they are difficult to preserve. A number of attempts to obtain them were made, but the pieces were either broken up in excavating or transporting them. The most solid fragment includes about a foot of the extremity. Its section is round, with two flattened sides. One of these is marked with longitudinal shallow striiform grooves and is the side which is worn obliquely by attrition at the extremity. The groove-like lines were probably covered by a layer of enamel. I observed such a layer, which formed a narrow band on the side of an extremity of a tusk, which I did not procure. The diameter of a fragment at seven inches from the apex is three inches.

The greater part of a small tusk is preserved, which probably belongs to the lower jaw. It is larger than the one found in place and above described, and is of a different form. One side is flat and the other presents two oblique faces, one wider and one narrower; the section being thus depressed-triangular, with rounded angles. The entire surface is coarsely striate-grooved, excepting where concealed by a nearly smooth coat of cement. Long diameter, $0^m.060$.

But few vertebræ were procured. The most characteristic of these is the dorsal centrum of an immature animal, lacking epiphyses. It is from the anterior part of the series, and is strongly opisthocœlian. The inferior surface is obtusely angulated at the front middle line. The capitular fossæ are strongly pronounced, and the posterior basal border of the intervertebral foramen is revolute.

Measurements of a dorsal vertebra.

		M.
Length of the centrum		0.047
Diameter of the centrum	transverse	0.192
	vertical	0.113
Width of the neural canal at the base		0.054

The imperfect neural arch of a cervical vertebra was found in connection with the mandibular ramus, which served as the typical specimen. There is no zygapophysis, and the arch is narrowed upward. The spine is convex before, concave behind. The width of the base of the spine is $0^{m}.067$; the elevation of the arch $0^{m}.082$.

The only long bone of the fore limb in the collection is an ulna, with the epiphyses wanting. The shaft is subtriangular in section, and wider than deep along its middle portion. At the distal end, the lateral angles rise, especially one from the inner side, so that the depth is much greater. Here the inner face is nearly flat, while the external border presents an angular protuberance. There is no coronoid process, but the superior borders of the two sigmoid portions of the humeral cotylus are very protuberant, that of the internal the most so. The olecranon is very short, not extending behind the olecranar portion of the humeral cotylus. Its inner border is produced, inclosing a deep groove with the inner border of the cotylus.

Measurements of the ulna.

	M.
Length without the epiphyses	0.470
Length of the cotylus in the median line	0.096
Greatest width of the cotylus	0.183
Depth at the fundus of the cotylus	0.114
Width at the middle of the shaft	0.082
Depth at the middle of the shaft	0.070
Width at the distal extremity	0.129
Depth at the distal extremity	0.108

Two carpal bones were obtained, the cuneiform and magnum, of which the former strongly resembles that of the Elephant of the Florence Museum figured by Cuvier.* Its ulnar face is rounded-triangular, and is divided into two facets, a right and a left, which are subequal in transverse extent and slightly concave. The inferior face has less transverse extent than the superior, and is undivided. The exterior tuberosity is large and decurved. The posterior or pisiform facet occupies a nearly median position on the superior half of the posterior face, descending along the external tuberosity. The magnum has a subquadrate transverse vertical section. Viewed from above, its superior face is rhomboid, with nearly parallel slightly-curved

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* Ossemens Fossiles, pl. xvi, fig. 19.

sides. The inferior face exhibits two facets, the one wide, the other narrow and subvertical. Each of the lateral faces is bounded below by a facet. The posterior tuberosity is not very prominent.

Measurements of the carpals.

		M.
Diameter of the cuneiform	transverse	0.098
	antero-posterior	0.074
	vertical	0.037
Transverse length of the superior face		0.075
Diameter of the magnum	transverse	0.057
	antero-posterior	0.105
	vertical	0.080
Antero-posterior length of the superior face		0.084
Width of the principal inferior facet		0.052

A nearly perfect left femur was obtained from near San Ildefonso. It is of the elongate type, and the shaft is flattened so as to be transverse in its proximal portion. At the middle of the shaft, its external border is almost acute. Distally, its section becomes more and more triangular, rising to the ridges of the patellar groove. The distal end of the femur is rather compressed; the intercondylar fossa being, as in other Elephants, narrow, while the patellar groove and ridges are more than usually prominent, the inner ridge being most elevated and prolonged on the shaft.

Measurements of the femur.

		M.
Total length		0.950
Diameter at the base of the trochanter	transverse	0.187
	fore-and-aft	0.100
Diameter at the middle	transverse	0.130
	fore-and-aft	0.085
Diameter of the distal end	transverse	0.180
	fore-and-aft	0.225
Diameter of the head		0.160
Diameter of the head of a second femur		0.160

The heads of the two femora measured are not yet coössified with the shafts.

The characters recorded in the preceding description indicate a species of *Mastodon* which differs from those described by previous authors as inhabiting North America, which I have named *M. productus*. It is unnecessary to compare it with the species of *Tetralophodon* (Falc.), to which, according to Leidy, the *Mastodon mirificus* of the Loup Fork beds of

Nebraska belongs; but the majority of American Mastodons are congeneric with the present species. Seven species of this genus are recorded by Falconer, and there may be added, as discovered in North America since he wrote, the species *M. obscurus* and *M. shepardii* of Leidy and *M. proavus* of Cope. There is also the *M. chapmanii* of Hays,* which has not been recently observed. The *M. productus,* belonging to that section of the genus in which the transverse valleys are interrupted by tubercles or cones, comparison with the *Mastodontes borsonii, tapiroides, ohioticus, proavus,* and *shepardii* is unnecessary. Among the species where the lateral cones are accompanied by others which interrupt the valleys, *M. humboldtii* and *M. andium* possess a short contracted symphysis without tusks. *M. angustidens* possesses the produced symphysis with tusks, and is also a species which stood on long limbs, like the *M. productus* and the living Elephants. The *M. productus* differs from it in well-marked characters, according to the descriptions of the latter which have been given by Dr. Falconer. This author states that the mandibular ramus of *M. angustidens* is much elevated in front, and most above the mental foramen. In *M. productus,* the elevation at the mental foramen is barely equal to the depth at the base of the coronoid process, while the elevation is greatest between these points at the anterior base of the penultimate molar, and it is not so great as in the European species. The symphyseal prolongation is not so long in *M. productus,* equaling to the mental foramen (without the tusks) two-thirds the length of the remaining portion to the base of the coronoid process. Dr. Falconer says of the *M. angustidens,* "The elongation of the symphyseal beak is enormous, far exceeding that of *Tetralophodon longirostris* or even of *Dinotherium;* the length from the mentary foramen forward being more than double that of the horizontal ramus measured from the same point backward to the base of the anterior margin of the coronoid process." According to the same writer, the symphyseal tusks of *M. angustidens* frequently have a channel on the superior and inner sides. In *M. productus,* the tusk is without channels.

Besides the generic character in the tooth-formula, this species differs from *Tetralophodon longirostris* in the form of the base of the symphysis.

* Trans. Amer. Philos. Soc., 1833, pl. xxii, figs. 3–4.

The inferior surface is a decurved continuation of the base of the ramus, as in *M. angustidens*, while in *T. longirostris* of Kaup the border of the ramus rises upward to the base of the symphysis.

Two specific names have been proposed for Mastodons whose remains are supposed to have been found in the United States. In each case, the name rests on an incomplete posterior molar tooth. One of these is the *M. chapmanii*, Hays, of uncertain locality. The arrangement of the cones of the crown differs materially from that seen in *M. productus*, for they are closely packed, almost closing the intervening valleys, as in the species of *Tetralophodon*. The cones of opposite sides are very unequal, and somewhat alternate, and the enamel borders are much lobate, all characters not found in *M. productus*. As regards the other species, *M. obscurus*, Leidy, Professor Leidy remarks that it may be the same as the *M. chapmanii*, but the existing evidence is not conclusive in favor of this view. It reposes on the cast of a tooth said to have been taken from the Miocene marl of Caroline County, Maryland.* It probably supported four transverse crests; but this is not certain, as the anterior extremity is broken away. In its constitution, it bears some resemblance to the last inferior molar of *M. productus*, but presents well-marked differences. It is narrower, the greatest width entering the length 2.5 times, while in all the corresponding teeth of the latter species the width is one-half the length. The second transverse crest in the type of *M. obscurus*, though but little worn, does not display the separation into opposite cones, which, in *M. productus*, is maintained nearly to their base; the worn section presenting, therefore, two areas, the one trifoliate, the other elliptic. In *M. obscurus*, the cones of opposite sides display a stronger tendency to alternation, and are generally less tubercular, differences by themselves perhaps unimportant. I, however, suspect this tooth to represent a species different from the *M. productus* characterized among other points by its narrower teeth. The discovery of the mandible and other bones will be necessary before it can be regarded as well established.

Another tooth figured† by Dr. Leidy resembles the molar of *M. pro-*

* Extinct Mammalia of Dakota and Nebraska, p. 245, pl. xxvii, fig. 13.
†Loc. cit., xxvii, fig. 15.

ductus very closely, and may belong to it; the figure is that of a cast supposed to be derived from a North American specimen. A fragment of another tooth from Tarborough, N. C., believed to be, like the Maryland specimen, from the Miocene marl, may belong to the *M. obscurus* or similar species. The formation alluded to has been usually correlated with the White River Miocene of the West, which preceded by a long period of time the Loup Fork epoch, from which the *M. productus* was derived. I must also add that there do not appear to be any striking characters by which the posterior molar teeth of the *Mastodon andium* can be distinguished from those of the *M. productus*.

The first notice which is unquestionably of this species is that published by Dr. Leidy in the Proceedings of the Philadelphia Academy, 1872, p. 142. Dr. Leidy there mentioned the characters of the lower jaw, as seen in a specimen obtained by the Hon. W. F. Arny, governor of New Mexico, and sent by him to the Smithsonian Institution, Washington. The same specimen is fully described and figured in volume I of the quarto Report of the United States Geological Survey of the Territories, by Dr. Leidy.

PERISSODACTYLA.

APHELOPS, Cope.

Paleontological Bulletin, No. 14, p. 1, July, 1873; Ann. Rept. Chief of Engineers, 1875, ii, p. 991.

Remains of Rhinoceros are not rare in the deposits of the ancient lake of the Rio Grande Valley, and among the most complete fossils obtained is the greater part of the cranium of a species allied to the *Aphelops megalodus* of the corresponding beds of Colorado. The specimen includes the dentition of both jaws, which exhibits the following formula: I. $\frac{?}{2}$; C. 0; Pm. $\frac{4}{3}$; M. $\frac{3}{3}$. The absence of the first premolar distinguishes the form from the Miocene *Aceratherium* as well as from the existing genus *Rhinocerus;* while the presence of inferior incisors separates it at once from the living *Atelodus*. I have named this genus *Aphelops;* like *Aceratherium*, it is hornless. To it are referred, besides the species mentioned, the *Rhinocerus crassus*, Leidy, and the *A. jemezanus*, first described below. These are, however, only referred to it provisionally, as the number of the premolar teeth is not yet known in either. The known species have only been found in the beds of the Loup Fork epoch.

The four known species may be distinguished as follows:

* Ramus mandibuli shallow and stout; last molar close to base of coronoid process .... *A. crassus.*
** Ramus mandibuli compressed; deeper:
  † Base of coronoid process flat in front, with lateral angles:
    Last molar at base of coronoid process; symphysis and external incisors small .... *A. meridianus.*
    Last molar well in front of base of coronoid process; symphysis and external incisors large .... *A. megalodus.*
  †† Base of coronoid process convex in front without lateral angles:
    Last molar largest, not close to base of coronoid .... *A. jemezanus.*

Aphelops meridianus, Leidy.

Plates lxxiii, figs. 1–2; lxxiv, figs. 1–3.

Rhinocerus meridianus, Leidy, Extinct Mammalia of Dakota and Nebraska, p. 229.
Aphelops meridianus, Cope, Ann. Rept. Chief of Engineers, 1875, ii, p. 991.

The *A. meridianus* was first described from a superior molar tooth from Texas. The corresponding molar in the New Mexican species does not differ from it. The general characteristics of this almost unknown species may then be learned from our specimens. In general features, it much resembles the *A. megalodus*, but there are numerous differences. There is a considerable protuberance of the anterior border of the posterior transverse crest, nearer the outer border of the crown than the protuberance of the posterior border of the anterior transverse crest. These give the transverse valley a sigmoid form, which is not seen in *A. megalodus*. There is no posterior protuberance of the anterior transverse crest of the last superior molar. There is a strong anterior basal cingulum on the true molars, and a very strong elevated cingulum connecting the inner ends of the transverse crests, but not passing round the interior extremities of the crests. It is represented in the last two molars by a small tubercle. There are no external cingula. The external faces of the superior molars present a convexity forward, which is very prominent in the true molars, each overlapping the preceding tooth. Immediately behind and parallel with this ridge is a groove, which is followed by a low ridge bounding the general external surface in front. The latter is slightly concave in the antero-posterior direction, excepting in the first and second premolars and third true molar. On continued attrition, the transverse valley of the crowns becomes isolated by the confluence of the posterior projection of the anterior cross-crest with the posterior cross-crest. The posterior emargination scarcely becomes isolated, and then is only inclosed by an enamel band. This is only possible on the third and fourth premolars and the first true molar. The sides of the transverse valley have no vertical ribs near the fundus or elsewhere, so that it does not become lobate, or divided into lakes, on attrition, as is the case with *Rhinocerus indicus* and several species of *Atelodus*. They have the simpler structure seen in the *Aceratherium occidentale*.

The mandibular ramus is compressed and not deep. Its inferior outline is gently curved, and without irregularity at either extremity. The masseteric region is flat, while the internal pterygoid insertion is a concavity of the inner face behind and below the coronoid process. The inferior premolar teeth increase regularly in size to the true molars, which are nearly equal. In all, but especially on the last two molars, the anterior limb of the anterior crescent is well developed, extending to the inner side. The external posterior projection of this crescent is rounded. The symphysis is short, commencing below the second premolar. Immediately in front of this point, it is contracted, and the superior surface forms a trough between the acute superior lateral borders. The symphysis is scarcely expanded at the extremity, where it supports two larger external and two smaller internal incisors.

The mandible differs from that of *A. megalodus* in the contracted form of the symphysis, and the small size of the outer tusk-like incisors, which are scarcely half as large as those of the former; but it is possible that this character is sexual. As compared with five mandibles of *A. megalodus*, the last molar originates closer to the base of coronoid process. In the latter, there is a considerable interval in front of the ascending process. The form of the dentary bone is that of *A. megalodus*, and not thick and massive, as in *A. crassus*.

The posterior part of the temporal bone is preserved. It supports a rather long and narrow postglenoid process. Just behind the superior base of the zygomatic process is the *meatus auditorus externus.* It is presented upward and outward, and is not closed below superficially, but is continued into the fissure between the postglenoid and mastoid processes. The latter is rather narrow antero-posteriorly, and extends as far inferiorly as the glenoid articular surface.

Measurements.

	M.
Length of the series of seven superior molars	0.237
Length of the three true molars	0.123
Length of the last true molar	0.037
Width of the same	0.046
Length of the first true molar	0.051
Width of the same	0.057
Length of the second premolar	0.029
Width of the same	0.033
Total length of the ramus mandibuli	0.455
Length of the symphysis	0.114
Width of the symphysis	0.058
Diameter of the external incisor	0.015
Diameter of the internal incisor	0.005
Depth of the ramus at the second premolar	0.062
Depth of the ramus at the third molar	0.086
Width of the inferior border of the ramus at the middle	0.035
Length of the series of inferior molars	0.220
Length of the series of three true molars	0.125
Length of the third premolar	0.037
Width of the grinding-face of the same	0.026
Length of the penultimate molar	0.042
Width of the grinding-face of the same	0.025
Length of postglenoid process	0.050
Width extero-internally	0.030
Width of the mastoid process postero-externally	0.029

These measurements indicate a size similar to that of the *Rhinocerus sumatranus.*

Aphelops jemezanus, Cope.

Plates lxxiii, figs. 3-4; lxxiv, fig. 4.

Ann. Rept. Chief of Engineers, 1875, ii, p. 992; Proc. Phila. Acad., 1875, p. 260.

That a second species of Rhinoceros, even larger than the other species of *Aphelops,* formerly existed in the region of New Mexico, is demonstrated by a right mandibular ramus, obtained, by Dr. H. C. Yarrow, from near the town of Santa Clara, on the west side of the Rio Grande. The specimen, in its present condition, includes the condyle, angle and ramus as far as the last premolar, and supports three true molars. The latter are worn, indicating the full age of the animal. They still retain the enamel surface of the sinus between the posterior and median transverse crests, and the lower end of the sharp inner margin of the anterior transverse crest.

While the ramus exhibits the compressed form seen in *A. megalodus* and *A. meridianus*, it differs from these and the *A. crassus* in many striking respects. Thus the inferior margin near the angle does not exhibit the protuberance and following contraction of the inner side seen in the first two species. In another feature, it differs from all the other species, *i. e.*, in the form of the ascending ramus. This rises very gradually from the basis of the last molar, leaving a subhorizontal edentulous space behind the latter as long as the second true molar; its anterior face, instead of being flat and bounded by strong lateral angular ridges, as is the case in *A. crassus* and the two other species, is rather narrowly convex. Instead of the usual ridge of the outer side, the anterior border of the area of insertion of the masseter muscle is marked by a prominent curved protuberant margin, which is wanting in the three other species, the surface in them being plane. Behind the condyle is seen the tuberosity characteristic of the *Rhinoceridæ*. The internal pterygoid fossa is well marked. Rugosities for insertion of the lower border of the masseter muscle are strong. The relations of the dentition of this species are also peculiar. The last molar is nearly half as large again as that of specimens of *A. megalodus* and *A. meridianus* of similar dimensions of ramus, and the teeth diminish in length anteriorly more rapidly than in width. Thus, while the first true molar is as long as in the two species named, the width is between one-half and one-third greater. There are no external nor internal basal cingula.

Measurements.

	M.
Length of the ramus from the fourth premolar (behind) to middle of masseteric fossa	0.240
Length of the series of true molars	0.148
Length of the first true molar	0.044
Width of the first true molar	0.033
Length of the third true molar	0.058
Width of the third true molar	0.035
Diameter of the ramus at the first molar	0.080
Depth of the ramus at the third molar	0.092

HIPPOTHERIUM, Kaup.

Hipparion, Christ.

Hippotherium calamarium, Cope.

Plate lxxv, figs. 1–2.

Ann. Rept. Chief of Engineers, 1875, ii, p. 990.

This three-toed Horse is indicated by the oral and palatine parts of the skull with the superior dental series of both sides, together with one mandibular ramus, with all its teeth, of an individual from near San Ildefonso, and also probably by molar teeth of two individuals from the Loup Fork beds of Colorado. The species is allied to the *H. paniense*, Cope, and differs from the *H. occidentale*, *H. speciosum*, and *H. gratum* of Leidy, in the relative form and size of the internal anterior dentinal column. As in the species first named, this column is subcylindric, and equal to, or smaller than, the posterior internal columnar fold. In the three species last named, the anterior column is flattened or oval in section, and often larger than the posterior columnar fold, and submedian in position.

In the typical or New Mexican specimen, the anterior column is large, and its center is anterior to the middle transverse line of the crown. In the present state of attrition, which has left two-thirds of the crowns of the median molars, this column presents an angular projection toward the inner anterior crescent, betraying an approach to the union seen in *Protohippus*, which is in the fifth molar of the right side of the present Horse actually accomplished through the medium of a narrow isthmus. The dentinal band connecting the inner crescents throws out two, rarely one, folds toward this column. The borders of the lakes are much plicate; the posterior border of the anterior lake having from four to six inflections. The posterior border of the posterior lake exhibits one deep inflection, which is generally bifurcate.

The first premolar is quite small, and is two-rooted. The second is a wide tooth, different in form from the elongate corresponding tooth of the *H. occidentale*, its anterior lobe being but little prominent. The palate is wide and well arched. The mandibular teeth are elongate, but not narrow; and the anterior lobes are well developed, especially the median ones. No basal cingula on teeth of either jaw. The last molar is smaller than the three preceding it, and the anterior lobe of the first is quite narrow.

The molars of one of the specimens from Colorado are closely similar in all respects, except that the anterior lobe of the second premolar is a little more produced. I also refer here the tooth described as "M. 2" under *H. paniense*, in Report of the United States Geological Survey of the Territories, 1873, pp. 522–523. As compared with the molars of that species, those of *H. calamarium* differ in the much greater complexity of the enamel folds; those of *H. paniense* being the simplest in the genus, even more so than in *H. affine*. The anterior inner column of *H. paniense* lacks the characteristic inner angle seen in the present Horse.

Measurements.

	M.
Length of the seven superior molars	0.134
Length of the three true molars	0.062
Length of the second premolar	0.026
Width of the crown of the second premolar	0.020
Greatest length of the second premolar	0.022
Greatest width of the second premolar	0.024
Greatest length of the penultimate molars	0.022
Greatest width of the penultimate molars	0.022
Width of the palate (chord) between the middles of the third premolars	0.042
Length of the crown of the antepenultimate lower molar	0.021
Width of the crown of the antepenultimate lower molar	0.012

The typical specimen belongs to an adult animal, and was taken from the matrix by myself without admixture of others.

Hippotherium speciosum, Leidy.

Plate lxxv, fig. 3.

Extinct Mammalia of Dakota and Nebraska, p. 282.

A series of superior molars nearly identical in character with those originally described as typical of this species, by Dr. Leidy, and figured on plate xviii, figs. 16, 18, 19, of the work above quoted, and agreeing with specimens from Colorado, was obtained near Pojuaque. Some of the specimens described by Dr. Leidy as of doubtful reference under the head of this species obviously do not belong to it.

PROTOHIPPUS, Leidy.

Leidy, Extinct Mamm. Fauna Dakota and Nebraska, 1869, p. 275.—Cope, Ann. Report U. S. Geol. Surv. Terrs., 1873, pp. 519-527.

This genus, originally described by Leidy from dental characters, I have shown to be more nearly allied to *Hippotherium* than to *Equus*. In 1873, I published the first account of the structure of many parts of the skeleton, including the limbs, showing that the genus is three-toed. Some time previously,* Professor Leidy had asserted that the genus *Hippidium* of Owen is identical with *Protohippus* of earlier name, and he refers the South American species, on which Professor Owen based his genus, to *Protohippus*. In 1875, Professor Burmeister published a full description† of the osteology of the *Hippidium neogæum*, Lund, from the post-Tertiary deposits of Buenos Ayres, showing that that animal possesses but a single digit on all the feet It is, therefore, quite distinct from *Protohippus*, and constitutes an important link in the series of Equine genera,—*i. e.*, the one between *Equus* and *Protohippus*. Certain fossil Horses from the Loup Fork beds of the Niobrara River present, according to Marsh, the same characters; but he names them *Pliohippus*,‡ being apparently unaware of the prior applicability of Owen's name. Slight differences between the North and South American species in the concavity of the face and form of the nasal bones are probably specific only.

Antecedent to *Protohippus* in its dental characters comes the genus *Hippotherium*, which has been for some years recognized by authors as connecting *Equus* with the Miocene *Anchitherium*. *Palæotherium*, Cuv., had been indicated by Huxley as the probable Eocene ancestor of *Anchitherium*, but I have shown that it was much more probably *Hyracotherium*. This view has been confirmed by Marsh, who treats of this genus as I have identified it in America, under the synonym *Orohippus* (see *supra*, page 260).

Protohippus, spec. indet.

Plate lxxv, fig. 7.

A single much worn molar, of the size of that of *P. sejunctus*, apparently represents this genus.

The specimens obtained indicate another species of Horse, but they are not sufficiently characteristic for determination.

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* Proc. Acad. Phila., 1870–1.

† Los Caballos Fossiles de la Pampa Argentina, 1875, pp. 37–43.

‡ Amer. Journ. Sci. Arts, 1874, p. 252.

ARTIODACTYLA.

MERYCHYUS, Leidy.

Proc. Acad. Phila., 1858, p. 24; Extinct Mammalia Dakota and Nebraska, 1869, p. 115.

Merychyus medius, Leidy.

Leidy, Proc. Phila. Acad., 1858, p. 25; Extinct Mammalia Dakota and Nebraska, p. 119.—Cope, Ann. Rept. Chief of Engineers, 1875, ii, p. 990.

The greater part of the premaxillary and maxillary bones of the right side of a single individual represent this species. The third, fourth, sixth, and seventh molars are well preserved, while the other teeth are fragmentary or wanting.

One of the characters of this and other species of *Merychyus* is the production forward of the anterior part of the jaws, beyond the postero-lateral border of the nares; the premaxillary being prolonged in front of this border further than the latter is in advance of the infraorbital foramen. The premaxillary is small, indicating a narrow upper lip, and contains three alveoli. It is coösified with the maxillary. The side of the maxillary above and in front of the infraorbital foramen is openly concave, in a manner not seen in *Oreodon culbertsonii.* There is a pronounced lachrymal fossa immediately in front of the orbit. The anterior border of the latter is above the middle of the posterior lobe of the penultimate molar. The infraorbital foramen issues above the middle of the last premolar. As in *M. major* and *M. elegans*, the third premolar has two internal lobes while the fourth has but one. The crowns are all well worn, indicating the maturity of the animal. Their inner lobes are convex and the external ones slightly concave, the lobes separated by a well-marked rib. There are no cingula, except a trace on the base of the external lobes of the true molars, and the enamel is wanting on the adjacent sides of the crowns. It is also wanting on the inner boundary of the central lakes of the true molars. The measurements agree very nearly with those given by Dr. Leidy.

Measurements.

	M.
Length of the superior dental series	0.1215
Length of the superior molar series	0.1020
Length of the true molar series	0.059
Length of the second true molar	0.023

Width of the same	0.022
Length of the third true molar	0.029
Width of the same	0.022
Width of the palate at the third premolar	0.034

It may be noted from the above measurements that the first true molar is a good deal smaller than the second.

PROCAMELUS, Leidy.

Proc. Phila. Acad., 1858, p. 89; Extinct Mammalia Dakota and Nebraska, 1869, p. 147.

The dental formula of this genus is I. $\frac{1}{3}$; C. $\frac{1}{1}$; Pm. $\frac{4}{4}$; M. $\frac{3}{3}$. The number of teeth of the superior series anterior to the true molars was left uncertain by Dr. Leidy, and I was able to complete our knowledge of it after an examination of Colorado specimens. I ascribed three superior incisors to this genus at that time, as they are possessed by the species which I named *Procamelus heterodontus*. Having obtained in New Mexico the nearly entire cranium of the *P. occidentalis*, I find that the single lateral incisor found in the existing *Camelidæ* is the only one that can be properly assigned to this genus. In this specimen, it is true, a small alveolus on one side contains a small crown of a second incisor, but, on the opposite side, the corresponding one is shallow and empty. As the last molar is not fully protruded, it would appear that this incisor is a temporary tooth, being removed before the maturity of the animal. It thus differs from the existing Camels only in the longer persistence of these transitory incisors. The position of the first incisor, in the specimen in question, is marked by a roughness of the surface, which indicates the still earlier removal of a tooth, and filling up of the alveolus. In the *P. heterodontus*, of which the superior dentition of an adult is in my possession, the alveoli of the three superior incisors are large and deep, showing that the dental formula is I. $\frac{3}{3}$; C. $\frac{1}{1}$; Pm. $\frac{4}{4}$; M. $\frac{4}{4}$. The alveoli are empty in the specimen, but this is doubtless due to their regular funnel-shape, which gives little hold for the conic, though elongate fangs. This animal, then, represents a genus distinct from *Procamelus*, defined by the dental formula just given, for which I have proposed the name of *Protolabis*.* The typical and only known species is *Protolabis heterodontus*, Cope, from the Loup Fork beds of Northeast Colorado.

* Proc. Acad. Phila. 1876, p. 145.

In *Procamelus occidentalis*, an extensive fossa is situated above the posterior premolar series of teeth, and greatly contracts the middle of the facial part of the skull. These fossæ are represented by rudiments in the *Auchenia lama.* In addition, the cavities known as "larmiers" in the *Cervidæ* are well developed in this genus, being many times as large as in the Llama, and quite equal to those possessed by some Deer. There are no lachrymal fossæ. The supraorbital foramen communicates with the superciliary border by an open fissure; the lachrymal bone is large. The cranium resembles that of the Llama in its moderate sagittal crest, elongate paramastoid process, and otic bulla, and the downward production of the pterygoid bones. The incisive foramina are narrow and distinct.

The ulna and radius are thoroughly coössified. The carpus displays the characters of the *Camelidæ* in the absence of trapezium and distinctness of trapezoides, and the subequality of the magnum and unciform facets of the lunar. There are but two metacarpals, which, in the specimen described, are only coössified in their proximal half. As the epiphyses of the vertebræ are not yet united, the present animal is not fully adult. In an older specimen, the cannon-bone is doubtless completed. In the tarsus, the cuboid and navicular bones are distinct, as in the existing Camel.

I obtained a complete cast of the cranial chamber of the *Procamelus occidentalis*, which bears a fair proportion to the general dimensions of the skull. As compared with a Llama of about the same size, the facial portion of the skull is longer, while the postorbital portion is as long, but narrower. This is indicated by the following measurements:

	Procamelus occidentalis. M.	*Auchenia lama.* M.
Length of the skull anterior to the orbit	0.180	0.153
Length of the skull posterior to the orbit	0.110	0.105
Width of the skull at the anterior border of the orbit	0.080	0.090
Width of the skull at the middle of the zygomatic fossa	0.062	0.065

The olfactory lobes of the brain have nearly the same position in the two species, extending anteriorly to opposite the middle of the orbits.

The brain exhibits large cerebellum and hemispheres and rather small olfactory lobes. The cerebellum is entirely uncovered by the hemispheres, but is in contact with them. The lateral lobes and vermis are well developed. The hemispheres are well convoluted, the longitudinal posterior convolutions giving way anteriorly to lobulate ones. The Sylvian fissure is well marked. The sides of the medulla oblongata are compressed and vertical at the pons, in correspondence with the vertical position of the petrous bones. The origins of the ophthalmic and maxillary branches of the trigeminus nerve are not divided by a septum, while that of the mandibular branch is quite distinct from the others. The optic nerves are large. The olfactory lobes are separated by a deep fissure below the extremity of the hemispheres; they project freely beyond the latter, being separated by a deep fissure. Their free portions are short, truncate, and compressed. The anterior pyramids are not preserved on the inferior face of the cast of the medulla oblongata. The hippocampal lobes are subround and protuberant.

From the description given under the head of the *P. occidentalis*, it may be derived, that while the arrangement of the convolutions of the anterior lobes of the hemispheres is more simple than in any recent Ruminant, that of the middle and posterior lobes is essentially similar to that characteristic of the latter order of *Mammalia.**

A number of specimens of individuals of this genus were obtained, which are referable to two species, a smaller and a larger. Still larger individuals may be referable to a third species of the genus, or to the *Pliauchenia vulcanorum*, whose teeth occur in the same localities. Three species, having similar relations of size, were originally described by Dr. Leidy, from Nebraska, under the names of *P. gracilis*, *P. occidentalis*, and *P. robustus*, and the first two are probably those found in the Santa Fé marls. In the corresponding horizon in Colorado, the proportions of the jaws and teeth of the *Procameli* obtained do not coincide with those of the species named by Dr. Leidy, one being intermediate in size between the *P. gracilis* and the *P. occidentalis*, and another intermediate between the latter and the *P. robustus*. The first I identified provisionally with the *P. occidentalis*, but I believe it to be distinct, and name it *P. fissidens*.† The second species is the *P. angustidens*, Cope.

* See Paul Gervais, Journal de Zoologie, i, 1872, p. 459.

* *Procamelus fissidens*, Cope (*? P. occidentalis*, "Leidy", Cope Ann. Rept. U. S. Geol. Surv. Terrs., 1873, p. 531).—This species is distinguished by the shortening of the series of true molar teeth as compared with the premolars; for, while the second, third, and fourth premolars are similar in dimensions to those of the *P. occidentalis*,

Procamelus gracilis, Leidy.

Proc. Acad. Phila., 1858, p. 89; Extinct Mammalia Dakota and Nebraska, 1869, p. 155.

An imperfect mandible, with the symphyseal portion complete, supporting several incisors and canines, and the bases of the first four molars, represents the smallest species of the genus known to me, which is probably the *P. gracilis* of Leidy. I give measurements of the fragment:

Measurements.

	M.
Length of the jaw to the end of the fourth molar	0.127
Length of the symphysis	0.053
Length to the base of the canine	0.020
Length to the first premolar	0.044
Length to the second premolar	0.076
Length to the first true molar	0.108
Depth of the ramus at the first true molar	0.033
Depth of the ramus at the second diastema	0.023

The canine tooth rises close behind the external incisor, and the mental foramen is below the first premolar.

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the true molars are considerably smaller. The crowns of the latter are stout, and not narrowed, nor furnished with an antero-external ridge, as in *P. angustidens*, and the anterior external crescent projects free posteriorly in an oblique angular rib on the external face of the crown, being separated from the second crescent by a deep fissure. The last inferior molar is not very elongate, and the fifth lobe has a crescentic section, *i. e.*, is concave on the external face, as in the *P. angustidens*.

The inferior border of the ramus is straight from the first true molar posteriorly. The anterior face of the coronoid process is oblique outward. The edge of the masseteric insertion forms a low ridge, concentric with the convex posterior border of the jaw. Like the inner face of the same portion of the jaw, the surface is flat.

Measurements.

	P. fissidens. M.	*P. occidentalis.* M.
Length of the entire molar series	0.112	0.126
Length of the premolars	0.0385	0.042
Length of the second true molor	0.023	0.0275
Width of the same	0.015	0.0165
Length of the third true molar	0.033	0.036
Width of the same	0.014	0.014
Depth of the ramus at the first true molar	0.035	......
Depth of the ramus at the middle of the last molar	0.040	0.051
Depth of the ramus at the apex of the coronoid process	0.140	......
Depth of the ramus at the condyle	0.108	0.118
Depth of the ramus at the postcondylar angle	0.069	0.085

One ramus nearly entire and the molars of another (excepting the last) were obtained near the Pawnee Buttes of Northeastern Colorado.

Procamelus occidentalis, Leidy.

Plates liii, fig. 2; lxxvi; lxxvii, figs. 1-3; lxxviii, figs. 1-9; lxxix.

Leidy, Proc. Phila. Acad., 1858, pp. 23, 89; Extinct Mammalia Dakota and Nebraska, 1869, p. 151.—Cope, Ann. Rept. Chief of Engineers, 1875, ii, p. 990, pl. ii.

The cranium and a considerable part of the skeleton of this species were excavated from a soft calcareous sandstone near the Pueblo village of Pojuaque by myself and assistant, and were preserved in good condition. They have given to paleontologists the first definite information as to the structure ot the limbs and cranium in this genus of extinct Camels.

The *cranium* is long and anteriorly narrow; its width is about equal to that of the Llama, but it is considerably longer, the excess being chiefly in front of the orbits. The sagittal crest is short and continues into the exoccipital crests, which themselves continue forward into the zygomata. The brain-case is rounded laterally and above in cross-section, descending slightly to the interorbital region, which is plane. The nasal bones are elongate and quite narrow, but do not project beyond the anterior border of the premaxillaries, with which their lateral borders are in contact for nearly an inch. The premaxillaries are produced downward and forward, and are of subequal width, until they turn horizontally forward, when they narrow to a slightly recurved acuminate apex. About half-way between this point and the orbit, the maxillary bone is extensively concave, thus narrowing the straight bridge of the nose. The space above the diastema is also concave in a longitudinally oval form. The malar ridge of the maxillary is not very prominent, continuing into the beveled and grooved inferior face of the malar bone. The anterior part of the latter rises to a point a little above the middle of the front of the orbit, and is in contact with the entire inferior border of the lachrymal. The lachrymal is a wide subparallelogrammic bone, wider behind, with its long axis directed downward and forward. It separates the lachrymal sinus by a rather narrow space from the orbit. The lachrymal sinus is large, longitudinal, and diamond-shaped; the maxillary or antero-inferior and the frontal or postero-superior borders being the longest. The orbit is completely closed, and is nearly round. Its superior and posterior borders are crenulated; the inferior is thin and entire. The low ridges from the postfrontal regions which bound the temporal fossæ do not unite anterior to the middle of the parietal bone.

The malar bone is deeply notched to receive the elongate wedge of the zygomatic process of the squamosal; its external face is concave. The zygomatic process is low, and but little expanded laterally.

The *otic bullæ* are especially large, projecting far downward. They are filled with cancellous tissue. They descend vertically from the *meatus auditorius* much below the basicranial axis, their long transverse axis being directed forward and inward. They present a deep, vertical stylohyal fossa, opening backward and then outward. The inner wall of this fossa is continued into the paroccipital process, forming a wall directed outward and backward to the apex. The paroccipital process is nearly transverse at its superior part where the external margin is rolled forward. It is not very long, not quite reaching the line of the inferior borders of the occipital condyles. Superiorly, the plane of its margin rises to the inion, and its posterior border turns backward into the occipital condyle. The middle of the space inclosed between the former ridge and the glenoid cavity is pierced by the round *meatus auditorius externus*, which has a prominent margin. In front of the anterior margin is a deep crescentic groove concentric with it. The inion is very prominent. The occipital region rises vertically from the foramen magnum, and its superior border is produced posteriorly. In transverse section, this region is very convex medially, and deeply concave on each side above the bridge connecting the paroccipital process with the condyle. A large foramen pierces the occipital bone in the fundus of this concavity.

On viewing the cranium *from below*, one is struck by the great inequalities of its surface. The occipital condyles inclose, with the paroccipital processes, a deep and wide fossa on each side. The bullæ are very protuberant, but do not project so far as the the pterygoid processes of the sphenoid bone. The palate is extremely narrow at the diastema between the first and second premolars, and gradually widens forward until, between the external incisors, it is as wide as between the second premolars. The apices of the premaxillaries are separated by a deep notch. The posterior angle of the maxillary bone projects well beyond the notch, separating it from the *processus triangularis* of the palatine bone, which carries the palatal roof back nearly as far as the posterior margin of the last molar. Anteriorly, the palatine bones extend as far as the line of the middle of the anterior column of the second true molar. The posterior nareal trough is very deep, rather short, and wider behind, owing to the gentle lateral spreading of the pterygoid processes of the alisphenoid. The occipital condyles converge rapidly below, and are almost in contact medially. The basioccipital is angulate in the anterior two-thirds of the middle line. The posterior portion is marked by an angulation on each side, which renders the inferior surface flat. The sphenoid is still more strongly angulated on the middle line, so that it is separated from the walls of the nareal fossa by an archway on each side.

Foramina.—The lachrymal canal opens on the inside of the orbit. The supraorbital foramen is connected by a deep fissure with the orbital margin. The *foramen infraorbitale anterius* opens above the anterior portion of the first true molar tooth. The incisive foramina are narrow ovals, extending from opposite the position of the second incisor tooth to half-way between the third incisor and canine tooth. They are separated by the posterior processes of the premaxillary. The external nares form a narrow oval, acuminate in front and below, and notching each nasal bone posteriorly and above. The palatine foramina are round and opposite the division between molars fourth and fifth, in the middle of the palatal face of each maxillary bone. The *foramen ovale* is round, and is situated at the apex of the deep notch which separates the anterior boundary of the otic bulla from the posterior border of the pterygoid process of the sphenoid. It is isolated from the *foramen lacerum anterius.* The latter is relatively small, and is nearly as wide as long. The *foramen lacerum posterius* is well separated from it, owing to the close appression of the otic bulla and basioccipital bone. It is divided into two foramina, of which the posterior is the *foramen jugulare*, while the anterior is the vagal foramen. There is no distinct carotid foramen, but the *foramen glenoideum* is present, of moderate size. The *foramen condyloideum anterius* is rather small, and is situated immediately under the anterior part of the condylar surface.

Besides the difference in proportions already mentioned, several important characters distinguish the cranium of this species from that of the Llama. One of these is the very slight palatal notch, which only extends to the line of the extremities of the last molars. In the Llama, it is deep, reaching the line of the middle of the penultimate molars. Second, the basioccipital is flat in the Llama, and the sphenoid only rounded; in the *P. occidentalis*, both are angulate or keeled. Third, the *foramen magnum* has a V-shaped superior border in the Llama; in the *P. occidentalis*, it is slightly notched at the middle of the superior border. Fourth, the pterygoids are only angulate in the extinct animal, not produced into processes as in the Llama. Fifth, the palatal foramina in the Llama have a more anterior position, issuing in front of the third (first) premolar. The glenoid and condylar foramina are much larger in the Llama.

The *teeth* of the specimen described are in good preservation. The external incisors and canines are alike, their crowns being slightly-compressed cones. The space between them is about equal to that separating the canine and first premolar, while the space between the first and second premolars is greater. The second premolar is small, half as large as the third, is compressed, and has a slight anterior cusp. The third consists of a small anterior cusp and a long posterior blade. A strong basal cingulum represents the interior crescent. The fourth premolar is little longer than the third, but differs from it in the possession of an inner crescent; its external angles are prominent, separating a concave face. The true molars are rather narrow. The anterior horn of each crescent is prominent, representing the section of a prominent ridge; between the ridges, the external face of the lobes is flat or concave. There is no enamel on the outer wall of the inner crescents in the last two molars. The enamel is smooth, and is without cingula. As compared with *Auchenia lama*, the molar teeth are larger and longer, and lack the prominent ridges on the external faces of the external crescents. The incisors and canine teeth have not the compressed trenchant form of those of the Llama.

Measurements.

	M.
Total length of the skull below	0.303
Length (axial) to the external incisor	0.023
Length (axial) to the canine	0.041
Length (axial) to the first premolar	0.061
Length (axial) to the second premolar	0.093
Length (axial) to the first true molar	0.126

Length (axial) to the end of the true molars	0.202
Length (axial) to the palatal notch	0.196
Length (axial) to the end of the nareal fossa	0.233
Length (axial) to the basioccipital	0.255
Length (axial) to the occipital condyles	0.282
Width at the external incisors	0.028
Width at the posterior diastema	0.015
Width between the extremities of the last molars	0.060
Width of the nareal fossa behind	0.031
Width between the otic bullæ interiorly	0.025
Width between the same exteriorly	0.075
Width of the occipital condyles	0.045
Width of the foramen magnum	0.020
Width of the external nares	0.023
Width of the bridge of the nose at the middle	0.020
Width of the front between the orbits	0.090
Width between the zygomata	0.117
Width of the brain-case	0.061
Width of the occiput	0.069
Length of the first true molar	0.0220
Width of the same	0.0165
Length of the second true molar	0.0310
Width of the same	0.0165

Of *vertebræ*, there were obtained a number of cervicals, dorsals, and lumbars. The cervicals are, as in other *Camelidæ*, disproportionately large, and display the typical character of the group in the absence of the vertebral canal. The atlas is rather short, and the transverse processes not much expanded laterally. They commence in front at the edge of the occipital cotylus, and expand backward, extending half an inch outward from, and an equal distance posterior to, the face for the axis. The anterior border has four notches, two larger and two smaller. The latter are lateral, and divide the occipital cotyli for half their depth. Of the former, the inferior is the wider, and does not separate the cotylar surfaces, which the superior notch does. The neural canal is anteriorly depressed, posteriorly round. The vertebral foramen enters at the superior base of the transverse process, and reappears on the inferior side at the posterior end of a fossa. At the anterior end of this fossa, it again pierces the neurapophysis, entering the neural canal, just behind the cotylar surface, on the upper side of the canal. At the point of exit, it also pierces the superior wall of the canal. There is no *tuberculum atlantis*, nor neural spine. The axis is elongate. Its odontoid process is only reverted at the sides near its base. In its distal half, the superior face is plane or convex, with a subacute margin all round. The articular faces of the centra of the other cervicals are plano-convex, the anterior ball being a good deal flattened. There is a sharp hypapophysial angle, which terminates behind in a short tuberosity. The transverse processes extend the entire length of the centrum, and are greatly expanded, forming a broad lamina, with concave inferior face, and produced downward and outward in front. Above this, the sides of the vertebra are concave, the open groove being bounded above by a strong obtuse angle, connecting the zygapophysis. The neural spine is represented by a low ridge, which extends between two angles or ridges of the surface, which come together a little behind the border of the neural canal, obliterating the median keel. The posterior dorsals, with the diapophysis low down, are rounded below. The zygapophyses are embracing, and the neural spine is rather high. The anterior lumbars have a median inferior angulate keel, while more posterior lumbars have an additional angle on each side of the median one. The articular extremities are nearly plane.

Measurements.

	M.
Length of the atlas on the median line above	0.035
Length of the atlas on the lateral border	0.069
Width of the atlas in front	0.051
Depth of the atlas in front	0.027
Diameter of the neural canal behind { vertical	0.026
Diameter of the neural canal behind { transverse	0.026
Transverse extent of atlas behind	0.072
Transverse extent of axis anteriorly	0.046
Length of the odontoid process	0.016
Length of an anterior cervical (below)	0.082
Diameter of the anterior ball { vertical	0.019
Diameter of the anterior ball { transverse	0.021
Expanse of the anterior zygapophyses	0.040
Least external width of the neural arch above	0.021
Length of a more posterior cervical below	0.080
Width of the same between the diapophyses in front	0.076
Width of the same between the diapophyses behind	0.066
Length of the centrum of the posterior dorsal	0.035
Diameter of the same posteriorly { vertical	0.019
Diameter of the same posteriorly { transverse	0.028
Height of the neural arch	0.011

Height of the neural spine above the arch		0.042
Length of a posterior lumbar		0.039
Diameter of the centrum behind	vertical	0.017
	transverse	0.027
Expanse of the posterior zygapophyses		0.022
Length of the base of diapophysis		0.016

The *atlas*, as compared with that of *Auchenia lama*, is similar in size, but the neural canal is smaller, its diameter in the Llama being 0.028 behind. The foramina are relatively still larger in the Llama. In the axis, it is noteworthy that the odontoid process is not so extensively excavated on the superior surface. The other cervicals are relatively and absolutely smaller than in the Llama, and the transverse processes are more widely expanded, especially along the middle of the centrum. The low neural spine of the recent species is wanting in the extinct one. The lateral angles of the inferior aspect of the centrum of the lumbar vertebræ of the *P. occidentalis* are wanting in the Llama.

The entire *fore limb*, with the exception of the two distal pairs of phalanges, is preserved with the proximal part of the scapula. The glenoid cavity of the latter is nearly semicircular in outline. The coracoid process is a thick protuberance, extending in the long axis of the glenoid cavity, which, toward its extremity, sends inward, at right angles, a flat hook, concave on the posterior side. The spine rises abruptly at its origin, and is continuous for a short distance with the anterior border of the scapula. The humerus is rather slender, and is characterized by the large size of the tuberosities. They are connected at their bases, the connecting mass inclosing a deep fossa with the head, or condyle. The greater tuberosity is produced much beyond the head *proximally*, but not much beyond the line of the anterior border of the shaft. Its extremity is curved inward and upward. The lesser tuberosity is parallel with the external face of the greater, and nearly with the long axis of the head, and only projects beyond the connecting mass by a keel. A tuberosity divides the bicipital sinus into two grooves. Not far below the head, the anterior border of the shaft presents a rather compressed protuberance. The condyles are compressed, and with a trace of epicondylar tuberosity on the outer side only. The olecranar fossa is deep and narrow, and the radial fossa is contracted and not very deep. On the inner side of the anterior face, just above the condyle, is a shallow excavation for contact with the head of the radius on flexion. The intertrochlear ridge is an obtuse angle.

The coössified *ulna* and *radius* form a slender bone, with a slight convexity of the inner border at the proximal fourth, but otherwise nearly straight. The proximal end of the ulna is much compressed and subacute below. The humeral cotylus is narrowed backward from the radius, and is equally divided by a strong longitudinal keel. The olecranon descends immediately from the coronoid process. A very narrow fossa (perhaps a foramen) separates the extremity of the ulna, and a groove bounds the narrow epiphysis of the same on the inner side. The three distal facets are all distinct, the lunar being a little the narrowest. The ligamentous groove of the superior (anterior) face is wide and smooth. The external side of the extremity presents a shallow fossa; above the internal extremity, the inner border is protuberant. The metacarpals still exhibit a trace of the common suture throughout the length, but there is no groove on the anterior face. The posterior face is concave for the proximal two-thirds. There are no faces for rudimentary lateral metacarpals. The distal fissure is deep, and the condylar carinæ large, but obtuse, and extending only on the posterior half of the condyle. The proximal interosseous foramen is minute, if present.

In comparing the scapula and fore limb of the *Procamelus occidentalis* with that of the *Auchenia lama*, the following relations are noticeable:—The bones are of the same length, but those of the extinct species are more slender. The portion of the scapula of the latter preserved resembles that of the Llama much, but the glenoid cavity is narrower. The humerus differs much in its proximal portion. The great tuberosity of the Llama is far less prominent in all respects, while the lesser and intermediate tuberosities are more so, the three together forming a much wider mass than in the *P. occidentalis*. The deltoid crest is curved backward in the Llama, which it is not in the fossil species. The condyles are much more robust in the Llama. In the ulno-radius, it is to be observed that the carina of the humeral cotylus is much less prominent in the Llama, and the olecranon does not descend so steeply from the coronoid process. The proximal interosseous foramen does not penetrate in the Llama, while it does in the *Procamelus*. The superior distal ligamentous groove is exterior in the Llama, nearly median in *P. occidentalis*. The cannon-bone is similar, but more slender. The carpal bones, although less robust, nearly resemble those of the Llama, but the magnum and unciform facets of the lunar are more nearly equal than in that species. The pisiform is large and expanded distally. Its cuneiform and radial facets are equal. The phalanges only differ from those of the Llama in the greater prominence of the proximal ligamentous insertions and the rather more slender shafts.

Measurements.

	M.
Long diameter of the proximal end of the scapula	0. 054
Long diameter of the neck of the scapula	0. 031
Long diameter of the glenoid cavity of the scapula	0. 035
Short diameter of the same	0. 029
Length of the humerus	0. 250
Diameter of the proximal end { long	0. 073
Diameter of the proximal end { short	0. 050
Long diameter of the head	0. 040
Projection of the greater tuberosity beyond the head	0. 034
Long diameter of the shaft at the middle	0. 030
Transverse diameter of the distal end	0. 040
Antero-posterior diameter of the same	0. 040
Length of the ulno-radius on the chord	0. 350
Depth at the head of the radius	0. 040
Depth at the middle of the shaft	0. 015
Width at the middle of the humeral cotylus	0. 012
Width at the middle of the shaft	0. 023
Width of the distal end of the radius	0. 042
Depth of the same	0. 027
Length of the cannon-bone	0. 226
Proximal diameter { antero-posterior	0. 023
Proximal diameter { transverse	0. 032
Transverse distal diameter	0. 041
Length of the carpal series	0. 025
Length of the lunar	0. 018
Width of the same	0. 013
Depth of the same	0. 022
Length of the pisiform	0. 025
Vertical width of the same	0. 019
Length of the trapezoides	0. 012
Width of the same	0. 012

Brain.—This organ displays the characters of the older types of *Ruminantia*, although not materially smaller than that of the Llama, an animal which it equaled in general proportions. The hemispheres are, however, not produced so far posteriorly in the *Procamelus* as in the *Auchenia*, reaching only to the line of the *meatus auditorius externus* in the former. The vermis of the cerebellum rises abruptly from the medulla, having a nearly vertical direction to a point a little lower than the superior plane of the hemispheres. The lateral lobes extend on each side of it, each one having a rather greater width than the vermis. Their posterior faces are subvertical, and are directed slightly forward. Each projects laterally into an apex at the middle of its elevation, and then contracts downward into the angular line which marks the posterior border of the petrous bone. From a point between each apex and the vermis, a ridge rises obliquely inward to the superior plane of the cerebellum, where each one enlarges and joins the median transverse line. The angle above described as descending from the lateral apex of the cerebellum curves forward, forming a lateral angular border of the *pons varolii* on each side. The flat space inclosed between this line and the posterior border of the hemisphere is interrupted by two prominent tuberosities. The superior is small and suboval, and is near to the posterior border of the hemisphere. The other is a short, prominent ridge, directed downward and forward, just behind the *lobus hippocampi*. Its inferior end corresponds with the origin of the mandibular branch of the trigeminus and perhaps the facial nerve.

The medulla oblongata is contracted at the foramen magnum, and has a subround section slightly flattened below. Its inferior face is then rounded, then flattened, and then concave between the anterior part of the lateral ridges. The bases of the maxillary branches of the trigeminus nerves are stout, and directly in line with the origins of the mandibulars. Between them, the base of the brain is concave, and the optic nerves issue but a little distance in front of them. The *lobi hippocampi* are subround and rather prominent. They are terminated in front at the *foramen sphenoörbitale* by the contraction of the cranial walls. Their surface displays slightly-defined convolutions, the best marked being inferior and subround in form.

The cerebral hemispheres, viewed from above, have an oval outline, and are rather narrower anteriorly than posteriorly. They contract posteriorly from the Sylvian convolution. The profile descends gradually to the olfactory lobes. The superior surface is little convex in the transverse direction. The fissure of Sylvius is nearly vertical in position, and its superior extremity is visible from above. A strongly-marked fissure extends posteriorly from it, defining the *lobus hippocampi* above. The Sylvian convolution is the thickest of all, and its outer border is emarginate in front and behind. Below the postero-superior emargination, it is thickest and most protuberant. Between it and the position of the falx, there are three longitudinal convolutions, the external, the median, and the internal. These are slightly divergent posteriorly, but the posterior extremities of those of one side tend to unite on the posterior border of the hemisphere. Their surfaces are smooth. The external is widest medially, and it terminates anteriorly just behind the apex of the Sylvian convolution. The internal is double posteriorly. The median is simple, and unites with the internal above the apex of the Sylvian convolution. The two conjoined continue for a short distance, and terminate in a broad tuberosity. Below the external convolution, on the side of the posterior part of the hemisphere, there are four small longitudinal convolutions. The orbital portion of the hemispheres is extensive, and nearly smooth from the olfactory lobes to the supraorbital border. This is not prominent, but is represented by a short longitudinal ridge. Above each of these, on the superior or front aspect of the hemispheres, is a massive convolution, bent crescent-shaped, with the convexity inward. The posterior part of the convolution is a subround tuberosity, which stands opposite to, and in front of, the furrow separating the Sylvian and median convolutions. The middle part of the crescent is less prominent, but the anterior extremity forms another tuberosity, whose long axis is directed downward and outward. The crescentic convolution of the one side is separated from that of the other by a wide, shallow, median, longitudinal groove, which extends transversely at the posterior tuberosities. The two tuberosities and the olfactory lobes form three descending steps.

As compared with the brains of the existing *Bovidæ*, that of the *Procamelus* differs in the forms of the cerebellum and medulla oblongata, as already pointed out. The hemispheres differ in being shorter behind and more depressed in front. The convolutions of the posterior region are the same in number as in the Sheep, but are less undulating in their outlines; but there is a marked difference in the anterior convolutions. The median convolutions do not, as in the Sheep, extend to the extremity of the anterior lobe, but terminate above the Sylvian fissure, so that there only remain in front of them the two large supraorbital convolutions, instead of the four common to existing *Bovidæ* and *Cervidæ*.* In this respect, it more nearly resembles *Oreodon*, but, in this genus, the internal convolution is continuous with the supraorbital.†

A fragmentary *lower jaw* of a second individual exhibits nearly all of the lower molars. They present the proportions of those of the *P. occidentalis* from Nebraska, and are not compressed, or otherwise like those of the *P. angustidens.*

Restoration.—As a result of the preceding examination, it is evident that the *Procamelus occidentalis* was an animal of about the size of the Llama, but one of more symmetrical proportions. The neck was not quite so disproportionately long, while the limbs were more slender and the head and muzzle more elongate. The muscular insertions being generally more prominent, we may conclude that it possessed in life greater muscular power, and especially agility.

PLIAUCHENIA, Cope.

Proc. Acad. Phila., 1875, p. 258; Ann. Rept. Chief of Engineers, 1875, ii, p. 989.

This genus is established on the dental characters exhibited by a mandibular ramus, in the following formula: I. ? 3; C. 1; Pm. 3; M. 3. The absence of a premolar tooth distinguishes this genus from *Procamelus*, the second, or first of the continuous series, being the one omitted. A portion of the left maxillary bone of a larger species is thought to belong to the same genus, although it presents the number of premolars found in *Procamelus*, viz, four. The first and second are, however, very close together, so as to leave about the same relative interval between the first and third as is seen in the *P. humphresiana*, should the second premolar be omitted

* See Leuret et Gratiolet, Anatomie comparée du Système Nerveux, 1839–57, Atlas, plates vii–x.

† Leidy, Extinct Fauna Dakota and Nebraska, plate xiv, fig. 11.

The latter tooth is wanting from the lower jaw of the *P. humphresiana*. The difference in dental formula between the superior and inferior dental series admitted provisionally in *Pliauchenia* finds justification in the formula of the Llamas (*Auchenia*), where the premolars are $\frac{2}{1}$.

The line of descent of the Horses has been already traced by several paleontologists. Another series has been nearly completed by recent discoveries,* viz, that of the Camels. I have already indicated† the antecedent relation in which the Miocene genus *Poëbrotherium* stands to the existing Camels in the structure of the limbs and teeth, as well as the intermediate position occupied by *Procamelus* in the characters of the incisor teeth. It now remains to point out the relations determined by the structure of the feet in *Procamelus*, and the dentition in *Protolabis*, and as described in the preceding pages. Commencing with the earliest genus, *Poëbrotherium*, we have the molar teeth 4–3, as in the primitive *Mammalia* generally. There are but two elongate metacarpals, which are not united into a cannon-bone; the lateral ones being rudimental, while the carpals are of the number characteristic of the *Mammalia* of all the orders with numerous toes, namely, seven. In *Protolabis* of the succeeding formation, the molar formula continues to be 4–3, but the posterior teeth are more prismatic in form than in the Miocene genus. The incisor teeth are present, thus displaying the primitive character of the class generally; though, as these teeth are easily shed, an approximation to the edentulous condition existing in this part of the mouth of Ruminants is apparent. It is in *Procamelus* that the incisor dentition of the existing *Camelidæ* is first seen, but that genus still retains the molar dentition of the primitive character, the formula being Pm. $\frac{4}{4}$; M. $\frac{3}{3}$. In the feet, the approximation to the existing *Camelidæ* is greater than in the dentition. Thus, the lateral rudimental metacarpals of *Poëbrotherium* have disappeared, and with them the trapezoides of the carpus. The magnum remains distinct, while the middle metacarpals are united at full age into a cannon-bone. In the contemporary genus *Pliauchenia*, a further modification of dentition is observed. As above stated, the molars of *Procamelus* number $\frac{4-3}{4-3}$; in *Camelus*, they number $\frac{3-3}{2-3}$; in *Pliauchenia*, we

* See Proc. Acad. Phila., 1875, p. 261.

† Bull. U. S. Geol. Survs. Terrs., No. i, 1874, p. 25; Ann. Rept. 1873 (1874), p. 500.

have the intermediate condition $\frac{?4-3}{3-3}$. The end of the series is seen in *Auchenia*, where the formula is $\frac{2-3}{1-3}$.

The evolution of the existing types of *Camelidæ* is a good illustration of the operation of the laws of acceleration and retardation. In evidence of this, we may follow the growth of the foot and dentition of the most specialized, and therefore the terminal genus of the series, the American *Auchenia*. It is well known that the animals of this genus, in common with other Ruminants, have the constituent metapodials of the cannon-bone distinct during a longer or shorter portion of fœtal life. As these elements are permanently distinct in the oldest or Miocene genus *Poëbrotherium*, it is evident that acceleration of the process of ossification has caused their union at successively early periods in the genera of later ages. This is indicated by the long duration of their separation in the Loup Fork genus *Procamelus*. It is also well known, since the time of Goodsir, that the embryos of Ruminants exhibit a series of superior incisor teeth, which disappear early. It is probable, but not certain, that, in the Miocene genus *Poëbrotherium* as in various contemporary Selenodont *Artiodactyla*, the superior incisors persisted. I have, however, discovered that these teeth persisted in the Loup Fork genus *Protolabis* during adult life. I have also found that one (the second) of these teeth in *Procamelus occidentalis* persisted without being protruded from the alveolus until nearly adult age. In genera (*e. g.*, the Bunodont *Artiodactyla*) where the incisors are normally developed, they appear at about the same time with the other teeth, and continue to develop to functional completeness. This development is retarded in *Protolabis*, since they are not so matured as to remain fixed throughout life in their alveoli. In *Procamelus*, the retardation is still greater, since the first incisor reaches very small dimensions, and is with its alveolus early removed, while the second incisor only grows large enough and for a sufficient time to occupy a shallow alveolus, without extending beyond it. In the first incisor, the process of retardation has reached its necessary termination, *i. e.*, atrophy* or extinction, while in the existing *Camelidæ* the second incisor also has disappeared in the same way. In Ruminants other than *Camelidæ*, the third or external incisor has undergone the same process,

* See Proc. Acad. Phila., 1876, p. 17, for an explanation of these terms.

while in the *Bovidæ* the canines also have been retarded in development down to atrophy.

In the genus *Auchenia*, as has been pointed out, the premolar teeth are two in number; in *Poëbrotherium* of the Lower Miocene, they number four, the first and second of the normal Mammalian series being present. The first premolar is present in *Poëbrotherium*, *Protolabis*, *Procamelus*, *Pliauchenia*, and *Camelus*. It is wanting in *Auchenia* and other *Ruminantia*. In the latter, it is present in the fœtus, but soon disappears. In *Auchenia*, according to Owen, it is retained for a somewhat longer time.* Thus retardation of the growth of this tooth is first seen in the latter genus so far as known, and is more pronounced in the other *Ruminantia*. The second premolar is present in *Poëbrotherium*, *Protolabis*, and *Procamelus*. It is absent in *Pliauchenia*, *Camelus*, and *Auchenia*. In the last two genera, it is a transitional character of immaturity, and we may infer that this is also the case with *Pliauchenia*. It is thus evident that retardation, in the supply of nutritive material to this tooth, has caused its reduced size, and terminated the duration of its existence. This has not occurred in the other lines of *Ruminantia*, where it remains as in *Poëbrotherium*. From these and many analogous cases, the general law may be deduced, that *identical modifications of structure, constituting evolution of types, have supervened on distinct lines of descent.*

It has been observed, as a remarkable fact, that North America should present us with the most complete history of the succession of genera which resulted in the Horse, and yet should have received this animal by importation from Europe. Nevertheless, the more prominent genera of this series have been obtained in the European formations, especially *Anchitherium* and *Hippotherium*. But, as regards the *Camelidæ*, the genera above described are exclusively North American, no well-determined form† of this group having been found in any formation of the Palæarctic region up to the present time. Until such are discovered, there will be much ground for supposing that the Camels of the Old World were derived from American ancestors, while the presence of the Llamas in the existing South

* Odontography, p. 530.

† *Merycotherium*, Bojanus (Nova Acta Acad. Leop. Car. Nat. Cur., vi), has not yet been distinguished from *Camelus*.

American fauna indicates the absence there of the conditions which caused their extermination from North America.

Pliauchenia humphresiana, Cope.

Plate lxxvii, fig. 4.

Proc. Phil. Acad., 1875, p. 258; Ann. Rept. Chief of Engineers, 1875, ii, p. 989.

The animal now described is of about the size of the *Procamelus occidentalis*, or somewhat larger than any of the existing Llamas. The mandible is stout and deep, contracting rapidly forward. The canine and first premolar are especially stout, and separated by a very short diastema; that separating the first and third premolars is also short, being less than that which separates the first and second in *Procamelus occidentalis*. Could it be supposed that the second premolar is abnormally absent from the *P. humphresiana*, the diastema would be reduced to a very small compass. Without this supposition, the diastemata, both before and behind the first premolar, are shorter than in any of the *Procameli*, as *P. robustus*, *P. angustidens*, *P. heterodontus*, and *P. gracilis*. The mental foramen issues below the anterior border of the first or cuniform premolar, and the anterior border of the latter marks the posterior margin of the symphyseal suture. The third premolar is nearly as long as, but narrower than, the fourth, and the true molars increase rapidly in size posteriorly.

Measurements.

	M.
Length of the dental series from the front of the canine to the front of the last molar	0.125
Length from the canine to the first premolar	0.010
Long diameter of the first premolar	0.010
Diastema to the third premolar	0.023
Length of the third premolar	0.011
Length of the first true molar	0.019
Width of the crown of the first true molar	0.011
Length of the crown of the second true molar	0.025

This species is dedicated to Brig. Gen. A. A. Humphreys, Chief of Engineers, U. S. A., in recognition of the enlightened interest in all departments of scientific investigation exhibited in his long and able administration.

Pliauchenia vulcanorum, Cope.

Plate lxvii, fig. 5.

Loc. cit., p. 259; loc. cit., ii, p. 990.

Represented by the left maxillary bone of a Camel of about the size of the existing Dromedary, and considerably larger than the species last described. The dental formula is, molars 4–3. The first premolar is only removed from the second by a diastema equal to the long diameter of the latter. The latter has no inner cingulum, while in the third it is so strong as to constitute an internal crescent. The third is much larger, and exhibits the usual single external and single internal crescents. The first molar is stout, long-rooted, and furnished with a strong ridge on the outer side, bounding the posterior crescent-bearing column in front. There is a weak ridge on the middle of the anterior column, and only a rudiment on the last premolar. There are no cingula on either the inner or outer bases of the crown. The enamel is nearly smooth. A palato-maxillary foramen issues opposite the anterior border of the base of the third premolar.

Measurements.

	M.
Length from the posterior border of the first premolar to the posterior border of the first molar	0.090
Length of the first true molar	0.030
Width of the base of the crown of the first true molar	0.024
Length of the fourth premolar	0.019
Width of the base of the crown of the fourth premolar	0.018
Width of the palate at the first true molar	0.040

The typical specimen was found near Pojuaque, a village of the Pueblo Indians. Various bones of Camels of the size of the *P. vulcanorum* were also found, some of which doubtless belong to it.

Fragments of Camels of the larger proportions of this species are abundant in the Santa Fé marls. One of these is a left premaxillary bone without apex, and with adjacent portions of maxillary. The three included fangs of incisor, canine, and premolar, are robust. A fragment of mandible includes bases of three premolars of the size of those of the *Procamelus occidentalis*, and may belong to that species. A portion of the maxillary bone of a Camel of the same size supports the three milk-molars, and the first permanent molar half protruded. The latter has the dimensions of the corresponding tooth of *P. vulcanorum*. The first milk-molar is elongate, and has a narrow inner crescent formed of an elevated cingulum, which is interrupted in the middle; the second premolar is three-lobed, the posterior two lobes composed of two crescents each. The third molar has a prominent interior intercolumnar style. The external crescents are separated on the outer face by a strong longitudinal fold of the crown.

Measurements.

	M.
Length of the milk series	0.061
Length of the first molar	0.014
Width of the same	0.006
Length of the second molar	0.023
Width of the same	0.010
Length of the third molar	0.026
Width of the same	0.015

DICROCERUS, Lartet.

Dicrocerus, Cope, Ann. Rept. Chief of Engineers, 1875, ii, p. 988.
Merycodus, Leidy, Proc. Acad. Phila., 1854, pp. 90–157; Journ. Acad. Phila., vii, 162.
Cosoryx, Leidy, Journ. Acad. Phila., vii, 173.

Molars $\frac{3-3}{3-3}$, prismatic; last superior premolar with an internal crescent; inferior premolars without internal crescent. Last inferior molar with fifth lobe or heel. Frontal bone supporting solid branched horns, which are normally continuous at the base.

The incisors, canines, and anterior superior premolars of this genus are as yet unknown, as well as the greater part of the skeleton. The distal extremity of the tibia of *D. furcatus* is much like that of the Deer in the downward prolongation of the internal malleolus and anterior tuberosity. The internal border is not preserved in our specimen except so far as to exhibit the anterior malleolar facet. The extremities of two cannon-bones show that they are fully coössified, and contain but a single medullary cavity at the distal third. The trochlear carinæ and lateral angles are fully developed.

The genus *Dicrocerus* was proposed by Édouard Lartet in 1839 for Ruminants which combine the characters of the Deer and the Antelopes. In 1851, the genus was further defined by him, and it was observed that in some of the specimens the horns are continuous with the frontal bones, as in the Antelopes, etc., while in others the basal part of the beam is furnished with protuberances in the form of a burr. These observations have also been made on the American species by myself, and published in the Report on the Vertebrate Fossils obtained in New Mexico (see Annual Report Chief of Engineers, 1874, p. 604). The specimens obtained by the expedition prove that four, perhaps six, species of this genus occur in the Santa Fé marls, one of which had been previously found by myself in the Loup Fork beds of Colorado and two others in the corresponding formations in Nebraska by Dr. Hayden. To one of the latter the name of *Merycodus necatus* was applied by Dr. Leidy in 1854, and *Cervus warrenii* in 1858. The former was represented by mandibles with dentition; the latter by horns. The discovery of crania with horns and teeth, enables me to unite these supposed species. A third species, discovered by Dr. Hayden in Nebraska, was named by Dr. Leidy *Cosoryx furcatus* in 1869. In commenting on this species, Professor Gervais remarks (Journal de Zoologie) that the genus *Cosoryx* is not distinct from *Dicrocerus*, a statement confirmed by the comparison with the figures of the *D. dichotomus*, Gerv., from the French Miocene.

More or less fragmentary horns of nineteen individuals of this genus were obtained by the expedition, of which thirteen, representing three species, include the basal part of the beam. As already remarked, some of these present a basal burr and some do not. Those in which the beam is without burr, or scar of it, are, *D. teres*, 1; *D. necatus*, 5; *D. furcatus*, 1. Those with the burr or scar are, *D. necatus*, 2; *D. furcatus*, 4. The occurrence of both these conditions in the same species indicates that the character, so constant and important in the definition of the existing *Ruminantia*, is here subject to causes the discovery of which will add an important item to the history of the origin of the genera, families, etc., of this order. A consideration of some other parts of the specimens throws additional light on the question.

In a specimen of each of the species *D. furcatus* and *D. necatus*, an antler is broken off, and just below the fractured extremity a burr or ring of osseous tubercles has been thrown out. The free extremity is short, and of spongy material, with an irregular surface devoid of dense layer. It is worn as though it had been softer than the remainder of the bone, and looks as though its vitality had been lost. In another specimen of *D. furcatus*, the extremity of an antler had been broken off, and, slipping down so as to overlap the fixed end for half an inch, had reunited by anchylosis without throwing out any burr.

I had at one time suspected that a fracture of the base of the beam had caused the deposit of the burr, and the rugose band surrounding the former beneath the latter has much the appearance of a surface of reunited bone. On making sections of two beams of the *D. furcatus*, which display the annulus, I find no indication of fracture during life, as both the denser and coarse central tissues are uninterrupted (see fig. 7, pl. lviii, and fig. 1, pl. lix).

From the facts of the case, the following inferences may be derived, premising that it is very probable that a genus allied to the present one gave origin to the family of the Deer. It is obvious that the horns of *Dicrocerus* did not possess a horny sheath as in the *Bovidæ*, from the fact of their being branched. As the sheath grows by addition at the base, the presence of branches, which necessarily obstruct its forward movement, would be fatal to the process. There is much to be said in favor of the view that the horns were covered with an integument, probably furred, as in the Giraffe and young of the Deer. Thus there are grooves on the beam for superficial blood-vessels, which must have been protected by skin. (I do not observe these grooves on the beam of *D. teres.*) The retention of the broken extremity of an antler so as to be reunited as aboved described could not have been accomplished without an integument. The presence of the burrs cannot be accounted for on any other supposition, as there are no foramina to give exit to nutritive vessels at the points where they exist; the irregularity of those positions forbids the latter idea, and adds to the probability that the arteries which furnished the deposit of phosphate of lime were contained in a superficial dermal coating. The supposition is also strengthened by the fact that the only existing Ruminants, the Giraffes, with permanent horns without horny sheaths, have them covered with hairy skin.

It appears that, in the antlers, the deposit of a burr was immediately associated with the death of the portion of the horn beyond it, so that it disintegrated and disappeared. This was not the case with the beam in the specimens observed. Nevertheless, it is probable that the death of the horn would be associated with the deposit of the burr in this case also, were the conditions the same. What those conditions were we can only surmise. It was very probably the death of the integument which invested and nourished the horn that produced the result; and this would more readily occur in the exposed antlers than in the more protected basal portion of the beam. It is very probable that this result would follow blows and laceration of the surface received during combat or accidental contact with hard substances. The integument would be stripped up to near the junction of antlers with each other, or of the beam with the cranium, and the arteries would be constricted or closed at those points. It is near these junctions that *all* of the burrs are found. But as such lesion would necessarily be less complete at the point where the horn has greatest circumference, so the entire death of the horn might be less usual than that of its branches. Should such lesions have occurred for a long period at the breeding-season, nature's effort to repair by redeposit of bony tissue might as readily become periodical as the increase in size and activity of the reproductive organs and other growths which characterize the breeding-season in many animals. The subsequent death of the horn would at some time be followed by its shedding by the ordinary process of sloughing.

Probably other considerations enter into a true comprehension of this point, but the above explanation will probably be found to be in the main correct. It must be remarked that it is not probable that this genus is the immediate ancestor of *Cervus*, from the fact that the molar teeth display in their prismatic form a higher degree of specialization than belongs to that genus. It is probable that the true ancestor combined the dental type of *Cervus*, with the distinct roots and short crowns of the molars, with the type of horns here described.

The genus *Antilocapra* is allied to *Dicrocerus* in its branched horns, and in the hairy dermal covering, which constitutes the immature stage of their horny sheath.

Some of the specimens of this genus display the accessory tubercles, or rudimental columns between the inner lobes of the inferior true molars characteristic of the *Cervi*. I find them in very different degrees of development; while they are prominent in *D. gemmifer*, Cope, there is a rudiment in the first true molar of a specimen of *D. necatus*. Under the circumstances, the species may be distinguished by the mandibular rami and dentition, as follows:

I. True molars without or with one rudimental accessory basal column	DICROCERUS.
Larger, length of premolar series $0^{m}.020$; teeth compressed; ramus very slender at the diastema	*D. furcatus.*
Size similar; teeth less compressed; ramus stouter at diastema	*D. necatus.*
Size smaller; premolar series $0^{m}.016$	*D. tehuanus.*
II. True molars with more or less developed basal columns	BLASTOMERYX.
Smaller; last molar $0^{m}.013$, less prismatic; basal columns well developed	*D. gemmifer.*

It is quite possible that the species last named may represent a genus distinct from those preceding it, but the last molar tooth is the only part of the dentition which is known. In that case, the name *Blastomeryx* may be applied to it. I obtained it first* in the Loup Fork beds of Eastern Colorado; a specimen from the Santa Fé marls resembles it closely. The largest two species have not left many teeth.

Dicrocerus furcatus, Leidy.

Plates lxxx; lxxxi, fig. 1; lxxxii, fig. 1.

Cosoryx furcatus, Leidy, Jour. Acad. Phila., vii, 1869, p. 173; Pl. xxviii, fig. 8.
Cosoryx ramosus, pars, Cope, Proc. Acad. Phila., 1874, p. 148; Ann. Rept. Chief of Engineers, 1874, ii, p. 604.
Dicrocerus furcatus, Cope, Proc. Acad. Phila., 1875, p. 257.

The horns of eleven individuals referable to this species were obtained by the expedition of 1874, and one of these is accompanied by a tooth which enables me to identify the separate lower jaws of two individuals as belonging to the same. The horns present common characters, but differ somewhat in size, the largest specimens considerably exceeding Dr. Leidy's type in this respect.

This species is about the size of the *D. necatus*, and differs from it in

* See Ann. Rept. U. S. Geol. Surv. Terrs., 1873, p. 531.

possessing two antlers instead of one, of which the first is given off at a point much farther from the base than in that species.

The dense layer of the tissue of the horns is very thick, leaving a narrow axis of coarse cells, without columnar structure. The surface is smooth, and with very few and shallow grooves. The beam near the base is curved a little inward, and is semicircular in section; the outer face being slightly concave, the inner very convex. The base is situated a short distance within the free superciliary border. The beam becomes more cylindric, and then, expanding in a fore and aft direction, gives off an antler at right angles, toward the front, nearly parallel to the cranial axis. At a distance little over half the elevation of the first antler, the beam gives off a second in a plane transverse to the axis of the skull. The terminal portion of the beam is cylindric, curved, and acute at the apex.

There is no emargination of the superciliary border, but a foramen pierces the frontal bone in front of the inner margin of the horn, as in other *Ruminantia*, issuing in a marked depression of the surface.

In a specimen in which a considerable portion of the frontal bone is preserved, a rough and tubercular burr surrounds the proximal part of the beam, standing on the interior side at a point about an inch above the base, and descending obliquely to the anterior and outer side. When broken away, an oblique, irregular bone of rough surface remains, which gives the appearance of a reunited fracture. A section of the beam above this point is an equilateral spherical triangle, and there is a very shallow groove on the external side. Diameter of beam before first bifurcation $0^{m}.014$; length of second antler on curve $0^{m}.105$.

A second specimen with the antlers broken off, is more strongly grooved on the outer side, and on the posterior face also. The beam is shorter, and the antlers are given off nearer together than in other specimens. There is no indication of burr or fracture at the base. Associated with it is a fragment of the horn of the opposite side, which includes the base of the second antler. This is broken off nearly an inch above the base, and is surrounded just below the stump by a burr of osseous tuberosities. Diameter of beam (first noticed) below first antler $0^{m}.014$; length of beam to first antler $0^{m}.046$; length from first to second antler $0^{m}.008$.

A third horn from the left side presents the characters of the last, but there is an indication of the rough girdle near its base, but no cingulum. Diameter below expansion for inferior antler $0^m.015$; length from base to first antler $0^m.072$; distance between bases of antlers $0^m.013$. The distal extremity of one of the antlers has been broken off and reunited, the fractured ends overlapping and coössifying without the formation of a burr. The adhesion of this broken end would indicate the existence of integument, which maintained it in position so far as to prevent its loss. A penultimate molar accompanies this horn, which may belong to the same animal. It is prismatic, compressed, and without accessory basal columns. The two lakes are entirely surrounded by the dentine, and the internal crescents are elevated and acuminate above the inner. Diameters of grinding surface: antero-posterior $0^m.012$; transverse $0^m.005$.

A fourth specimen is remarkable for the distance between the first and second antlers; basal part of beam not preserved. Diameter of beam as before $0^m.015$; distance between bases of antlers $0^m.033$.

A fifth consists of the basal part of a horn, remarkable for its size and for the distinct traces of a burr. A sixth is of normal size, and exhibits the rough band surrounding the base obliquely, descending outward and backward. In this specimen, it resembles a reunited fracture, although no burr is present. Diameter of the fifth an inch from base $0^m.017$; diameter of sixth $0^m.015$.

In a seventh specimen, without basal portion, the beam is $0^m.014$ in diameter below the first antler, and the two antlers are $0^m.013$ apart at their bases. The horns of the other individuals present nothing remarkable.

Thus of the horns in which the basal portion is preserved, one presents a burr, three exhibit traces of the burr, and one is entirely smooth. No mention is made of indications of burr in Dr. Leidy's description.

The mandibles already alluded to present the dentition of both sides, excepting the first premolar, which is broken off. The ramus increases in depth posteriorly in accordance with the successive increase in size of the teeth. It is compressed, and with very little convexity on the outer side. The portion anterior to the second premolar is both long and slender, with a less vertical diameter than in the corresponding portion of *D. necatus.* It displays a long diastema, and, like all other specimens of the genus yet obtained, does not exhibit the teeth anterior to it, but a portion of an alveolus only. There is a single small mental foramen immediately below the anterior root of the second premolar.

The molars differ from the premolars in not being prismatic in form; their crowns are contracted at the base fore and aft, and distinguished from the roots. They are slightly convex on the external side, but present strong vertical crests on the inner side. The third and fourth premolars present three of these, of which the anterior is the incurved anterior margin, but the posterior is a branch. The molars are much compressed, especially the last. The inner crescents rise in acute points; the external wear flat. There are no tubercles between the bases of the external columns. The enamel is finely and obsoletely roughened.

Measurements.

	M.
Length of the molar series	0.0565
Length of the diastema	0.0275
Depth at the last molar	0.0210
Depth at the second (first) premolar	0.0120
Depth of the diastema at the middle	0.0070
Length of the premolars	0.0210
Length of the first true molar	0.0090
Width of the first true molar	0.0050

Portions of a second individual display similar proportions.

The mandibles of the *Dicrocerus furcatus* are about the size of those of a Sheep.

Dicrocerus necatus, Leidy.

Plates lxxxi, figs. 2–6; lxxxii, figs. 2–3.

Merycodus necatus, Leidy, Proc. Acad. Phila., 1854, pp. 90–157; 1857, p. 89; 1858, p. 23; Jour. Acad. Phila., vii, p. 162, pl. xiv, figs. 9–10.
Cervus warrenii, Leidy, Proc. Acad. Phila., 1858, p. 23; Jour. Acad. Phila., vii, 1869, p. 172, pl. xxvii, fig. 12.
Dicrocerus necatus, Cope, Proc. Acad. Phila., 1875, p. 257.

This species is represented by the horns of seven individuals, two of which present those of both sides. Each of these individuals includes also the inferior dentition, and one of them a part of the maxillary bone, with its teeth. The identification of the mandibular rami and dental characters enables me to discriminate more satisfactorily those of the other species here described.

The horns are characterized by but one bifurcation, the beam dividing into an anterior and a posterior antler at a distance of about two inches above the base. In both horns of an individual which are perfectly preserved, the anterior division is a little the longer, hence the posterior may be called the antler. It is given off and continues in a fore-and-aft plane, which passes through the other branch. It presents a gentle convexity backward, while the anterior branch is nearly straight. The surface of both is marked with shallow longitudinal grooves rather closely placed, while the beam is nearly smooth. The latter arises a little within the superciliary margin, which is but little prominent. The supraorbital foramen issues opposite the inner base of the horn, a little in advance of the anterior base.

Specimen No. 1 includes both horns, the mandibular ramus, which wants the first two and the last molars, portions of the sternum, a phalange, etc. The section of the horn at the base is an antero-posterior oval, flattened behind, but it soon becomes a regular oval. The branches are nearly round in section. The teeth are about the same size as those of *D. furcatus*, but are relatively wider. The fourth premolar is incurved anteriorly, and sends inward a middle rib and a prolongation of the posterior side, which unite, inclosing an area or fossette. The first true molar has a basal columnar lobe between the external columns, but there is none on the second molar. The mental foramen is a little anterior to the second (first) premolar. A sternal segment is broad and stout, a little longer than wide, flat on one side, and gently convex on the other. The posterior segment perhaps is divided, and one of its halves remains. Its inner side near one end is grooved obliquely for a blood-vessel.

Measurements.

	M.
Length of the horn	0.140
Length of the beam	0.050
Length of the posterior antler	0.074
Diameter of the beam at the base	0.016
Diameter of the anterior branch at the middle	0.011
Length of the five anterior molars	0.038
Length of the premolars	0.017

Length of the first true molar	0. 0086
Width of the first true molar	0. 006
Depth of the ramus at the last molar	0. 020
Depth of the ramus at the diastema	0. 0102
Length of the sternal segment	0. 0253
Width of the same	0. 022

A second specimen embraces portions of both horns, the last premolar and first true molars, part of the mandible containing the last molar, fragment of sternum, distal portion of cannon-bone, etc., all indicating a rather smaller animal than the last. As in that one, the beams of the horns are smooth and without indication of fracture at the base. The principal branch is, however, broken off a short distance above its bifurcation, and just below the irregularly-rounded extremity is surrounded by a burr-like osseous ring of considerable prominence, repeating what has already been described in the *D. furcatus.* The molars of both jaws are without basal tubercles between the inner columns. The external side of each of the superior true molars presents a longitudinal rib opposite the anterior extremity of each crescent. Immediately behind the anterior rib in the last premolar and the second true molar is a well-marked groove; otherwise the external face is plane. The enamel is obsoletely roughened. In the last inferior molar, the dentine of the fifth column is continuous with that of the two which precede it.

Measurements.

	M.
Length of the beam of the horn	0. 046
Diameter at the base	0. 015
Length of the superior molars four, five, and six	0. 025
Length of the fifth superior molar	0. 0085
Width of the same	0. 0090
Length of the last inferior molar	0. 015
Depth of the ramus at the same	0. 020
Transverse diameter of the distal extremity of the cannon-bone	0. 016

A third horn is of rather larger size than those above described. Length of beam $0^{m}.063$; diameter at base $0^{m}.017$. A fourth specimen is similar to the second in size and form, but has a prominent osseous rim, or simple burr, extending round the beam one-third the distance from the base. It descends extero-posteriorly, as in the *D. furcatus.* Length of beam $0^{m}.058$; diameter above base $0^{m}.013$. A fifth specimen is similar in character; the burr is lowest on the intero-posterior aspect, being highest outside, contrary to the obliquity in the fourth specimen. This burr is quite prominent, and its undivided margin is turned downward. Where a portion is broken away, the surface is quite rough. Length of beam $0^{m}.058$; diameter above base $0^{m}.013$. This and the last specimens are the *Cervus warrenii* of Leidy. The other specimens are broken off below the bifurcation; none of them display the burr, nor a rough annular scar.

A mandibular ramus, of proportions identical with those of *D. necatus*, presents some peculiarities in the dentition, which lead me to question its pertinence to this species. The molars have the stout form, as already described, but present some basal intercolumnar tubercles, which are like those of the *D. gemmifer*. The molars are entirely prismatic, and the last one is without the basal tubercles, as I ascertained by removing it from the jaw. The tubercles are present between the columns of the first and second true molars; in the first, it is so fully developed as to enter into the composition of the crown. It here forms, on wearing, a loop of the antero-external enamel border of the posterior column. The premolars preserved (Nos. 3 and 4) present the prominent three folds of the inner side.

Measurements.

	M.
Length of the six posterior molars	0.050
Length of the true molars	0.036
Length of the first true molar	0.009
Width of the same	0.006
Length of the last true molar	0.016

On the dentition of this individual I originally discriminated the *D. ramosus*, describing also portions of the *D. furcatus*. Should it prove to belong to a distinct species, the former name may be preserved for it.

Dicrocerus teres, Cope.

Plate lxxxi, fig. 7; lxxxii, fig. 6.

Dicrocerus teres, Cope, Proc. Acad. Phila., 1875, p. 257.
Cosoryx teres, Cope, l. c., 1874, p. 149; Ann. Rept. Chief of Engineers, 1874, ii, p. 605.

This Ruminant is known from the upper portion of the cranium supporting the broken horns of a single individual. This indicates a species of perhaps double the proportions of the preceding ones, equaling, in the size of the corresponding parts, the Virginia Deer. In various respects, it differs from the species above described, and its reference to this genus is provisional only. The horns have a compression in the proximal portion like those of the other species, and may very possibly be divided in the same manner at a point beyond the portion of the beam exhibited by the specimen.

The horns stand immediately above the orbits as in the *Antilocapra*, but while they present a face outward, they present a still wider one backward to the zygomatic fossa. This is due to the fact that there is no oblique horizontal crest connecting the orbit with the parietal region, as in the Deer and Sheep, the postorbital process descending directly from the base of the horn. The parietal region is rather more contracted than in either the Sheep or Deer, while the frontal region is expanded and slightly concave in the transverse direction. There is no free superciliary border at the base of the horn, as in *D. furcatus* and *D. necatus*. The section of the beam near the base is a regular oval, the long axis directed longitudinally and a little outward in front. The beam is erect, with a slight curvature outward near the base. The tissue is rather more spongy than in the species named. The supraorbital foramen is large, and issues near the anterior inner base of the horn. The interior face of the parietal bones displays the impression of three superior longitudinal convolutions of the cerebral hemispheres.

Measurements.

	M.
Outer width between the bases of the horn-cores	0. 112
Inner width between the bases of the horn-cores	0. 055
Width of the temporal fossa behind the horns	0. 053
Long diameter of the horn-core	0. 028
Short diameter of the horn-core	0. 021
Length of the part preserved	0. 033

Dicrocerus trilateralis, Cope.

Plate lxxxi, fig. 8; lxxxii, figs. 7–9.

This species is the largest of the Deer-antelope here described, portions of the jaws and teeth equaling in dimensions corresponding parts of the Red Deer (*Cervus elaphus*). I discovered the bones lying on a gentle slope of sandy rock in three little collections, each two feet from the others, and in a straight line: in one of these were found portions of the pelvis and sternum and a fragment of a horn; in another, portions of the mandible, with teeth; in the third, fragments of ribs. They are all in the due proportion of the parts of a single skeleton, and the horn, symphysis, and teeth coincide with the type of *Dicrocerus*, and differ from that of any other genus of Ruminants which I found in the same formation.

The horn fragment measures four and a half inches in length, and is rather slender, and gives no evidence of branching. It is probably a portion of a branch, or of the beam above the bifurcation, since its diameter is less than that of the beam proper of the *D. teres*. It is slightly curved in one direction, and its section at one extremity is that of an isosceles spherical triangle. At the distal extremity, the form is modified, so that the section is nearly round. The dense layer is thickest at the base, while the distal portion is almost entirely occupied by coarse cells. The external surface is smooth.

The distal part of the mandible is quite narrow and produced. The symphysis is not coössified, is rather strong, and the inferior face is strongly convex. The canine teeth are in the uninterrupted series with the incisors, and, judging from their basal portions, have the same size and direction. There is no indication of first premolar in the diastematic border for an inch (as far as preserved) behind the canine, nor for half an inch farther on the opposite side, where the inner half of that edge is preserved. The teeth preserved are fragmentary, and belong to different positions. They show that the premolars were compressed, as in the other species, and that the true molars had no intercolumnar basal tubercles. The fragments of the latter display the size of the species; the long diameter of an external crescent being $0^m.014$, giving for the antero-posterior diameter of the last molar $0^m.038$. The enamel is nearly smooth.

The ribs are stout, and one of them exhibits a large tubercular facet. The pieces of the pelvis preserved are both acetabula and the symphyses pubis and ischii. The former are a little larger than those of an adult female *Cervus elaphus*, but the walls are a good deal stouter. The symphyseal portions differ from those of *C. elaphus* in superficial extent about as do the acetabula, but are much more robust, being at least three times as thick, and thoroughly coössified. Both pubes and ischia present a median keel-like tuberosity downward. The ischia diverge outward and backward, as in other Ruminants.

Measurements.

	M.
Longer diameter at the base of the fragment of the horn	0.020
Longer diameter at the distal end of the same	0.016
Length of the symphysis mandibuli	0.048
Transverse diameter at the middle	0.020
Length of the dentigerous portion	0.025
Diameter of the rib below the tubercle	0.023
Length of the tubercle of the same	0.022
Diameter of the acetabulum	0.045
Vertical diameter of the symphysis pubis	0.028
Vertical diameter of the symphysis ischii	0.026
Width of the ischium from the obturator foramen to the posterior bifurcation.	0.038
Transverse diameter of the sacral centrum anteriorly	0.045

These remains indicate a robust animal, bearing the relation to the *D. teres* that the Red Deer does to the Virginian Deer. The material preserved renders it probable that the horns differ in form from those of *D. teres.*

Dicrocerus tehuanus, Cope.

Plate lxxxii, figs. 10–? 12.

Several mandibles, found in the same deposit as the species already described, show that an allied form existed of smaller size. The jaws differ among themselves in size, so that it is not entirely certain that they all belong to one species. I have selected as typical a portion of a right ramus which displays the least dimensions.

This fragment supported the first four molars. Those which remain are well worn, indicating maturity. The ramus has the proportions of that of *D. necatus*, with the portion at the posterior part of the diastema similarly stout. The mental foramen is well in advance of the second (first) premolar. Length of premolars $0^m.016$; of first true molar $0^m.0076$; depth of ramus at first true molar $0^m.013$. The posterior part of the ramus of the same side accompanies the anterior part. It is not certain that it is part of the same ramus. Its dimensions are those of *D. necatus.* Length of tooth $0^m.0155$; width $0^m.0058$.

In a second specimen, which displays corresponding parts, with the addition of the second true molar, the length of the premolar series is a little greater, viz, $0^m.017$; length of second true molar $0^m.010$; depth of ramus at first true molar $0^m.012$.

A third specimen is a large part of a right ramus supporting all but the first two premolars. This specimen exhibits the smaller dimensions of the true molars, the three occupying the space of the last two of *D. necatus* and *D. furcatus.* They are rather wide, and without accessory tubercles. The premolars are larger than those of either of the specimens above described.

Measurements.

	M.
Length of the last four molars	0.036
Length of the last premolar	0.007
Length of the first true molar	0.0074
Width of the same	0.006
Depth of the ramus at the first true molar	0.013
Depth of the ramus at the last true molar	0.020

Dicrocerus gemmifer, Cope.

Plate lxxxii, fig. 13.

Merycodus gemmifer, Cope, Ann. Report U. S. Geol. Surv. Terrs, 1873, (1874), p. 531; Bulletin of do., Jan., 1874, p. 22, partim.

A portion of the right mandible supporting the posterior molar represents this species in the collection made near Santa Fé in 1874, which is the part previously discovered by myself in Northeastern Colorado. With the latter were described some other specimens, which probably do not belong to the same species. This molar is the least obtained, and is more Deer-like than any of the others. This is seen in the short crown contracted at the base, and well defined rather long roots. There is an elevated basal cone between the first and second columns, and an angulate cingulum in front of the latter. The lake between the two median crescents continues inward and backward to the inner face of the crown as a fissure, which prevents the fusion of the inner and fifth lobes of the crown, except on prolonged attrition. A trace of the same is seen in the more fully-worn type-specimen from Colorado. Enamel obsoletely rugose.

Measurements.

	M.
Long diameter of crown	0.012
Short diameter of crown	0.0055

As already remarked, I suspect that this species will be found to belong to a genus distinct from *Dicrocerus.*

REVIEW OF THE VERTEBRATE FAUNA OF THE LOUP FORK EPOCH.

The thirty-two ascertained species of the Santa Fé marls are distributed into orders as follows:

REPTILIA		2
Testudinata	2	
AVES		3
MAMMALIA		29
Rodentia	4	
Proboscidea	1	
Perissodactyla	6	
Artiodactyla	11	
Carnivora	5	
Incertæ sedis	2	
		34

The absence of Fishes and Crocodiles is a noteworthy feature, and is true of other deposits of the same age in Colorado and Nebraska. This fact, especially the absence of remains of Fishes, suggests that the formation is that of a marsh, and not of a lake. This view is confirmed by the numerous vertical streaks, or rods, of a white calcareous mineral, which penetrate the soft rock in many places. These resemble the tubes formed by the decay of roots of a marsh vegetation, or by the borings of mud-loving animals.

This fauna has now been studied in three widely-separated localities in the region west of the Mississippi River. It was first discovered by Dr. Hayden, whose collections furnished the basis of Dr. Leidy's determinations in 1858.* It was next observed by myself in Colorado in 1873,† and twenty-one species were determined; and, in the following year, I identified the Santa Fé marls of New Mexico, already observed by Dr. Hayden, with the same horizon.‡ There is a near lithological resemblance between the strata at these localities, and the fauna presents a common character as distinguished from those which preceded and followed it. The

*See Proc. Acad. Nat. Sci. Phila., 1858, p. 20, and Extinct Mammalia of Dakota and Nebraska.

†Bulletin of the U. S. Geolog. Surv. Terrs., No. 1, Jan., 1874.

‡Ann. Rept. Chief of Engineers, 1874, ii, p. 603.

difference between it and that of the White River beds which underlie it in Nebraska and Colorado is far less important than that which distinguishes the latter from the older Eocene fauna. The orders of *Mammalia* characteristic of the Eocene are not present in either the White River or Loup Fork deposits, which contain, on the contrary, representatives of the orders at present existing in the Northern Hemisphere, Africa, and, to a less extent, South America. The distinctions between the two later faunæ are found in subordinate modifications of these orders. It is, however, true that *Insectivora* and *Quadrumana*, observed in the White River beds, have not yet been found in those of the Loup Fork epoch, while *Proboscidea*, which are abundant in the former, are unknown in the White River period. The latter distinction is likely to be maintained, as our knowledge of the White River fauna is the more complete. The following table represents the peculiarities of the two faunæ by contrasting the corresponding forms of each order:

	White River.	Loup Fork.
Carnivora.	Machaerodus.	
	Dinictis.	
	Hoplophoneus.	
		Pseudaelurus.
	Bunaelurus.	Mustela.
	Canis.	Canis.
	Amphicyon.	Amphicyon.
		Tomarctus.
		Aelurodon.
Artiodactyla.		Dicrocerus.
		Pliauchenia.
	Poëbrotherium.	Procamelus.
	Hypisodus.	
	Hypertragulus.	
	Leptomeryx.	
	Oreodon.	Merychyus.
	Leptauchenia.	
	Agriochœrus.	
	Hyopotamus.	
	Elotherium.	
	Pelonax.	
Perissodactyla.		
		Protohippus.
		Hippotherium.

	White River.	Loup Fork.
	Anchitherium.	
	Hyracodon.	
	Aceratherium.	Aphelops.
	Menodus.	
	Symborodon.	
Rodentia.		
	Palæolagus.	Panolax,
	Eumys.	?Eumys.
	Heliscomys.	
	Gymnoptychus.	
	Ischyromys.	
		Steneofiber.

Dr. Leidy, in his work on the Extinct Mammalian Fauna of Dakota and Nebraska, enumerates several genera of the existing fauna as having been discovered by Dr. Hayden in the Loup Fork beds. Such are *Hystrix*, *Castor*, *Equus*, and *Dicotyles*. Many of the specimens referred to this epoch are stated to have been derived from the sands found along the banks of the Loup Fork, which are composed of sediments of a mixed character, some of the specimens being, in Dr. Leidy's opinion, of Quaternary age, and others, especially some referred to *Canis* and *Equus*, belonging to existing species. I possess a specimen of a cranium of a *Thomomys* from the sands of the Big Blue River, Kansas, which, in like manner, I am unable to distinguish from an existing species. These sands are probably the deposits of more than one epoch, being primarily derived from the bluffs and mesas of the true Loup Fork formation, carried to the lowest level, and inclosing remains of species of Quaternary and those of modern age. These reflections are not due to my own examinations of the region in question, which I have not visited, but for the following reasons:

The fossils of this epoch from Colorado and New Mexico which I have described were all found in place by myself, and excavated by my own hands or in my presence. The specimens are numerous, especially those from Colorado. I have not found the modern genera above mentioned as enumerated by Dr. Leidy, nor any others of modern or Quaternary character. On the contrary, the result has been to isolate the Loup Fork fauna from the Quaternary as well as from the White River epochs. It includes three existing genera of *Mammalia* only, one of which, *Canis*, occurs in the White River beds also; three genera only are common to the two beds, as indicated by dental characters of the lower jaw only.

Dr. Leidy identified this horizon with that of the European Pliocene, with reservations expressing doubt as to actual synchronism, and they have been so called by subsequent writers. But the omission of the genera above enumerated makes an important difference, and the additional forms discovered have increased the resulting greater antiquity of the *facies*. *Steneofiber*, formerly referred to the White River beds, probably belongs here. The supposed *Cervus* turns out to be a *Dicrocerus* of prior geological existence; the *Mastodon* is a near ally of a European species cotemporary with the genera mentioned, while one of the Dogs at least is of an ancient type. In view of the entire appropriateness of the association with these of several of the genera already known, I remarked* that "the smaller percentage of existing genera in the Loup Fork beds, with the persistence of an Oreodont (*Merychyus*), indicates that these also should be placed anterior to the Pliocene of France". Still later I referred to them as follows: †—"The *facies* of the fauna of this horizon throughout the West, including, as it does, *Amphicyon*, *Dicrocerus*, *Hippotherium*, *Aceratherium* (*Aphelops*), *Mastodon*, nearly allied to *M. angustidens*, etc., etc., more nearly resembles the upper Miocene of Europe than the Pliocene of that continent." In confirmation of this view, I may take up the genera of the list above given, and show their stratigraphic position in Europe:—*Pseudælurus*, Miocene, Sansan, Gers.; *Mustela*, Middle Miocene and upward (Bronn); *Canis*, Miocene and upward; *Amphicyon*, Middle Miocene (Bronn); *Dicrocerus*, Middle Miocene or Helvetien (Renevier); *Hippotherium*, Middle Miocene and Pliocene; *Mastodon* (type of) *angustidens*, Upper Miocene, Tortonien (Renevier); *Steneofiber*, Miocene (Bronn). The proper discrimination of the Pliocene fauna of North America remains to be accomplished, although we are doubtless already acquainted with fragments of it. Its existence was terminated by the Glacial epoch, which separated it from the southern fauna, which occupied the continent after its close.

A decrease in the abundance of Vertebrate life in North America from

* Ann. Report U. S. Geol. Sur. Terrs., 1873, p. 462.
† Proc. Phila. Acad., 1875, p. 257.

the Eocene period is revealed by paleontology. The fauna of the Eocene was the richest in all respects; that of the White River epoch was less prolific, though much more so than the present period; the Loup Fork epoch exhibits a great reduction of both species and genera. But this diminution of numbers was accompanied by greater specialization of structure, variety being gained while abundance was lessened. An exception must be made in the case of the *Carnivora*, for the saber-toothed Tigers have not yet been observed in its deposits. But the elimination of *Elotherium*, most of the *Oreodontidæ*, of *Hyopotamus*, and of *Poëbrotherium*, and their replacement by Camels and *Merychyus*, is a case of the substitution of more for less specialized genera. The case is still stronger in the *Perissodactyla*, where the types with half Bunodont dentition (*Anchitherium*, *Titanotherium*, etc.) are dropped, and three-toed Horses, with the more complex Selenodont teeth, are introduced; and the Rhinocerotic forms with full incisors (*Hyracodon*) or premolars (*Aceratherium*) are represented by a genus (*Aphelops*), with both reduced by one degree, and in so far approaching the most specialized recent genera. We may then safely maintain that, in the lapse of Tertiary time in North America, decrease in the number of specific and generic forms of *Mammalia* was accompanied by increasing specialization or perfection in those that remained.

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PLATE XXII.

Chiefly Triassic fossils, natural size.

FIG. 1. Part of the right maxillary bone of *Typothorax coccinarum*, outer side: *a*, view of posterior end of the fragment; *b*, inferior side; *c*, internal or sutural side, displaying suture for the succeeding bone at the right superior angle. Page 30.

FIG. 2. Fragment of a vertebra found with the preceding specimen, from below: *a*, articular extremity.

FIG. 3. Fragment of bone with articular condyle found with the preceding, side view: *a*, extremital view.

FIG. 4. Portion of dermal scutum found with the preceding.

FIG. 5. Portion of another dermal bone found with the preceding.

FIGS. 6–9. Broken or entire dermal bones found at another locality in the neighborhood of the specimens figured from No. 1 to No. 5: views of sections marked *a*.

FIGS. 10-12. Coprolites from the same locality as Figs. 6–9; Fig. 12 split, displaying in its interior rhomboganoid scales of fishes.

FIG. 13. The broken crown of a tooth found in the same locality as specimens Figs. 6–12, the unworn side: *a*, posterior side; *b*, section from below.

FIG. 14. Vertebra of a supposed Sauropterygian, from another locality in the same neighborhood, and from the side: *a*, articular extremity; *b*, inferior view.

FIG. 15. Part of the crown of a tooth of a carnivorous Dinosaurian from near the locality of Fig. 14, concave side; *a*, cutting-edge; *b*, section of inferior view of fragment.

FIGS. 16–17. Teeth of Sharks from Cretaceous No. 3 or 4, on the Gallinas Creek, between the Triassic and Eocene bad-lands.

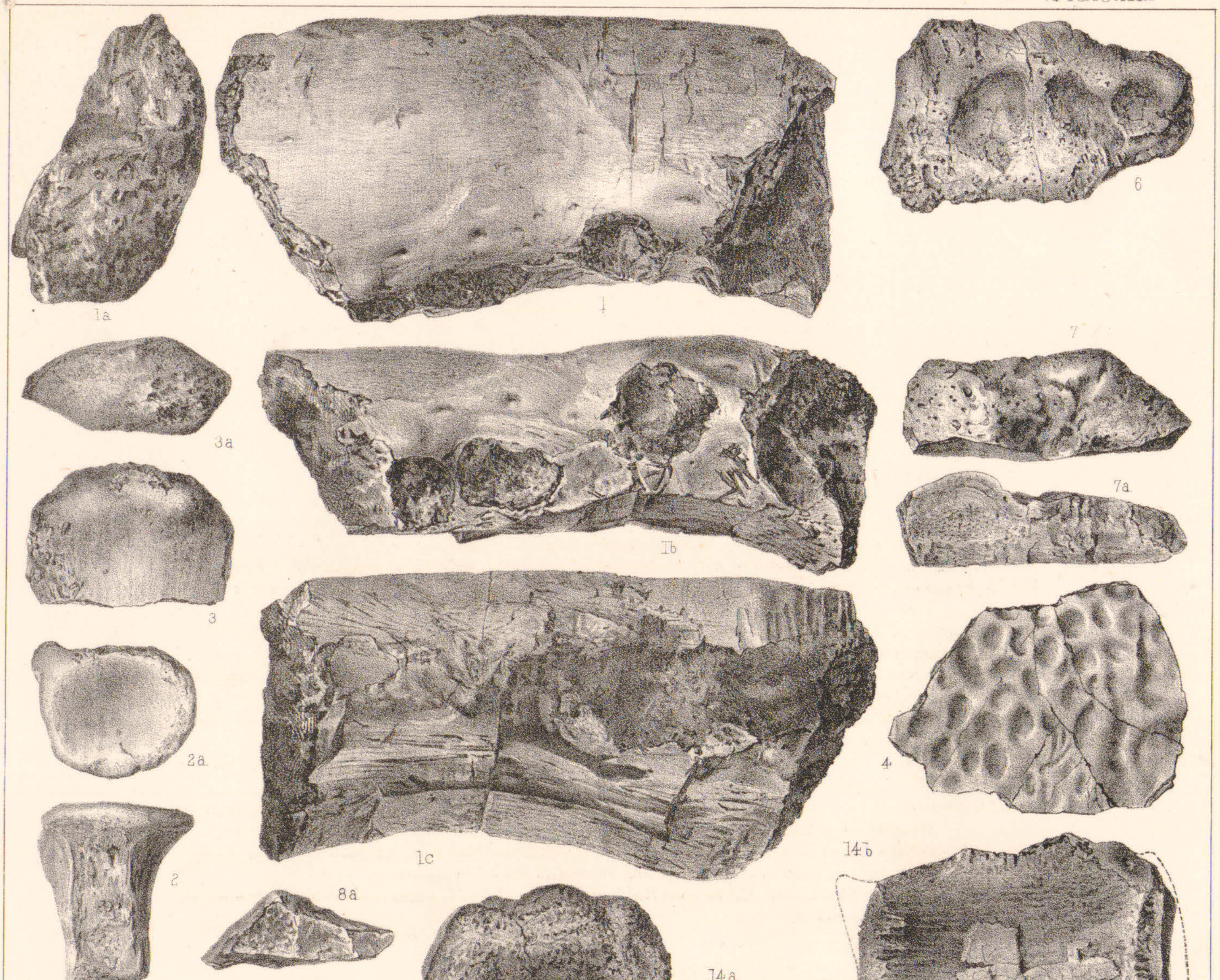
FIGS. 16, 16*a*. *Galeocerdo.*

FIGS. 17, 17*a*. *Otodus.*

FIGS. 18, 19. Sharks' teeth from the bad-lands of the Eocene.

FIGS. 18, 18*a*. *Galeocerdo pristodontus.* Page 38.

FIGS. 19, 19*a*. ? *Otodus.* Page 38.



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1-9 Typothorax. 10-12 Coprolites. 13-15 Saurians. 18-19 Sharks. 20 Ostrea.

PLATE XXIII.

FIG. 1. *Syllæmus latifrons* Cope, natural size, seen from above. The body behind the dorsal fin is broken off; 1*a*, the same from below. The body is distorted by pressure, so that the line of mucous pores of the right side is visible in this figure. Page 27.

FIGS. 2-9. Unios from the Trias of the Gallinas, obtained with the Saurians figured on Plate I, and described by Mr. Meek in the Annual Report of Lieutenant Wheeler for 1875, Appendix G 1, page 83. Natural size.

FIGS. 2, 2*a*. *Unio cristonensis*. Page 9.

FIGS. 3, 3*a*, 4, 5. *Unio cristonensis*.

FIGS. 6, 6*a*. *Unio gallinensis*. Page 9.

FIGS. 7, 7*a*. *Unio terrærubræ*. Page 9.

FIGS. 8, 8*a*, 9, 9*a*. *Unio* of undetermined species.

FIGS. 10-29. Cranial bones, vertebræ, and scales of the typical specimen of *Clastes aganus*, natural size. Page 38.

FIGS. 10-14. Basioccipital bone and dorsal vertebræ, seen from below, with two interruptions.

FIG. 10*a*. Basioccipital bone, posterior view.

FIGS. 11*a*, 12*a*. Posterior views of vertebræ 11 and 12.

FIGS. 12*b*, 13*b*. Anterior views of vertebræ 12 and 13.

FIGS. 15-20. Cranial bones, from above; *a*, from below; *b*, edge or sutural view.

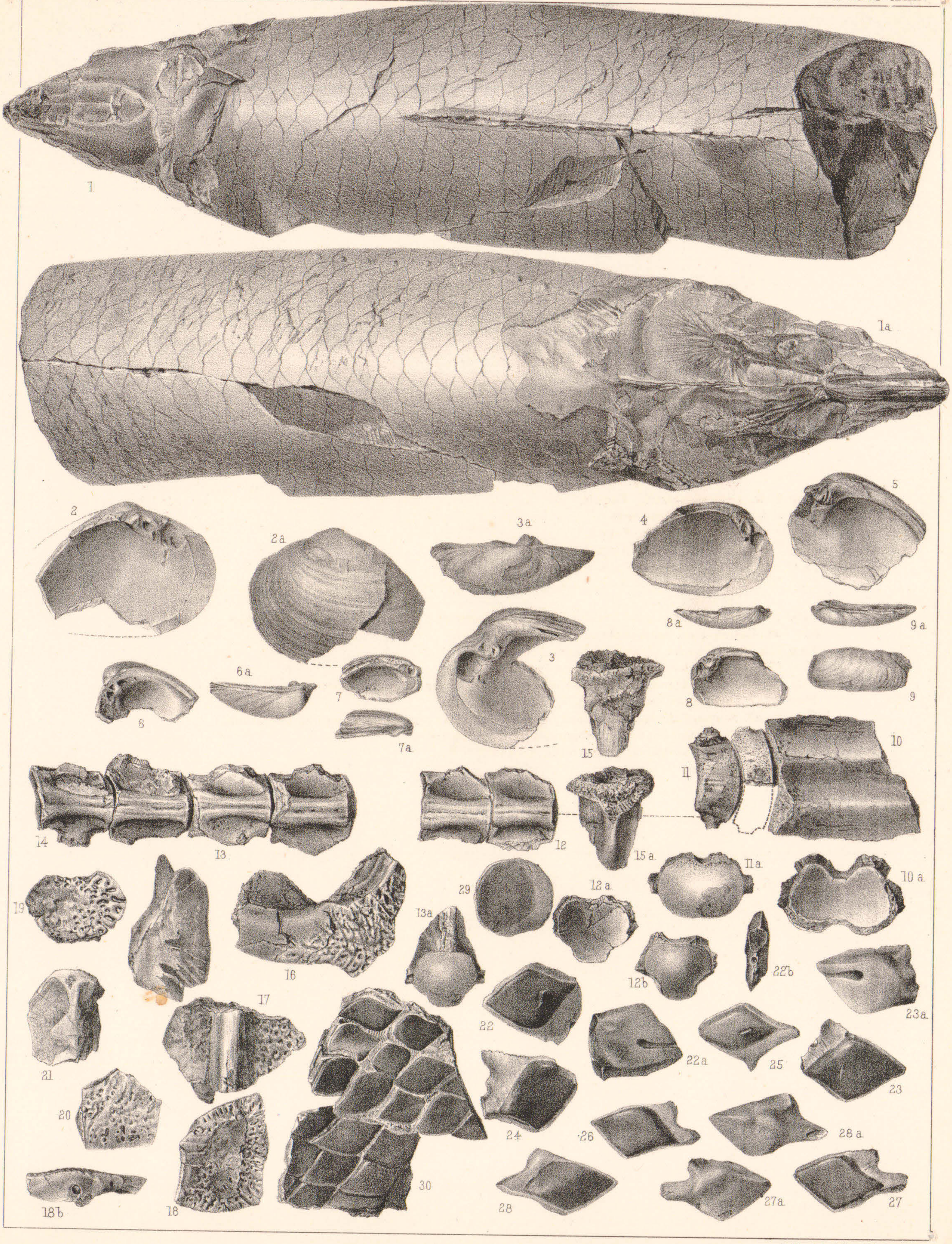
FIG. 21. Fragment from scapular arch.

FIGS. 22-29. Scales of the same specimen; *a*, inferior views; figs. 22-25 pierced by lateral line.

FIGS. 30-31. Scales and bone of Gar found together, natural size.

FIG. 30. Portion of the dermal armor of the right side.

FIG. 31. An opercular bone.



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1. Syllaemus latifrons. 2-9 Unios. 10-27 Clastes.

PLATE XXIV.

FIGS. 1–15. Parts of the skeleton of a single individual of *Clastes integer*, natural size. Page 41.
FIG. 1. Part of right scapular arch, external view.
FIG. 2. Part of left side of superior cranial wall, with free margin, superior view.
FIG. 3. Another and smaller superior cranial bone, from above: *a*, sutural edge.
FIG. 4. First vertebra, anterior face.
FIG. 5. A dorsal vertebra, from below.
FIG. 6. A caudal vertebra, right side: *a*, from below.
FIG. 7. A more posterior caudal, lateral view: *a*, inferior view.
FIG. 8. An osseous fin-ray, fragment, anterior view: *a*, posterior side; *b*, section.
FIGS. 9–15. Scales; 9–10, pierced by the lateral line: *a*, interior views; *b*, edge view.
FIG. 16. A dorsal vertebra of a second and smaller individual of *Clastes integer*, from the inferior side: *a*, from the left side; *b*, the posterior articular surface.
FIGS. 17–31. Fragments of four individuals of *Dermatemys costilatus*, natural size. Figs. 17-20 belong to No. 1; 21–22, to No 2; 23–25, to No. 3; and 26–31, to No. 4. Page 52.
FIG. 17. Part of a vertebral bone, superior view.
FIG. 18. Part of a vertebral bone, superior view.
FIG 19. Part of a costal bone, superior view: *a*, edge view.
FIG. 20. Part of a costal bone, superior view: *a*, edge view.
FIG. 21. Part of a costal bone, superior view: *a*, edge view.
FIG. 22. Broken vertebral bone, from above.
FIG. 23. Part of a costal bone, from above.
FIG. 24. Anterior part of a vertebral bone.
FIG. 25. Posterior part of a vertebral bone.
FIG. 26. Part of the margin of the plastron.
FIG. 27. Part of a costal bone, from above.
FIG. 28. The same costal, from below.
FIG. 29. Half of a marginal bone, from above: *a*, the sutural edge.
FIG. 30. Costal with suture for ascending process of plastron, from above: *a*, from below.
FIG. 31. Part of left episternal, from above.
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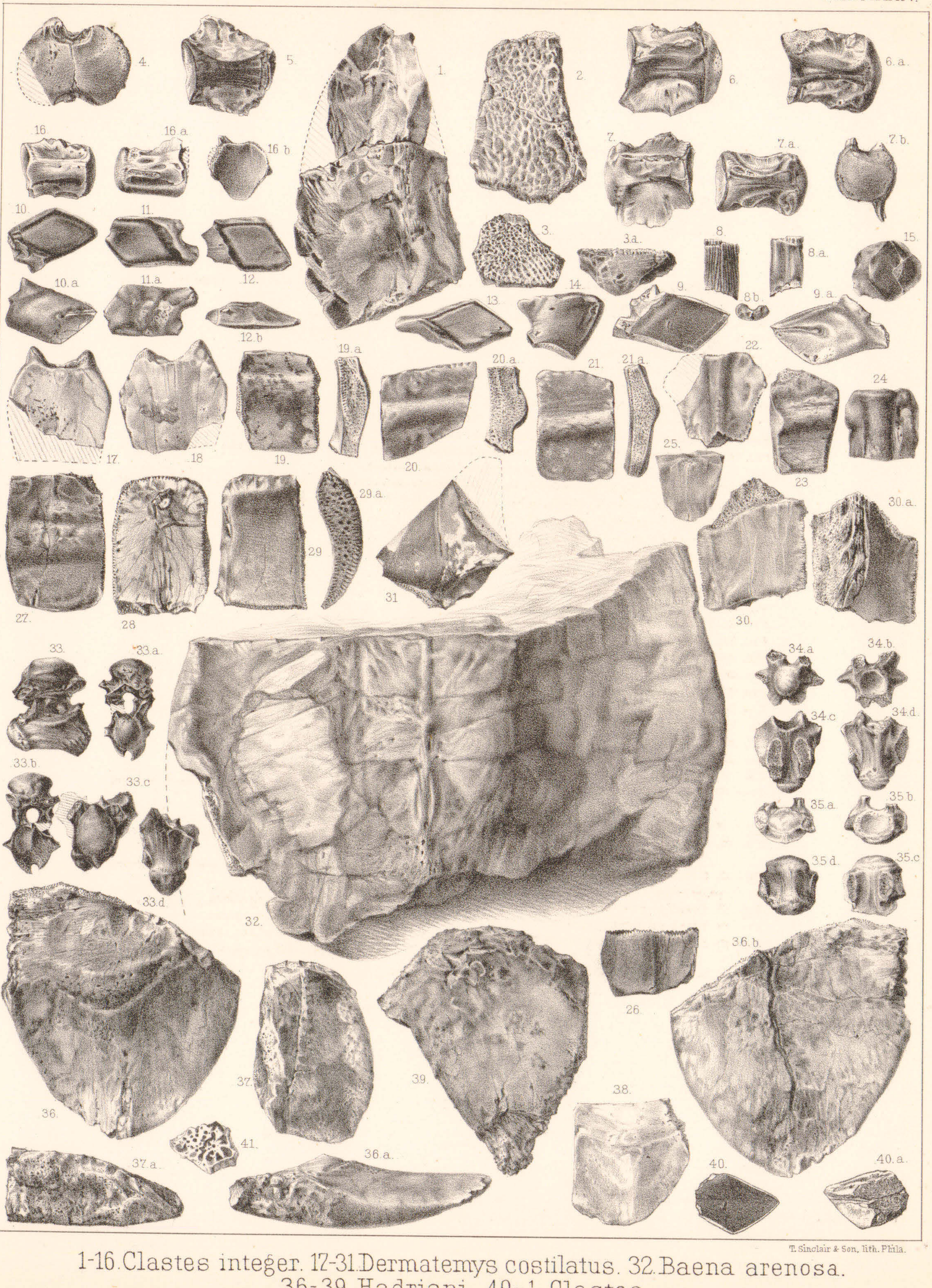
FIGS. 33–35. Caudal vertebræ of a tortoise, described on page 43, belonging to a single animal, natural size: *a*, anterior view; *b*, posterior; *c*, superior and inferior views.
FIGS. 36–39. Fragments of *Hadriani*, one-half natural size.
FIG. 36. Posterior process of right postabdominal bone of *Hadrianus corsonii*: *a*, inner edge; *b*, inferior side. Page 58.
FIG. 37. Corresponding part of another *Hadrianus*, the inner portion broken away; *a*, view of the broken inner edge.
FIG. 38. Posterior process of left postabdominal bone of another *Hadrianus*, from above.
FIG. 39. Right episternal, median part of anterior border of anterior lobe, inferior side.
FIG. 40. Scale of the lateral line of a specimen of *Clastes*; *a*, the opposite side of the same scale, which is split in its vertical plane, exhibiting the direction of the perforating canal.
FIG. 41. Scale from the anterior region of another *Clastes*.



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1-16. Clastes integer. 17-31. Dermatemys costilatus. 32. Baena arenosa.
36-39. Hadriani. 40-1. Clastes.

PLATE XXV.

FIGS. 1-6. *Plastomenus communis,* different individuals, two-thirds natural size. Page 50.
FIG. 1. Typical specimen; a series of costal bones, whose positions are conjectural; *a,* an edge view of the second from the top; *b,* inner portion of the left hyosternal.
FIG. 2. A posterior costal bone of another individual; *a,* edge view.
FIG. 3. A costal bone of a third individual.
FIG. 4. Distal part of a costal bone of a small and perhaps immature individual; *a,* edge of the same.
FIG. 5. Part of a costal bone of a specimen of var. I; *a,* edge view of the same.
FIG. 6. Part of costal bone of a second individual of var. I; *a,* edge view.
FIG. 7. End of costal bone of type-specimen of *Plastomenus lachrymalis; a,* the edge view; *b,* fragment of another costal of the same carapace, natural size. Page 51.
FIGS. 8-10. Broken costals of *Plastomenus serialis,* natural size; page 51.
FIG. 8. From one individual;
FIG. 9. From a second; and
FIGS. 10-10*a*. From a third specimen.
FIG. 11. *Plastomenus multifoveatus;* part of a costal bone, natural size. Page 49.
FIGS. 12-19. *Plastomenus fractus,* fragments of one individual, natural size. Page 49.
FIGS. 12, 18. Proximal ends of costals.
FIGS. 13-16. Middle portions of costals.
FIG. 17. Distal end of a costal.
FIG. 19. Anterior moiety of a vertebral bone.
FIGS. 20-26. Fragments of two individuals of *Plastomenus corrugatus,* natural size. Page 48.
FIG. 20. Sternal bone, below; *a,* above.
FIGS. 21-26. Parts of one specimen.
FIGS. 21, 26. From middles of costals.
FIGS. 22, 23. Distal ends of costals.
FIG. 24. Distal extremity of first or last costal.
FIG. 25. Portion of left hyosternal bone, from below; *a,* from above.
FIGS. 27-31. Fragments of carapace of the *Trionyx leptomitus,* natural size.
FIGS. 27-28. Median parts of costal bones.
FIGS. 29-30. Distal parts of costal bones.
FIG. 30*a*. Section at fractured edge of No. 30.
FIG. 31*a*. Distal extremity of No. 30; fore end of the costal broken off.

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1-6. Plastomenus communis. 7. P. lachrymalis. 8-10. P. serialis. 11. P. multifoveatus.
12-19. P. fractus. 20-26. P. corrugatus. 27-31. Trionyx leptomitus.

PLATE XXVI.

FIGS 1–4. *Trionyx leptomitus*, fragments, the natural size. Page 44.
FIG. 1. Left hyposternal, from below; *a*, from above.
FIG. 3. Part of the distal end of the costal of the specimen represented by Figs. 1 and 2; *a*, edge view.
FIG. 4. Right hyposternal of a second specimen, from below.
FIGS. 5–10. Fragments of *Trionyx cariosus*, natural size. Page 44.
FIGS. 5–9. Parts found in close connection.
FIGS. 5, 6. Proximal ends of costal bones of opposite sides, seen from above.
FIG. 7. Distal end of a costal bone, from above.
FIG. 8. A vertebral bone from above; *a*, from below.
FIG. 9. Probable postabdominal bone, from below; *a*, edge view.
FIG. 10. Distal portion of costal bone of a second individual, from above; *a*, distal view.
FIGS. 11–16. Fragments of *Trionyx radulus*, natural size. Figs. 11 and 12 belong to one, the remainder to another specimen. Page 45.
FIGS. 1 , 12. Distal parts of costal bones, from above; 12*a*, edge view of Fig. 12.
FIGS. 13, 14, 15. Fragments of costal bones.
FIG. 16. A vertebral bone; *a*, from below.

Plate XXVI

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1-4 Trionyx leptomitus. 5-10 T. cariosus. 11-16 T. radulus.

PLATE XXVII.

FIG. 1. Carapace of *Emys lativertebralis*, superior view, one-half natural size; restored from loose fragments. Page 53.

FIG. 2. Plastron of *Emys lativertebralis*, inferior view, one-half natural size.

FIG. 3. Anterior portion of plastron of *Emys lativertebralis*, a second specimen, one-half natural size, seen from below.

FIG. 4. Anterior part of plastron of *Emys cibollensis*, inferior view, one-half natural size. Page 57.

Plate XXVII

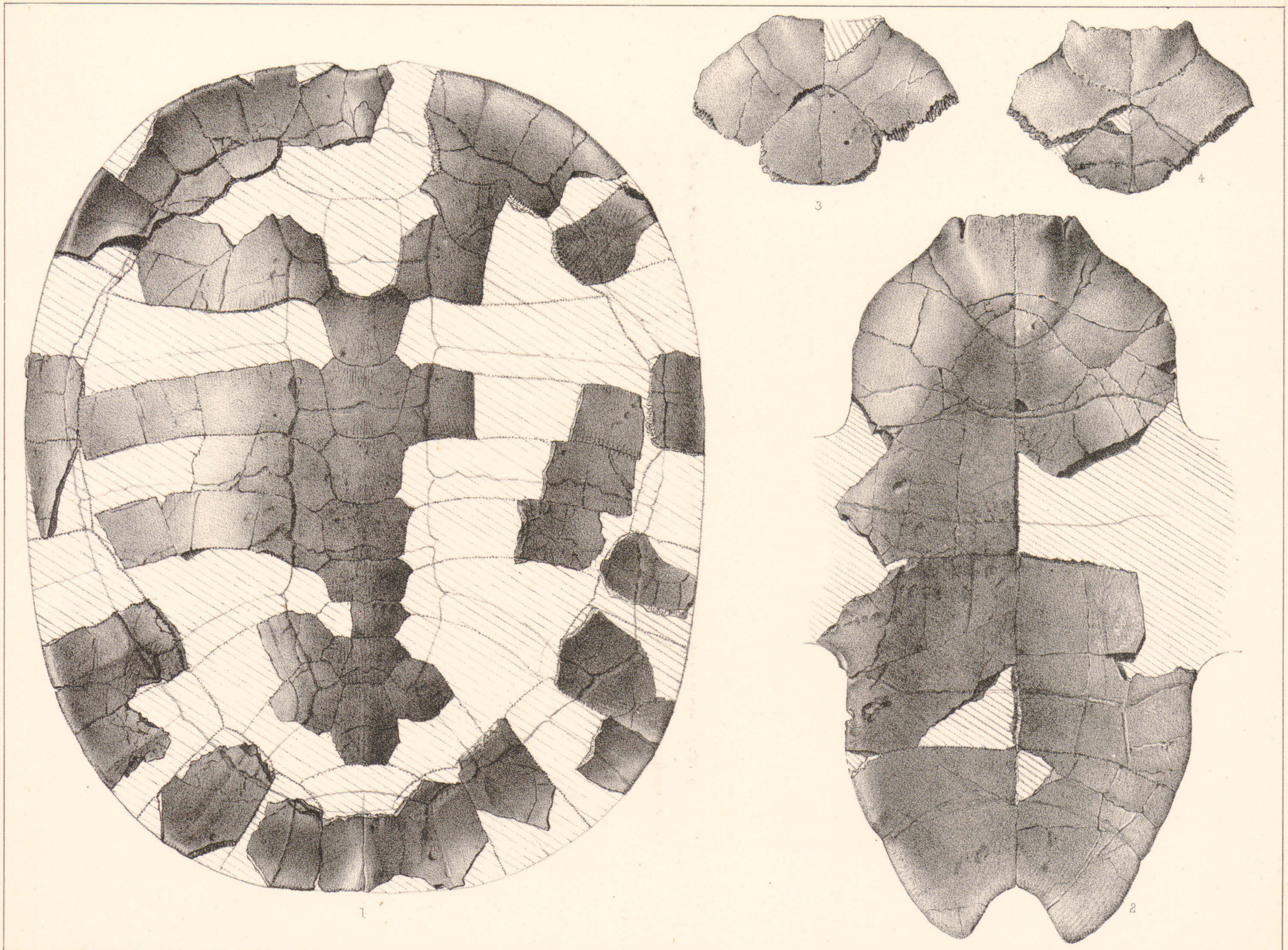

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PLATE XXVIII.

FIG. 1. Carapace of *Emys lativertebralis*, seen from below, one-half natural size.

FIG. 2. Plastron of *Emys lativertebralis*, superior face, one-half natural size; from the individual figured on the preceding figure and preceding plate.

FIG. 3. Anterior part of plastron of *Emys cibollensis*, from above, one-half natural size.

FIG. 4. Right side of posterior lobe of plastron of the same specimen represented in the last figure and in Fig. 4 of the preceding plate.

FIG. 5. An imperfect marginal bone of the same specimen, from above ; *b*, from the sutural border.

FIG. 6. A marginal bone of the same specimen, from above ; *b*, from the sutural border.

Plate XXVIII

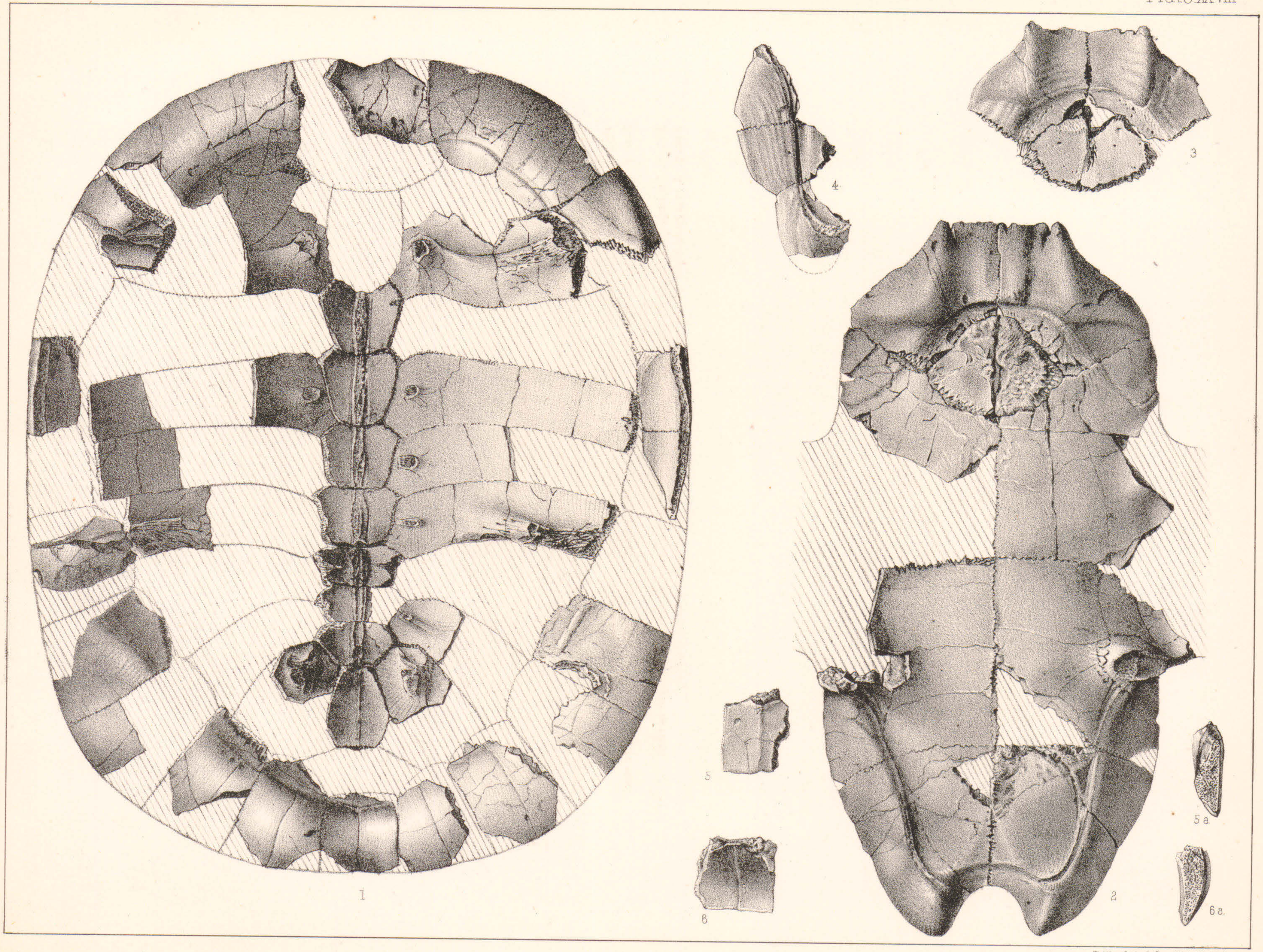

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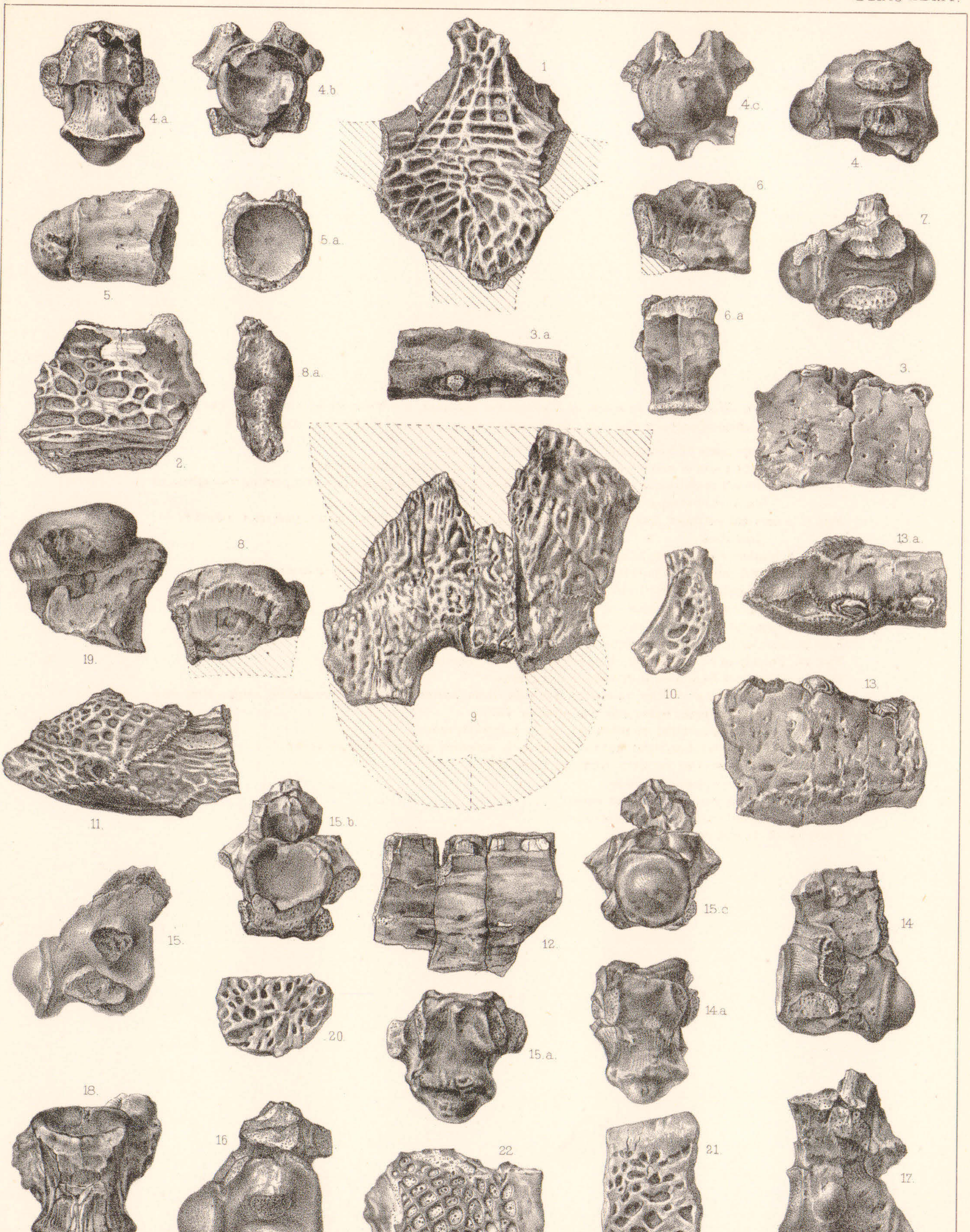
PLATE XXIX.

Fragments of the skeleton of two specimens of Diplocynodus sphenops, two-thirds the natural size. The first individual includes Figs. 1–8; the remaining figures represent the second. Page 60.

FIG. 1. Adjacent parts of frontal and parietal bones, from above.
FIG. 2. Adjacent parts of articular, angular, and surangular bones, external view.
FIG. 3. Part of left mandibular ramus from the posterior part of the symphysis, supporting two adjacent canines, external view; *a*, superior view.
FIG. 4. A cervical vertebra, from the right side; *a*, from below, *b*, anterior, and *c*, posterior articular extremities.
FIG. 5. A lumbar vertebra, right side; *a*, anterior extremity.
FIG. 6. A sacral centrum, somewhat compressed by pressure, lateral view; *a*, inferior view.
FIG. 7. First caudal vertebra, from above.
FIG. 8. Proximal end of humerus; *a*, a distal view.
FIG. 9. Fragment of end of muzzle, somewhat flattened by pressure.
FIG. 10. Part of left postfrontal bone.
FIG. 11. Portion of external wall of mandible at the angulo-dentary suture.
FIG. 12. Fragment from middle of mandibular ramus.
FIG. 13. Portion of mandibular ramus of left side, from posterior part of symphysis, supporting two canine teeth, outer side; *a*, superior view.
FIG. 14. An anterior cervical vertebra, left side; *a*, inferior side.
FIG. 15. Cervical vertebra, right side: *a*, inferior, *b*, anterior, and, *c*, posterior views.
FIG. 16. Another cervical vertebra, from the right side.
FIG. 17. A dorsal vertebra, left side.
FIG. 18. A lumbar vertebra, inferior view.
FIG. 19. Proximal extremity of humerus.
FIGS. 20, 22. Dorsal dermal bones.



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Diplocynodus sphenops Cope.

PLATE XXX.

Figures of parts of skeletons of Crocodilus grypus, two-thirds natural size; first individual from Fig. 1 to Fig. 6, second individual the remaining figures. Page 63.

FIGS. 1–2. Portions of right and left rami of the mandible, including alveoli, five teeth on the right side, and three on the left; *a*, the external view of the right ramus, the outer wall broken away; *b*, the distal view of the fractured distal end of the same, displaying the large terminal tooth.

FIG. 3. Part of angular bone, external view.

FIG. 4. Articular bone, quadrate cotylus, from above.

FIG. 5. Portion of upper jaw, with base of crown of large tooth.

FIG. 6. Part of maxillary bone, with perfect crown of a successional tooth.

FIG. 7. Right half of right frontal bone from above; *b*, from below.

FIG. 8. Portion of left premaxillary bone, showing large tooth and notch for inferior canine.

FIG. 9. A portion of the dentary bone, with crowns of three teeth, not fully protruded.

FIG. 10. A dermal bone, superior surface.

FIG. 11. An anterior cervical vertebra, right side; *a*, inferior, *b*, anterior, and, *c*, posterior view.

FIG. 12. Anterior dorsal vertebra; *a*, inferior, *c*, posterior views.

FIG. 13. Dorsal vertebra.

FIG. 14. A lumbar vertebra; *c*, posterior view.

FIG. 15. First caudal vertebra; *a*, inferior view.

FIGS. 16–17. Anterior caudal vertebræ; *a*, inferior, *b*, anterior, *c*, posterior views.

FIG. 18. A posterior caudal; letters as above.

FIG. 19. Head of humerus; *a*, proximal view.

FIG. 20. Proximal part of scapula (?).

FIG. 21. Head of femur; *a*, proximal view.

FIG. 22. Femur, side view; *a*, distal view.

FIG. 23. Proximal part of tibia: *a*, proximal view; *b*, distal extremity, lateral view; *c*, distal view.

FIGS. 24–25. Articular extremities of long bones.

FIG. 26. Calcaneum, outer side; *a*, from above *b*, internal side; *c*, from behind.

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Crocodilus grypus

PLATE XXXI.

FIGS. 1–5. *Crocodilus wheelerii*, fragments of skull, two-thirds natural size. Page 64.

FIG. 1. Parts of parietal, frontal, nasal, etc., bones, viewed from above; *a*, the first named from below; *b*, the same fragment, anterior edge, showing the small development of the olfactory ridges.

FIG. 2. Part of the left premaxillary bone with teeth, external view; *a*, inferior view.

FIG. 3. Right quadrate bone, from above; a portion of the quadrato-jugal adheres.

FIG. 4. Parts of angular and surangular bones, seen from the outer side, at the cotylus.

FIG. 5. Fragment of mandibular ramus flattened (?) abnormally; *a*, external face.

FIGS. 6–7. Fragments of skull of *Crocodilus ? elliottii*, two-thirds natural size. Page 65.

FIG. 6. Frontal bone, from above; *a*, from below; *b*, view of anterior fractured edge, showing the strong lateral olfactory crests.

FIG. 7. Part of mandible, with a tooth.

FIGS. 8–17. Parts of a skeleton described under the head of *Crocodilus elliottii*, drawn of the natural size.

FIG. 8. Posterior part of right ramus mandibuli, from above.

FIG. 9. A tooth from an anterior position in the jaws, from the side; *a*, from the edge.

FIG. 10. Another tooth from a posterior position in the jaws; *a*, edge view.

FIG. 11. Distal end of quadrate bone, superior view; *a*, distal view.

FIG. 12. A cervical vertebra, from below; *a*, from behind.

FIG. 13. A dorsal vertebra, anterior view, partly adherent to the matrix; *a*, inferior surface.

FIG. 14. A long bone; *a*, proximal articular surface.

FIG. 15. Radial carpal bone; *a*, proximal, *b*, distal extremities.

FIG. 16. Proximal extremity of the femur; *a*, proximal view.

FIG. 17. An ungual phalange, profile; *a*, inferior face.

FIGS. 18–23. Fragments of skeleton of a Crocodile, referred provisionally to *Crocodilus liodon*. Page 67.

FIG. 18. Part of the parietal bone, from above.

FIG. 19. Distal extremity of os quadratum, from above; *a*, distal view.

FIG. 20. Axis with odontoid bone, from below.

FIG. 21. An anterior cervical vertebra; *a*, anterior view, showing fusion of hypapophysis and parapophysis.

FIG. 22. Another cervical vertebra, inferior view.

FIG. 23. Lumbar vertebra, right side; *a*, anterior articular extremity.

Plate XXXI.

1-5 Crocodilus wheelerii 6-17 Crocodilus? sp. 18-23 Crocodilus ? sp

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PLATE XXXII.

FIGS. 1-22. Bones of *Crocodilus chamensis*, the natural size, belonging to four individuals. The first is represented in Figs. 1-10; the second, 11-12; the third, 13-21; the fourth, Fig. 22. Page 67.

FIG. 1. Frontal bone, from above; *a*, from the front.

FIG. 2. Quadrate bone, distal extremity, the upper surface; *a*, the inferior surface; *b*, the articular surface.

FIG. 3. Portion of lower jaw and muzzle, with teeth, from the left side; *a*, from below.

FIGS. 4-10. Dermal bones, superior surfaces.

FIG. 11. Superior view of part of premaxillary bone of the specimen of *C. chamensis* first described.

FIG. 12. Inferior view of the same, showing round section of teeth.

FIGS. 13-16. Vertebral column, with numerous omissions, of a young *C. chamensis*.

FIG. 17. Anterior view of the third of the above series.

FIG. 18. Anterior view of the sixth of the same series.

FIG. 19. First caudal vertebra of the same series.

FIG. 20. Part of left side of frontal bone, from above; *a*, from the front.

FIG. 21. Proximal part of femur of the same.

FIG. 22. Distal end of quadrate bone of a younger specimen, from above; *a*, articular extremity.

FIGS. 23-25. Portions of the tarso-metatarse of the *Diatryma gigantea*, two-thirds natural size. Page 70.

FIG. 23. Proximal part of the tarso-metatarse, anterior view; *a*, posterior view; *b*, the internal edge; *c* the proximal or tibio-tarsal extremity.

FIG. 24. The median distal condyle, viewed from the front; *a*, from behind; *b*, from below.

FIG. 25. The interior condyle, viewed from before; *a*, posterior, and, *b*, distal views.

FIGS. 26-36. Fragments of the skeleton of a Lizard of the family *Placosauridæ*, species and genus not determined, all found together.

FIGS. 26-34. Dermal and cranial plates; twice natural size.

FIG. 35. Distal end of femur, from below; *a*, distal view.

FIG. 36. Shaft of humerus.

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1–22. Crocodilus chamensis. 23–25. Diatryma gigantea.
26–36. Placosauridae.

PLATE XXXIII.

Ambloctonus sinosus, natural size. Page 91.

FIGS. 1-10. Fragments of skeleton of the typical specimen.

FIG. 1. Right maxillary bone, with teeth, seen from the outer side; a wide fracture of the bone is occupied by a mass of limestone: *a*, the right canine tooth worn to the base of the crown; *b*, the maxillary bone viewed from below; *c*, maxillary and premaxillary from the front, displaying the alveolus for the large outer incisor.

FIG. 2. Posterior true molar of the left side, viewed from the outer side; *a*, the same, viewed from below.

FIG. 3. Left mandibular ramus, a fragment which supported the last three molars: *a*, from the outer side; *b*, inside of the same; *c*, superior view of the same; *d*, portion of condyle.

FIG. 4. Worn canine tooth of the left side.

FIG. 5. Glenoid cavity.

FIG. 6. Distal end of ulna, from above; *a*, from below; *b*, distal view.

FIG. 7. Femur without the great and little trochanters, but displaying the third trochanter; *a*, section at distal fractured end.

FIG. 8. Right femur, inferior portion of the shaft.

FIG. 9. Left tibia, inferior extremity and part of shaft, front view; *a*, posterior view; *b*, inferior view.

FIG. 10. Calcaneum; anterior portion wanting.

FIG. 11. Portion of right mandibular ramus of a second individual, external side; *a*, view from above. A large piece of matrix adheres to the inner side.

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Ambloctonus sinosus.

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1-13 Oxyaena morsitans. 13-37 Oxyaena lupina.

PLATE XXXV.

FIGS. 1–4. *Oxyæna lupina*, natural size.

FIG. 1. Left maxillary bone, supporting the posterior four molars, with the canine from the outer side; *a* maxillary bone, from below; *b*, last superior molar, a part broken away.

FIG. 2. Left ramus of the mandible, from the outer side, with the third premolar and the canine; *a*, the same, viewed from above.

FIG. 3. The zygomatic portion of the squamosal bone, from below; *a*, the same, extero-posterior view.

Fig. 4. Portion of right mandibular ramus supporting the second, third, and fourth premolars, seen from the inner side.

FIGS. 5–6. Femur and anterior part of calcaneum of an *Oxyæna*, found six feet from the remains figured Plate II, figs. 5–9, and belonging perhaps to the same individual, viewed from above.

FIGS. 7–12. Fragments of skull of *Oxyæna forcipata*, found together, natural size. Page 105.

FIG. 7. Parietal and part of frontal bone, with sagittal crest, seen from above; *a*, the same, inferior side, showing form of superior surface of brain; *b*, the same, from the left side.

FIG. 8. Right maxillary bone, showing fossa for reception of large inferior molar. This specimen was found a short distance from the others, but resembles them very closely in a peculiar color and specific gravity, and is of the size appropriate to the mandibular ramus.

FIG. 9. Portions of maxillary and premaxillary bone and canine tooth, with free nareal border.

FIG. 10. Posterior part of malar bone, with orbital border.

FIG. 11. Glenoid cavity of squamosal bone, seen from below.

FIG. 12. Portion of the mandibular ramus behind the last premolar tooth, seen from the outer side; *a*, the condyle, seen from behind.

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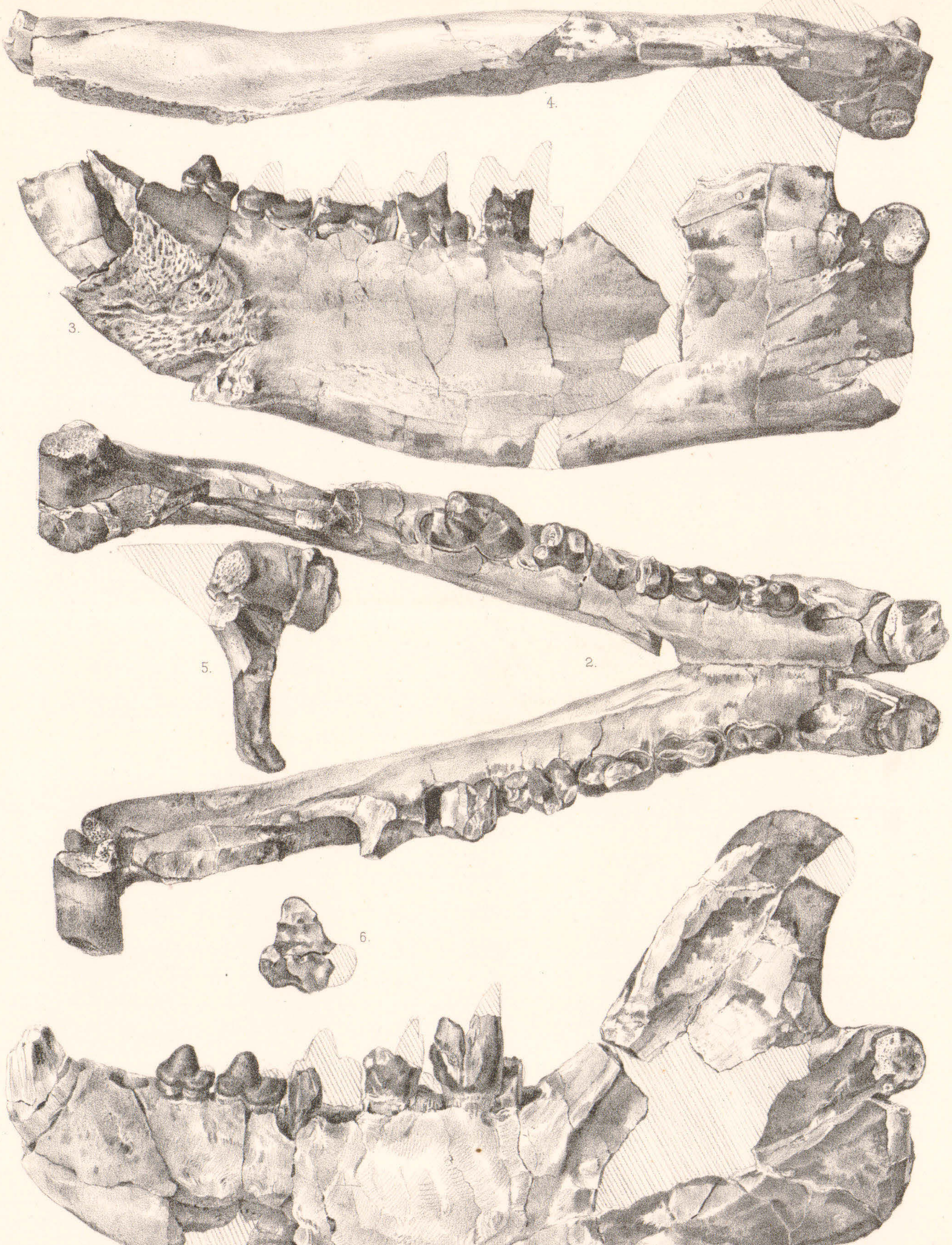
1-4 Oxyaena lupina. 5-12 Oxyaena forcipata.

PLATE XXXVI.

Lower jaw of Oxyæna forcipata, natural size.

FIG. 1. Left ramus, outer side.
FIG. 2. Both rami in position, from above.
FIG. 3. The right ramus, inner side.
FIG. 4. Left ramus, from below.
FIG. 5. Left ramus below condyle, from behind.
FIG. 6. Penultimate right superior molar, from below.



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Oxyaena forcipata.

PLATE XXXVII.

Bones of Creodonta, natural size.

FIG. 1. Parietal bone, with broken sagittal crest, of *Oxyæna forcipata*, the specimen figured in Plate XV, the superior view; *a*, the inferior surface, partially imperfect; *b*, from the front.

FIGS. 2–5. Mandibular teeth of another individual of *Oxyæna forcipata*.

FIG. 2*c*. Right posterior molar, inner side.

FIG. 3. Left posterior molar, external side; *a*, from behind; *b*, from above.

FIGS. 4. ? First inferior premolar.

FIG. 5. Right inferior canine, inner side; *a*, from above; *b*, outer side.

FIG. 6. External side of part of ilium, including part of acetabulum of another individual of *Oxyæna*.

FIGS. 7–8. Found together, and supposed to pertain to the same individual.

FIG. 7. Inferior extremity of tibia, inner side; *a*, from outer side.

FIG. 8. One of the inferior true molars, outer side; *b*, from above; *c*, inner side.

FIG. 9. Maxillary, containing roots of two premolars, with premaxillary supporting three incisors of an isolated individual of *Oxyæna*, seen from below.

FIGS. 10–22. Bones of skeleton of *Creodus incertæ sedis*, No. II, all found together. Page 129.

FIGS. 10–11. Cervical vertebræ, from below; 10*a*, articular extremity of 10.

FIGS. 12–13. Dorsal vertebræ, from below; *a*, corresponding articular ends.

FIGS. 15–16. Caudal vertebræ; *a*, articular extremities; *b*, sections at middle.

FIG. 17. A superior molar tooth accompanying the remains, from below; *a*, from the side.

FIG. 18. Right humerus, from the posterior side; *a*, from the outer side; *b*, intero-anterior view; *c*, proximal end.

FIG. 19. Distal end of left humerus, posterior view; *a*, anterior view; *b*, distal view.

FIG. 20. Radius minus the proximal end, seen from above; *a*, from the outer side; *b*, from distal end.

FIG. 21. Radius, proximal end, from below; *a*, head, proximal view.

FIG. 22. Ulna minus the distal end; *a*, inferior view.

FIGS. 23–31. *Creodus incertæ sedis*, No. I, portions of skeleton, natural size. Page 127.

FIG. 23. Left mandibular ramus anterior to second true molar, from above.

FIGS. 24–25. Vertebræ: *a*, articular faces; *b*, from above; *c*, from below.

FIG. 26. Proximal part of scapula; *a*, glenoid cavity.

FIG. 27. Humerus, without head or condyles; the deltoid crest seen as the right border.

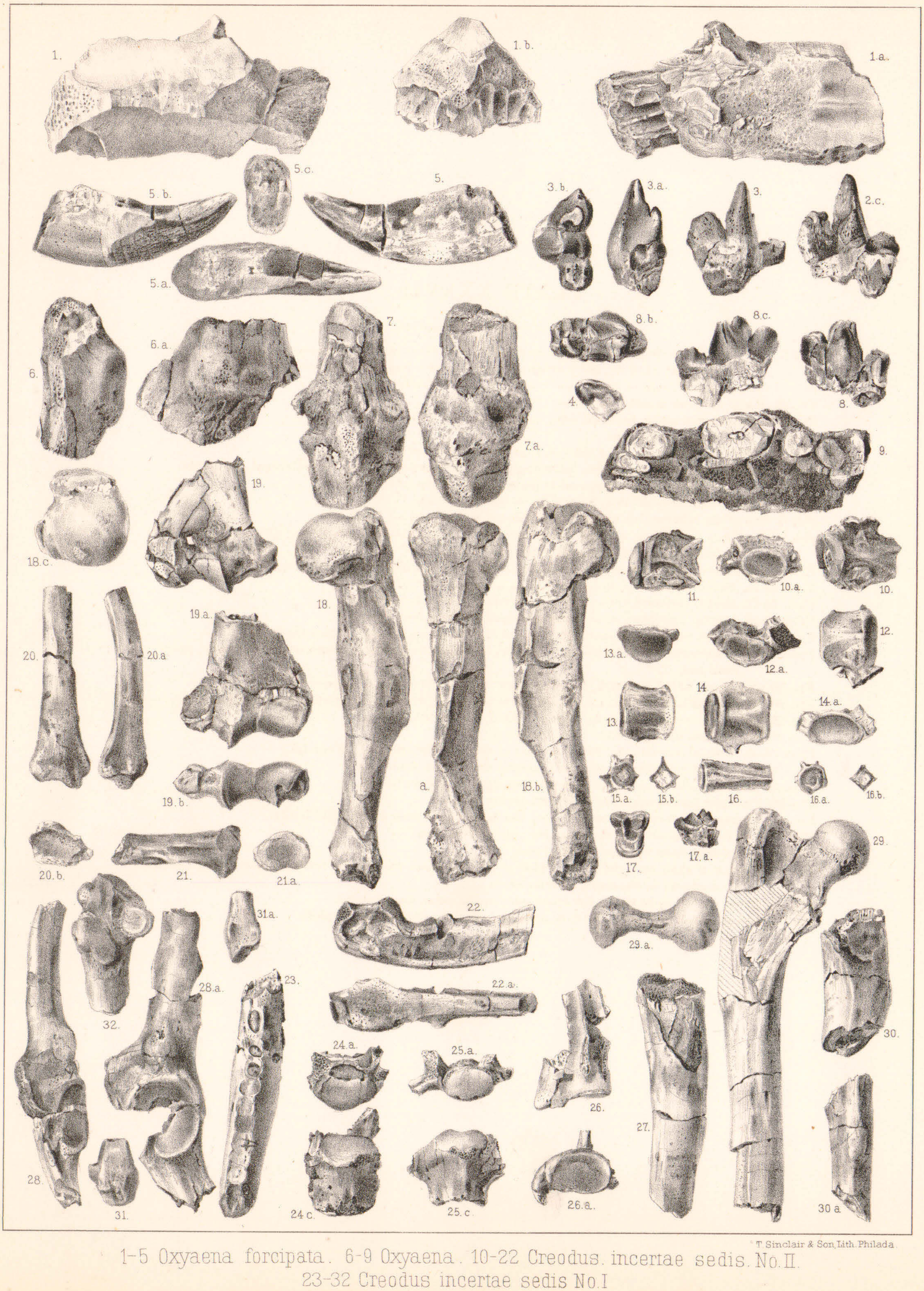
FIG. 28. Left ilium and ischium, anterior view; *a*, exterior view.

FIG. 29. Left femur, from behind; *a*, distal end.

FIG. 30. Portion of shaft of right femur which is wanting from that of the left side, displaying third trochanter; *a*, the same, exterior view.

FIG. 31. Distal extremity of fibula, the inner side; *a*, the same, from behind.

FIG. 32. Calcaneum of left side, seen from above; posterior extremity incomplete.



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1-5 Oxyaena forcipata. 6-9 Oxyaena. 10-22 Creodus. incertae sedis. No. II.
23-32 Creodus incertae sedis No. I

PLATE XXXVIII.

FIGS. 1-11. *Stypolophus viverrinus*, fragmentary skeleton of typical specimen, natural size. Page 112.

FIG. 1. Anterior part of cranium from below. The inferior face of the left maxillary supporting the last five molars is presented, while the right maxillary is twisted underneath so as to exhibit the three molars in front of the last in profile. Between the maxillaries, the left ulna and radius lie in close relation. 1*a*, the occipital portion of the same cranium, viewed from above; *b*, the frontal and part of the nasal region, the superior view of Fig. 1.

FIG. 2. A cervical vertebra, from behind; *a*, from below; *b*, from above.

FIG. 3 A lumbar vertebra, from the end; *a*, from below.

FIG. 4. Two lumbar vertebræ from the front; *b*, from above; *c*, from the side.

FIG. 5. A caudal vertebra: *a*, from below; *c*, from the side.

FIG. 6. Sacrum, the anterior portion, with the right anterior angle broken off, from before; *b*, from above.

FIG. 7. Left humerus, the proximal end, from the outer side; *b*, proximal view.

FIG. 8. Part of the proximal end of the femur, from behind.

FIG. 9. Part of distal end of femur, from the side; *a*, from above.

FIG. 10. Distal part of shaft and extremity of the right tibia, from behind; *a*, from front; *b*, distal end.

FIG. 11. Calcaneum, from above; *a*, the cuboid, articular face.

FIG. 12-20. Portions of the skeleton of the typical individual of *Stypolophus hians*, natural size. Page 118.

FIG. 12. Cranium posterior to the orbits, showing the narrow form and broken parietal crest, from the left side; *a*, from above.

FIG. 13. The right ramus of the mandible, the middle portion wanting, external view.

FIG. 14. Left half of atlas, seen from behind; *a*, from below.

FIG. 15. An anterior dorsal vertebra, from below; *a*, articular extremity of centrum.

FIG. 16. Another dorsal vertebra from below; *a*, from behind; *b*, from the right side.

FIG. 17. An anterior lumbar vertebra, from below; *a*, articular extremity of centrum.

FIG. 18. A posterior lumbar vertebra, from below; *a*, articular end.

FIG. 19. A caudal vertebra, from below.

FIG. 20. A more distal caudal vertebra; *a*, articular extremity.

FIG. 21. Glenoid cavity of scapula.

FIG. 22. Proximal part of humerus, postero-interior view.

FIG 23. Distal end of the humerus, anterior view.

FIG. 24. Proximal end of the ulna, interior side.

FIG. 25. Parts of ilium and ischium with acetabulum, exterior view; *a*, anterior view.

FIG. 26. Proximal end of tibia, exterior side.

Fig. 27. Distal extremity of tibia, posterior view; *a*, exterior view.

FIG. 28. Calcaneum, from above; a small portion lost from its middle; *a*, cuboid facet, etc., of the same.

FIG. 29. Entocuneiform bone, outer side; *a*, distal articular facet; *b*, inner view.

FIG. 30. Distal extremity of a metapodial bone, from below.

Plate XXXVIII

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1-11 Stypolophus viverrinus. 12-30 Stypolophus hians.

PLATE XXXIX.

Creodonta and Mesodonta.

FIGS. 1-9. *Didymictis protenus*, natural size. Page 123.

FIG. 1. Left mandibular ramus, supporting five molars, the elevated cusps of the tubercular sectorial broken off, from the outer side; *a*, from the inner side.

FIG. 2. Left mandibular ramus of another individual, from above, displaying all the molars or their alveoli; *a*, from the inner side.

FIG. 3. Part of ilium, the same individual, inner side; 3*a*, same, outer side.

FIG. 4. End of tibia of the same individual, the inner distal tuberosity broken off.

FIG. 5. Left astragalus of the same individual, from above; *a*, right astragalus of the same individual, from below; *b*, from the outer side.

FIG. 6. Distal end of radius of the same individual, from below; *a*, from above; *b*, from the distal end.

FIG. 7. Posterior part of left ramus of another individual, with the sectorial tubercular better preserved, but broken; *a*, from the inner side; *b*, from above.

FIG. 8. Right mandibular ramus of another individual, with tubercular sectorial and canine preserved.

FIG. 9. Outer view of cusps of tubercular sectorial of another individual supposed to be of this species, showing the blade.

FIG. 10. Last superior premolar of *Pachyæna ossifraga*, natural size, from the outer side; *a*, from the inner side; *b*, from below. Page 94.

FIG. 11. *Stypolophus strenuus*, right mandibular ramus, from the outer side, the matrix somewhat adherent and the molars partially broken, with the canine tooth adherent to the upper posterior angle; *a*, from the inner side; *b*, the left ramus, posterior portion, viewed from above, showing the sections of the broken tubercular sectorial molars. Page 117.

FIG. 12. *Stypolophus multicuspis*, left mandibular ramus, natural size, from the outer side; *a*, portion of the right mandibular ramus, viewed from above. Page 116.

FIG. 13. *Stypolophus multicuspis*, portion of the right mandibular ramus of another individual, from the inner side.

FIG. 14. *Stypolophus multicuspis*, a third individual: four superior molars of the right and one of the left side of the same animal, natural size, *a*, superior molars of right side, in profile.

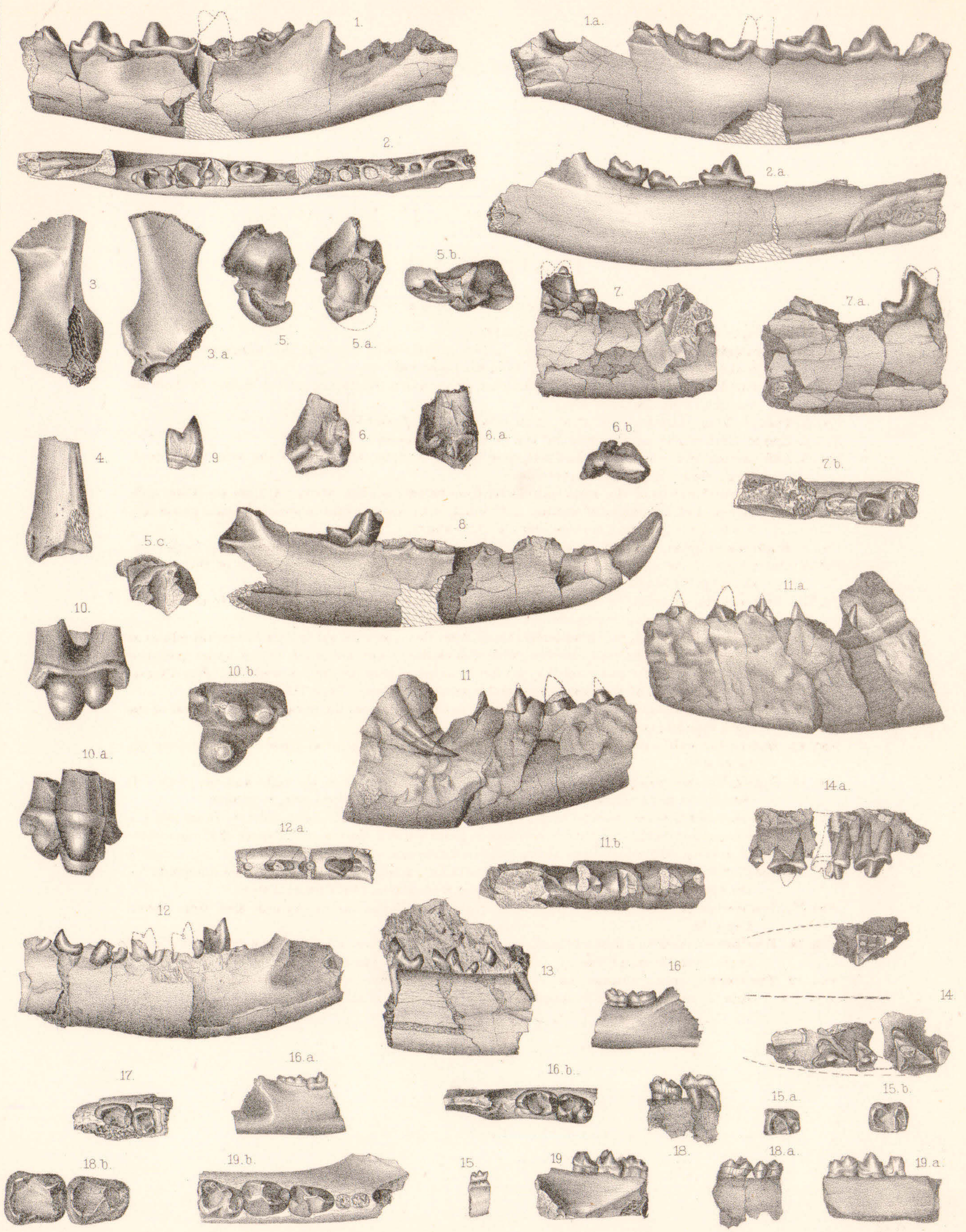
FIG. 15. *Tomitherium angulatum*, portion of the left mandibular ramus, natural size, from the inner side; *a*, molar tooth of this fragment, from above, twice natural size; *b*, molar tooth of the mandible of another individual, from above, twice natural size. Page 144.

FIG. 16. *Tomitherium frugivorum*, portion of right mandibular ramus, natural size, from the inner side; *a*, the same, from the outer side; *b*, the same, from above, twice natural size.

FIG. 17. *Tomitherium jarrovii*, posterior portion of right mandibular ramus, natural size, from above. Page 137.

FIG. 18. *Tomitherium jarrovii*, a broken right mandibular ramus, natural size, from the inner side; *a*, the same, from the outer side; *b*, the same, twice natural size, from above.

FIG. 19. *Tomitherium tutum*; anterior part of right mandibular ramus, which supported four teeth, inner side; *a*, the outer side; *b*, superior aspect, twice natural size.



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1-9. Didymictis protenus. 10. Pachyaena ossifraga
11. Stypolophus strenuus. 12-14. Stypolophus multicuspis 15. Tomitherium angulatum.
16. T. frugivorum. 17-18. T. jarrovii. 19. T. tutum.

PLATE XL.

FIGS. 1–15. Bones found with the teeth of *Tomitherium jarrovii*, natural size. Page 137.
FIG. 1. Olecranar portion of ulna, lateral view; *a*, the same, from below.
FIG. 2. Distal end of ulna, from above; *a*, the distal articular face.
FIG. 3. Proximal end of radius from below; *a*, proximal articular face.
FIG. 4. Head of the femur.
FIG. 5. External margin of femur, displaying third trochanter.
FIG. 6. Patella, external face; *a*, internal face.
FIG. 7. Distal end of fibula, from behind; *a*, inner face; *b*, outer face
FIG. 8. Calcaneum, superior face; *a*, distal end.
FIG. 9. Astragalus in two fragments, from above; *b*, from below.
FIG. 10.? Navicular bone, from above; *a*, from the side; *b*, from below.
FIG. 11. Cuboid bone, from the front; *a*, from the inner side; *b*, the proximal, and *c*, the distal ends.
FIG. 12. Mesocuneiform bone, from the side; *a*, from the front; *b*, from above.
FIG. 13. The entocuneiform bone, from the outer side; *a*, from the inner side; *b*, from below.
FIGS. 14–15. Sesamoid bones; *a*, external faces.
FIGS. 16–25. Bones found with the teeth of *Tomitherium tutum*, including portions of feet, natural size. Page 141.
FIG. 16. Astragalus and calcaneum in mutual relation, from the outer side; *a*, from above; *b*, astragalus, from below.
FIG. 17. Extremity of right tibia in relation with the astragalus, from the front.
FIG. 18. Extremity of right tibia, from below.
FIG. 19. A metacarpal bone, antero-superior view; *a*, from the side; *b*, another metacarpal, proximal view.
FIGS. 20, 21, 22. Phalanges, from above; *a*, from the side; *b*, proximal end.
FIG. 23. Ungual phalange, from above; *a*, from the side; *b*, proximal extremity.
FIG. 24. Mesocuneiform bone, side view; *a*, the front; *b*, end view.
FIG. 25. Unknown element, concave face; *a*, plane face.
FIG. 26. *Esthonyx burmeisterii*, posterior part of right mandibular ramus, from the outer side, supporting the last inferior molar; *a*, the same, from above. Page 156.
FIGS. 27–30. Typical specimen of *Esthonyx bisulcatus*, natural size. Page 154.
FIG. 27. Left mandibular ramus, supporting the last three molars and the penultimate premolar, external view; *a*, internal; *b*, superior, and, *c*, inferior views.
FIG. 28. Fragment of the right mandibular ramus, supporting the two last molars, viewed from above.
FIG. 29. Supposed superior incisor: *a*, external view; *b*, lateral view; *c*, internal view.
FIG. 30. Supposed inferior incisors: *a* and *b*, those of opposite sides, viewed from behind; *c*, left tooth, view from the outer side; *d*, the same, inner side; *e*, the same, from the front.
FIG. 31. Portion of the right mandibular ramus of a second specimen of *Esthonyx bisulcatus*, from the outer side; *a*, the inner side; *b*, from above, natural size.
FIG. 32. Fragment of lower jaw of a third specimen, supporting a molar, inner side; *a*, from above.
FIG. 33. An inferior molar of a fourth specimen of *Esthonyx bisulcatus*, the outer side; *a*, superior face.
FIGS. 34–39. Superior incisor of the *Ectoganus novomehicanus*, natural size. Page 159.
FIG. 34. Outer side of incisor.
FIG. 35. Inner side of incisor.
FIG. 36. Front border of incisor.
FIG. 37. Posterior border of incisor.
FIG. 38. Proximal end, fractured.
FIG. 39. Distal end, masticating surface.

Plate XL.

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1-15 Tomitherium jarrovii. 16-25 T. tutum. 26 Esthonyx burmeisterii.
27-33 Esthonyx bisulcatus. 34-39 Ectoganus novomehicanus

PLATE XLI.

FIGS. 1-12. Teeth of *Ectoganus gliriformis*, natural size, from one individual. Page 160.

FIG. 1. Superior incisor, from inner side; *a*, the apex; *b*, the outer side; *c*, the front.

FIGS. 2-3. Inferior incisors, anterior face; *a*, posterior face; *b*, external face; *c*, base of the shaft.

FIGS. 4-5. Corresponding incisors of opposite sides from the front; *a*, from behind; *b*, from inner, *c*, from outer side.

FIG. 6. A smaller incisor, from the front; *b* and *c*, lateral views.

FIGS. 7-8. Two molar teeth, from the side; *a*, grinding face, each with the corresponding angle broken off; *b*, side view; *c*, external view.

FIG. 9. A molar tooth, fractured.

FIG. 10. An inferior molar tooth, from the side; *a*, from the end; *b*, from above.

FIGS. 11-12. Fragments of molar teeth.

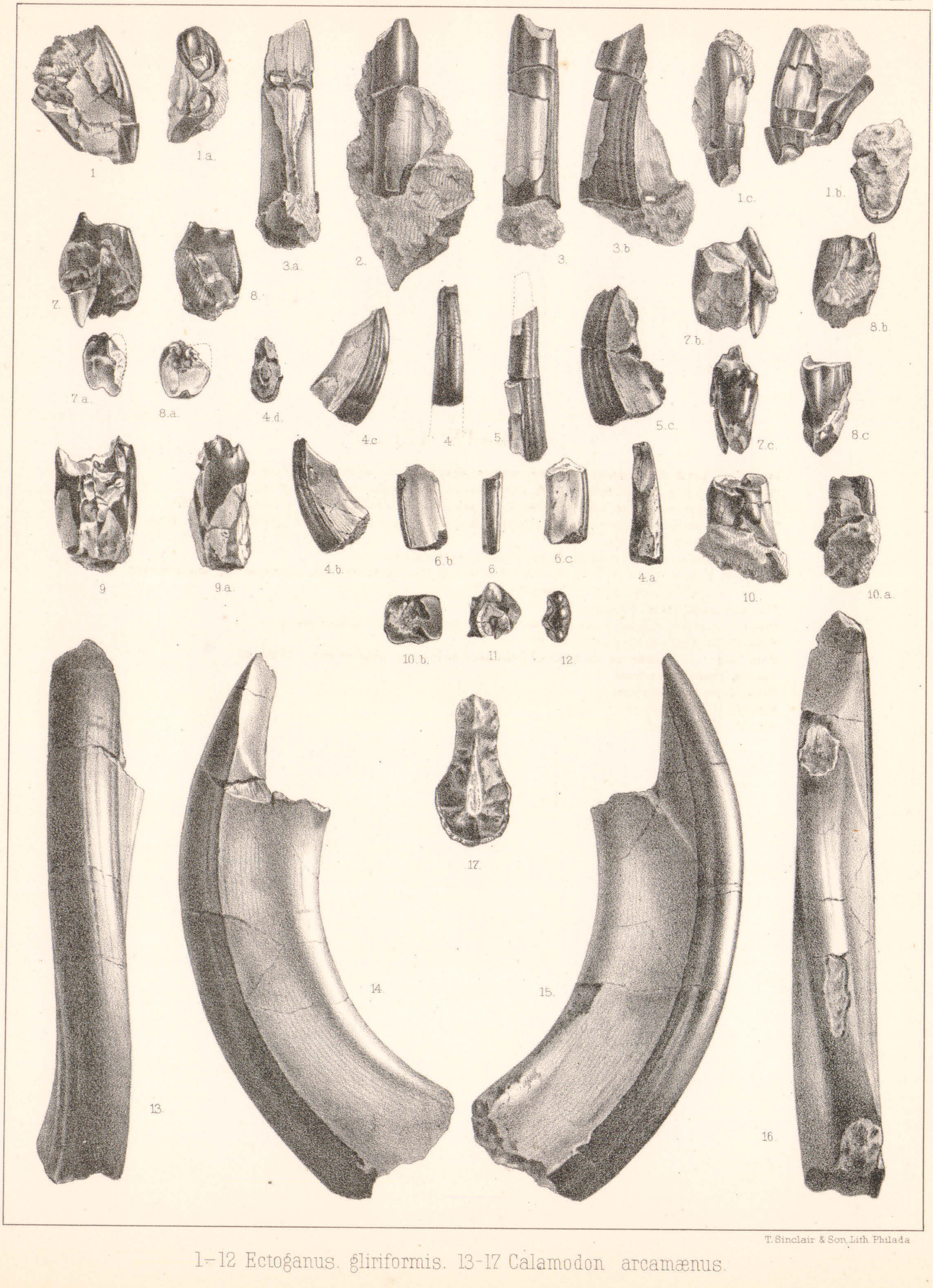
FIGS. 13-17. An inferior incisor tooth of *Calamodon arcamœnus*, natural size. Page 163.

FIG. 13. Front of the tooth.

FIGS. 14-15. Lateral views.

FIG. 16. Posterior aspect.

FIG. 17. Base of shaft.



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1–12 Ectoganus. gliriformis. 13-17 Calamodon arcamænus.

PLATE XLII.

FIGS. 1-5. Fragments of lower jaw and dentition of *Calamodon arcamœnus*, natural size.

FIG. 1. Left mandibular ramus, outer side; a portion of the external wall wanting, displaying the inner sides of the alveoli; *a*, the same, viewed from above; *b*, inferior view of the same.

FIG. 2. A portion of the inferior border of the right ramus, viewed from above, so as to display the fundus of the incisive alveolus.

FIG. 3. Extremity of the left inferior incisor, front view; *a*, internal aspect; *b*, posterior aspect; *c*, external view.

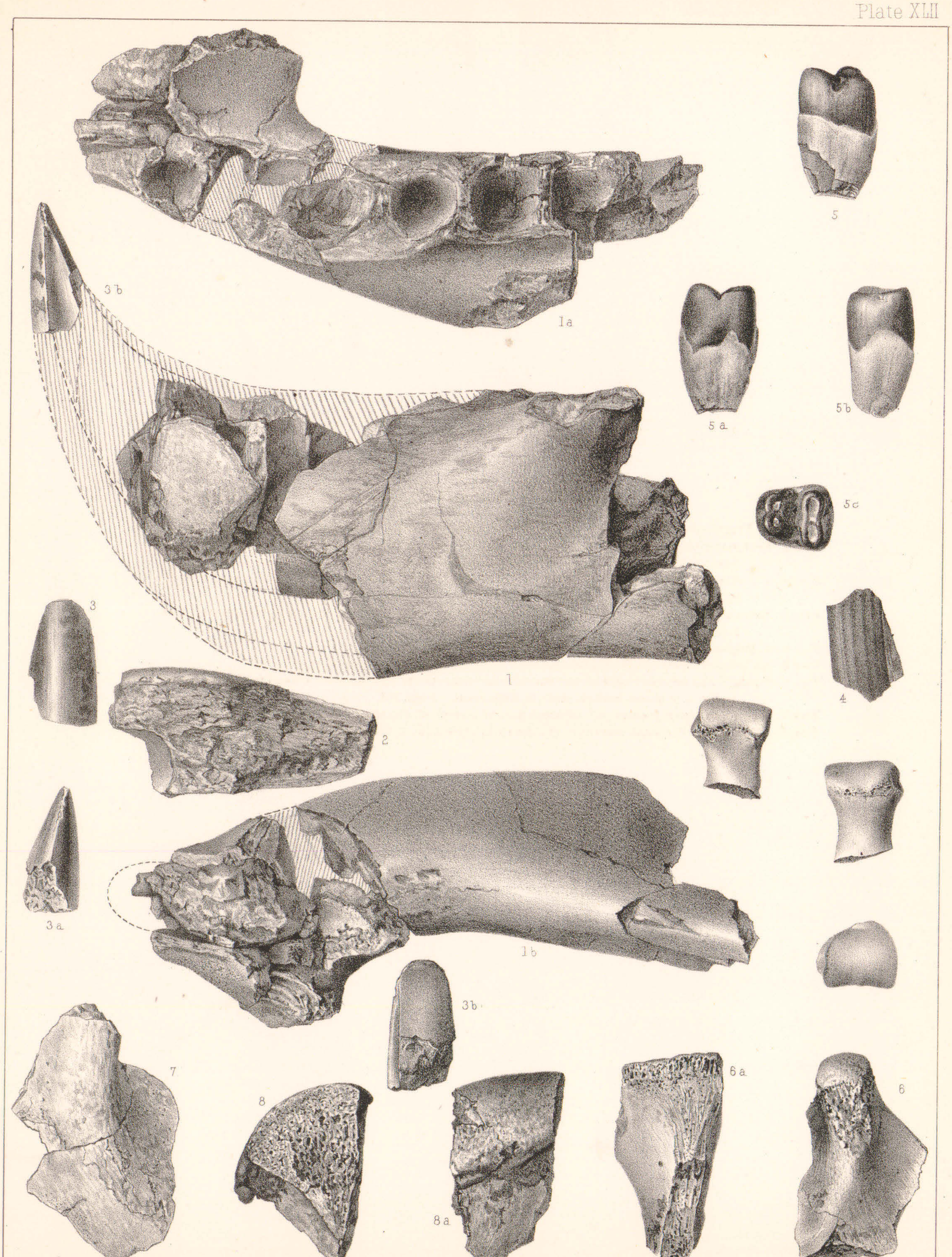
FIG. 4. A fragment from the inner side of the right inferior incisor.

FIG. 5. An inferior molar tooth: *a*, lateral view; *b*, anterior view; *c*, superior view.

FIG. 6. Condyle and adjacent part of the mandibular ramus of the specimen of *Calamodon simplex* figured on the next plate, natural size; *a*, from front. Page 166.

FIG. 7. Base of coronoid process and adjacent part of ramus, of the same specimen, outer side.

FIG. 8. Fragment of the same specimen, of uncertain reference; *a*, lateral view.



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1-5 Calamodon arcamænus. 6-8 C. simplex.

PLATE XLIII.

Fragments of the skeleton of a single individual of Calamodon simplex, partially figured on the preceding plate, natural size. Page 166.

FIG. 1. Superior incisor, external view; *a*, inner, *b*, distal, *c*, proximal views.
FIG. 2. Inferior incisor, the enamel-face and apex lost.
FIG. 3. Apex of the inferior incisor, lateral view; *a*, anterior view; *b*, section of base of fragment.
FIG. 4. Portion of the enamel-face of an inferior incisor.
FIG. 5. A small incisor, front view; *a*, lateral view; *b*, triturating surface.
FIG. 6. A molar tooth; *a*, triturating surface.
FIG. 7. Another molar tooth fragment.
FIG. 8. Fragment of articular extremity of scapula, outer view.
FIG. 9. Two fragments of the right humerus, placed in hypothetical relationship, anterior view; *a*, the same, internal side.
FIG. 10. Right ulna, both ends wanting, outer side; *a*, superior aspect.
FIG. 11. Right radius placed in relation with the ulna, external aspect; *a*, superior, *b*, proximal views.
FIG. 12. Os magnum, anterior side; *a*, lateral view; *b*, inferior, and, *c*, superior aspects.
FIG. 13. Ungual phalange, lateral view; *a*, proximal extremity; *b*, superior aspect.

Plate XLIII

Calamodon simplex.

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PLATE XLIV.

All the figures on this plate are of the natural size, excepting Fig. 8 b, which is one and one-half natural size.

FIG. 1. Inferior incisor tooth of *Calamodon arcamœnus*, which was found alone, seen from the side; *a*, anterior, *b*, proximal, and, *c*, posterior views.

FIG. 2. Inferior incisor of an isolated individual of *Calamodon simplex*, seen from the side; *a*, anterior view; *b*, proximal view, giving section; *c*, posterior view.

FIGS. 3–4. Teeth of one individual of *Calamodon simplex*.

FIG. 3. Molar tooth, outer side; *a*, inner side; *b* and *c*, anterior and posterior views; *d*, triturating surface of the crown.

FIG. 4. Portion of the inferior incisor tooth, including only the enamel-covered face; *a*, from front; *b*, section; *d*, lateral view.

FIG. 5. A superior incisor of another specimen of *Calamodon simplex*, lateral view.

FIG. 6. An isolated superior molar of a species of *Calamodon*, worn by prolonged use, lateral view; *a*, external side; *b*, triturating face; *c*, base of fang.

FIG. 7. Fragment of an incisor tooth of uncertain reference, from the side; *a*, anterior face; *b*, section at end of shaft.

FIG. 8. Superior maxillary bone of *Plesiarctomys buccatus*, from below; *a*, from the outer side; *b*, inferior aspect, enlarged one-half. Page 171.

FIG. 9. Left mandibular ramus of *Plesiarctomys delicatissimus*, inner side; *a*, outer side; *b*, superior view. Page 172.

FIG. 10. Left ramus of mandible of *Plesiarctomys delicatior*, inner side; *a*, outer side; *b*, superior, *c*, inferior views. Page 172.

FIG. 11. Right ramus of *Plesiarctomys delicatior*, from within; *b*, from above.

FIG. 12. Right inferior incisor of *Plesiarctomys delicatissimus*, front and side views.

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1 Calamodon arcamænus. 2-5 C. simplex. 8 Plesiarctomys buccatus.
9 and 12 P. delicatissimus. 10-11 P. delicatior.

PLATE XLV.

FIGS. 1–5. *Phenacodus primævus*, jaws and teeth, natural size. Page 174.

FIG. 1. Portion of left mandibular ramus, with mandibular and maxillary teeth, viewed from the outer side; 1 *a*, the same, from the inner side.

FIG. 2. Superior molar teeth of the same specimen, viewed from below.

FIG. 3. Inferior molar teeth of the same, viewed from above.

FIG. 4. Fragment of the right mandibular ramus of another individual, supporting true molars, viewed from the outer side; 4 *a*, from above.

FIG. 5. Last inferior true molar from a third individual, from above.

FIG. 6. Superior true molar of *Phenacodus omnivorus*, crown from below, natural size. Page 178.

FIG. 7. Superior molar of *Phenacodus sulcatus*, from below, natural size; 7*a*, the same, double natural size. Page 179.

FIG. 8. Fragment of mandibular ramus of *Opisthotomus flagrans*, containing the last molar, the outer side, natural size; 8*a*, the same, from above. Page 152.

FIG. 9. Last and preceding inferior molar of *Opisthotomus astutus*, natural size, viewed from the side; 9 *a* the same, from above. Page 152.

FIG. 10. *Hyopsodus miticulus*, left mandibular ramus, viewed from the inner side, natural size; 10*a*, from above. Page 150.

FIG. 11. *Hyopsodus miticulus*, right mandibular ramus, natural size, viewed from the inner side; 11*a*, from above.

FIG. 12. *Hyopsodus miticulus*, right mandibular ramus, the outer side; 12*a*, from above.

FIG. 13. *Hyopsodus ?*, superior molar teeth, viewed from below, natural size; 13*a*, the same, twice the natural size; 13*b*, the same, natural size, viewed from the outer side.

FIG. 14. *Hyopsodus ?*, portion of maxillary bone with superior molar teeth, natural size, viewed from below; 14*a*, the same, twice natural size.

FIG. 15. *Sarcolemur mentalis*, fragment of right mandibular ramus, viewed from the outer side; 15*a*, from above; both natural size. Page 149.

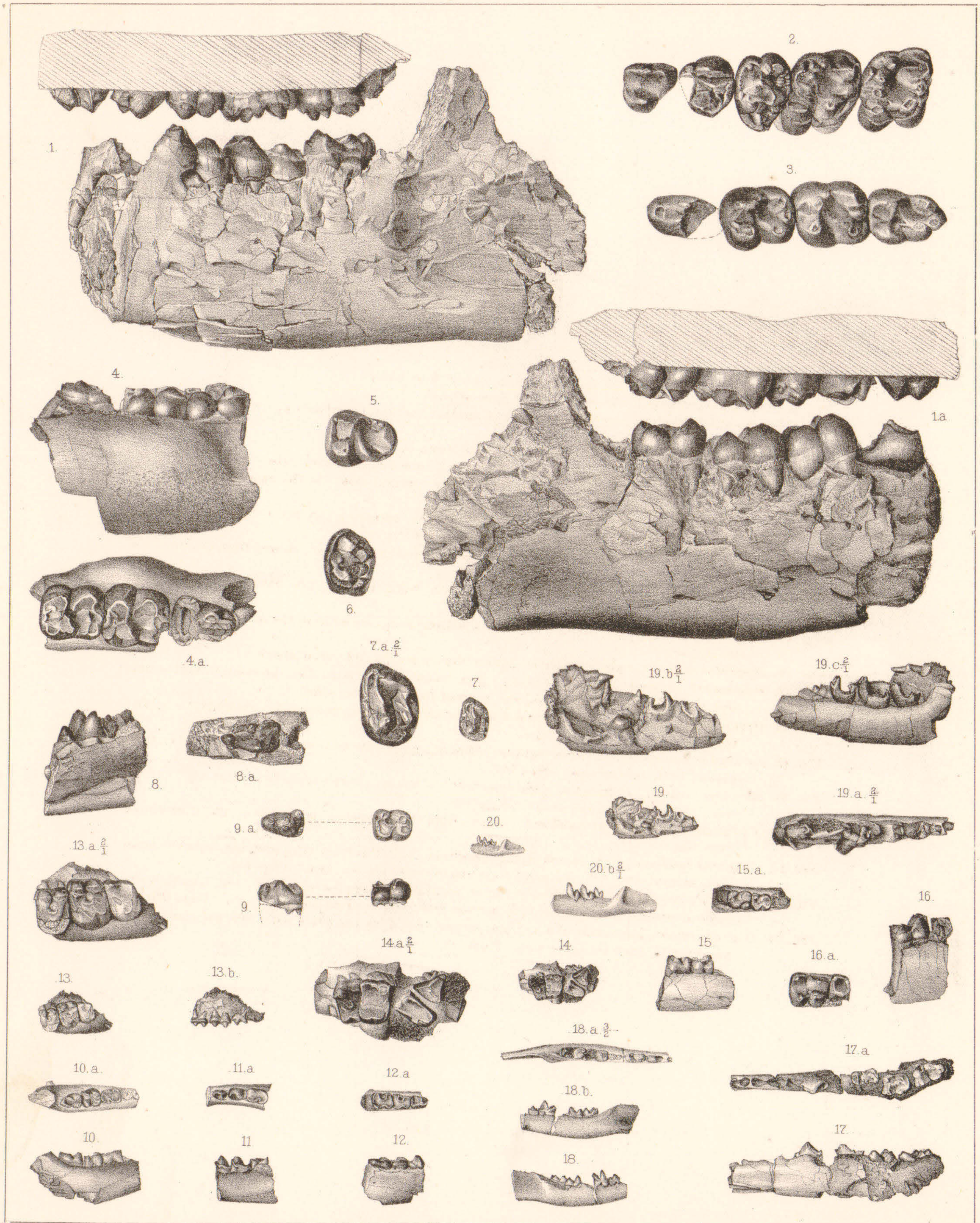
FIG. 16. *Sarcolemur crassus*, fragment of right mandibular ramus, viewed from the outer side, natural size; 16*a*, the same, from above. Page 149.

FIG. 17. *Pantolestes chacensis*, right mandibular ramus, from the inner side, natural size; 17*a*, from above. Page 146.

FIG. 18. *Apheliscus insidiosus*, right ramus of the mandible, from the inner side, and, 18*a*, from the outer side, natural size; 18*b*, the same, from above, twice natural size. Page 147.

FIG. 19. *Diacodon alticuspis*, right mandibular ramus, natural size, from the outer side; 19*a*, *b*, and *c*, twice natural size: *a*, from above; *b*, from outer side; and, *c*, from the inner side. Page 132.

FIG. 20. *Diacodon celatus*, left ramus of mandible, natural size, from the outer side; 20*b*, the same, twice natural size, from the outer side. Page 133.



1–5 Phenacodus primævus. 6 P. omnivorus. 7 P. sulcatus. 8 Opisthotomus flagrans. 9. O. astutus. 10-12 Hyopsodus miticulus. 15 Sarcolemur mentalis. 16 S. crassus. 17 Pantolestes chacensis. 18 Apheliscus insidiosus. 19 Diacodon alticuspis. 20 D. celatus.

PLATE XLVI.

Dentition of Coryphodons, natural size.

FIG. 1. Fragment of right mandibular ramus of *Coryphodon cuspidatus*, supporting part of last molar, from the inner side; *a*, from above; *b*, from the outer side. Page 206.

FIGS. 2–10. Teeth of *Coryphodon lobatus*. Page 209.

FIG. 2. Left superior canine, postero-exterior view; *a*, postero-interior view; *b*, anterior view, displaying triturating surface.

FIGS. 3–4. Superior premolars, from below; 4*a*, the posterior premolar, from the front.

FIG. 5. Interior extremity of crown of penultimate superior true molar, from below.

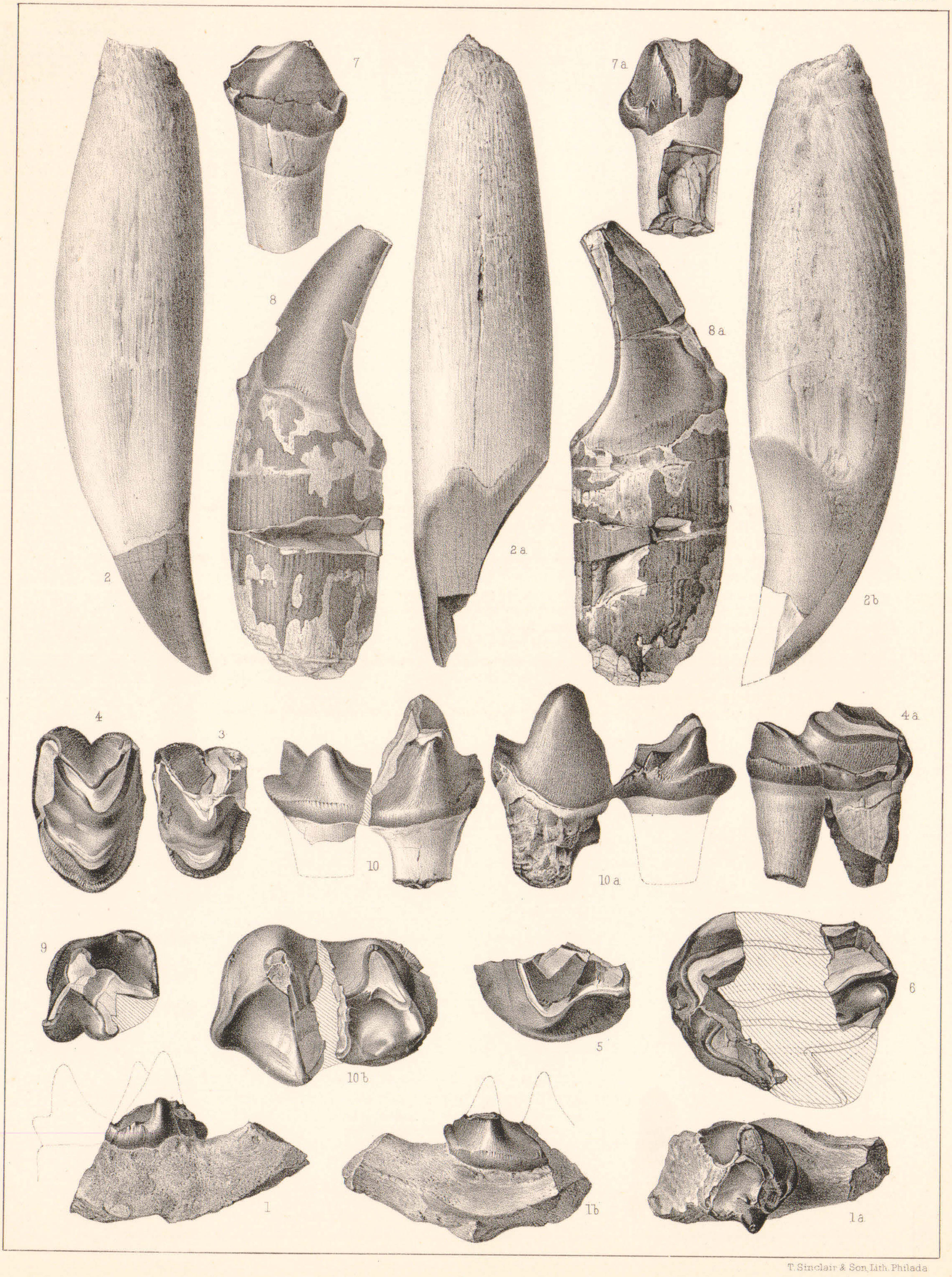
FIG. 6. Posterior superior molar, crown from below.

FIG. 7. Incisor tooth, from within; *a*, exterior view of the same.

FIG. 8. Left inferior canine, the exterior side; *a*, interior side; both displaying surface worn by superior canine.

FIG. 9. Anterior inferior premolar, from above.

FIG. 10. Posterior inferior molar, exterior view; *a*, interior view; *b*, crown, viewed from above.



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1 Coryphodon cuspidatus. 2 C. lobatus.

PLATE XLVII.

Dentition of Coryphodon, natural size, except Fig. 1, which is two-thirds nature.

FIGS. 1–3. *Coryphodon obliquus.* Page 207.

FIG. 1. Portion of the left mandibular ramus supporting the last and part of the penultimate molars, the inner side; *a*, the same, external side.

FIG. 2. Inferior canine, posterior view.

FIG. 3. Last and part of penultimate molar, grinding face, from the ramus, Fig. 1.

FIGS 4–6. *Coryphodon radians*, teeth of one individual. Page 211.

FIG. 4. Posterior superior molar of the right side; 4*a*, the corresponding tooth of the left side; viewed from below.

FIG. 5. Posterior inferior molar, viewed from above; *a*, from behind.

FIG. 6. Apex of the superior canine, from behind; *a*, base of the fragment.

FIGS. 7–10. Teeth of a second individual of *Coryphodon radians*, from a different locality from the last.

FIG. 7. First superior true molar, viewed from below; *a*, anterior view.

FIG. 8. An incisor tooth, probably inferior.

FIG. 9. Right inferior canine; inner side; *a*, posterior aspect.

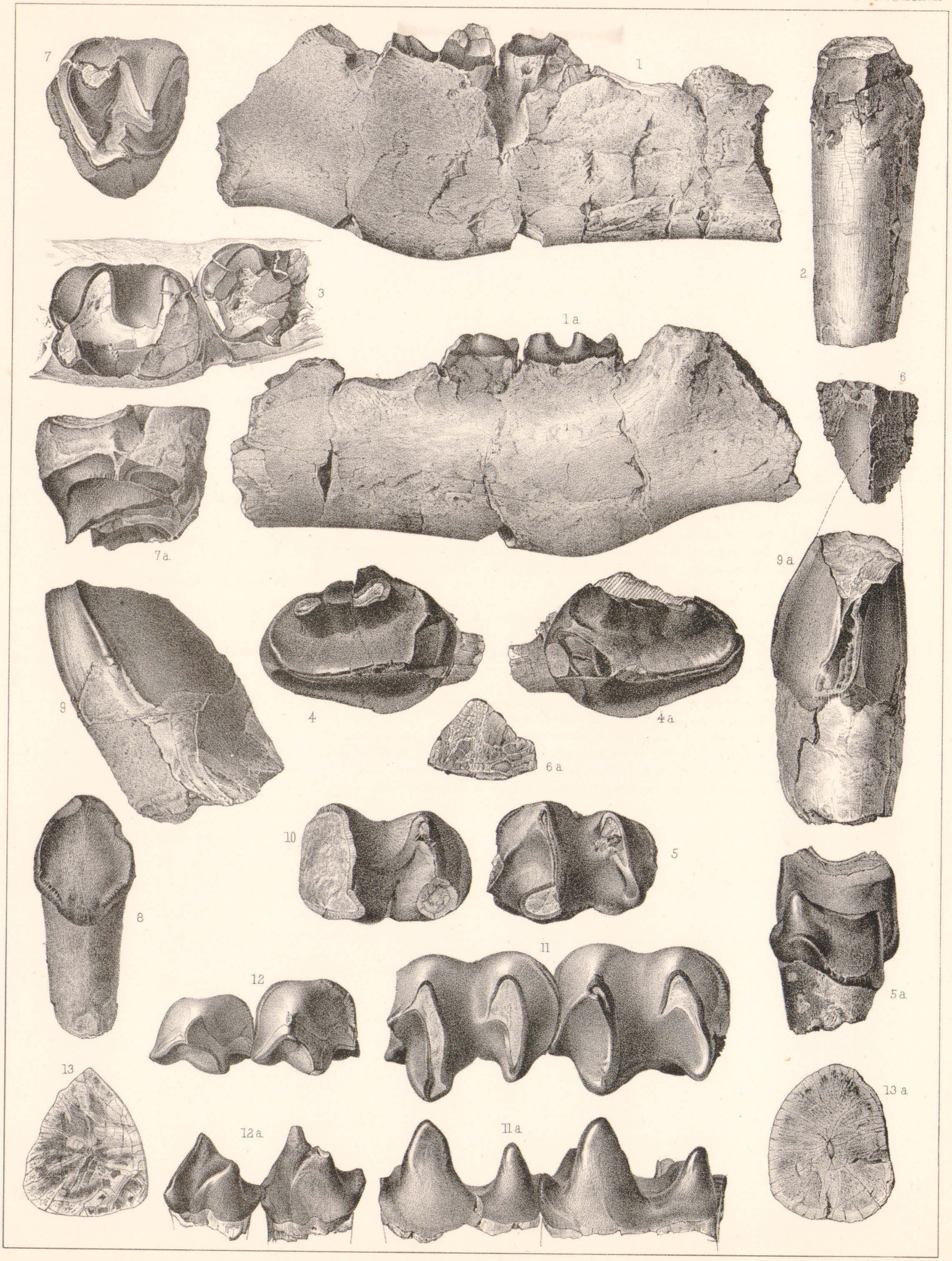
FIG. 10. Right posterior inferior molar, from above.

FIGS. 11–13. Teeth of a third individual of *Coryphodon radians*, natural size.

FIG. 11. Last two inferior molars, from above; *a*, the same, from the inner side.

FIG. 12. Second and third premolars, from above; *b*, from the inner side.

FIG. 13. Superior canine, section of base of crown; *a*, section of fang.



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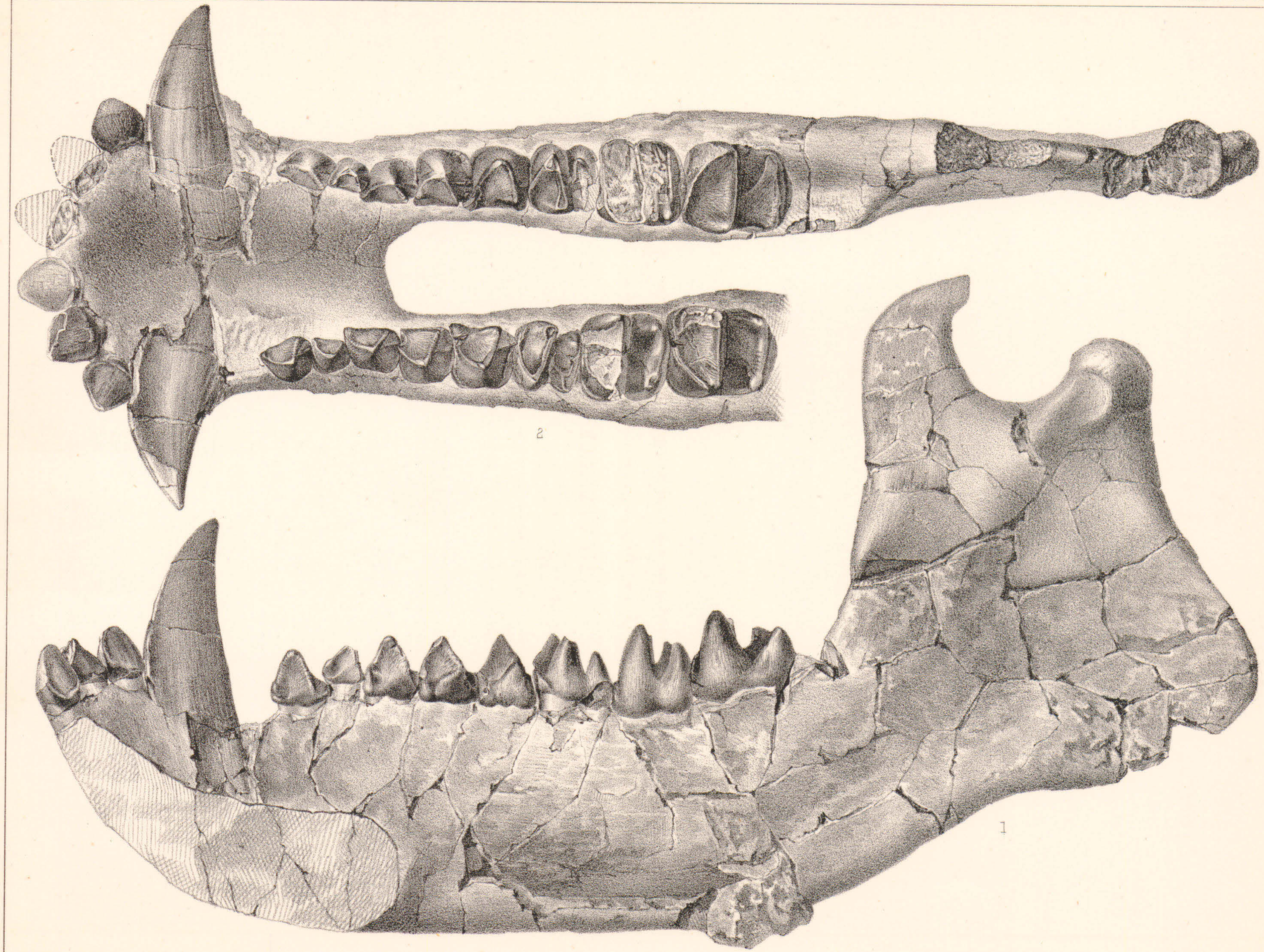
1-3 Coryphodon obliquus. 4-13 Coryphodon radians.

PLATE XLVIII.

FIG. 1. Internal view of the right ramus mandibuli of *Coryphodon latidens*, two-thirds natural size. Page 214.

FIG. 2. The dental series of both rami, viewed from above, two-thirds natural size.



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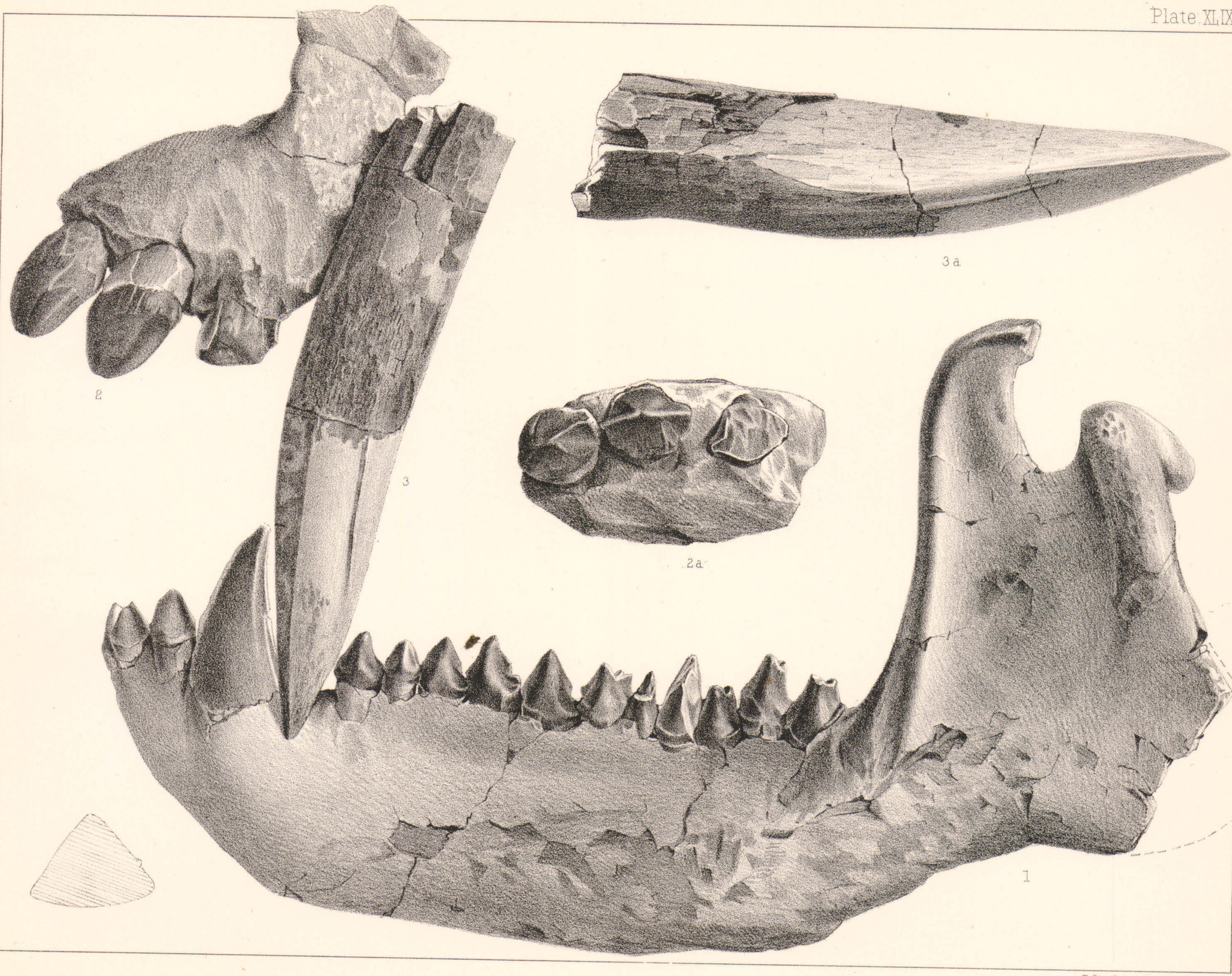
Coryphodon latidens.

PLATE XLIX.

Coryphodon latidens.

FIG. 1. Left ramus of the mandible, viewed from the outer side, two-thirds natural size.
FIG. 2. Premaxillary bone, external view; *a*, inferior view; natural size.
FIG. 3. Left superior canine in relation with the premaxillary, external view, natural size; *a*, posterior view of the same; *b*, section of the crown, near the apex.



Coryphodon latidens.

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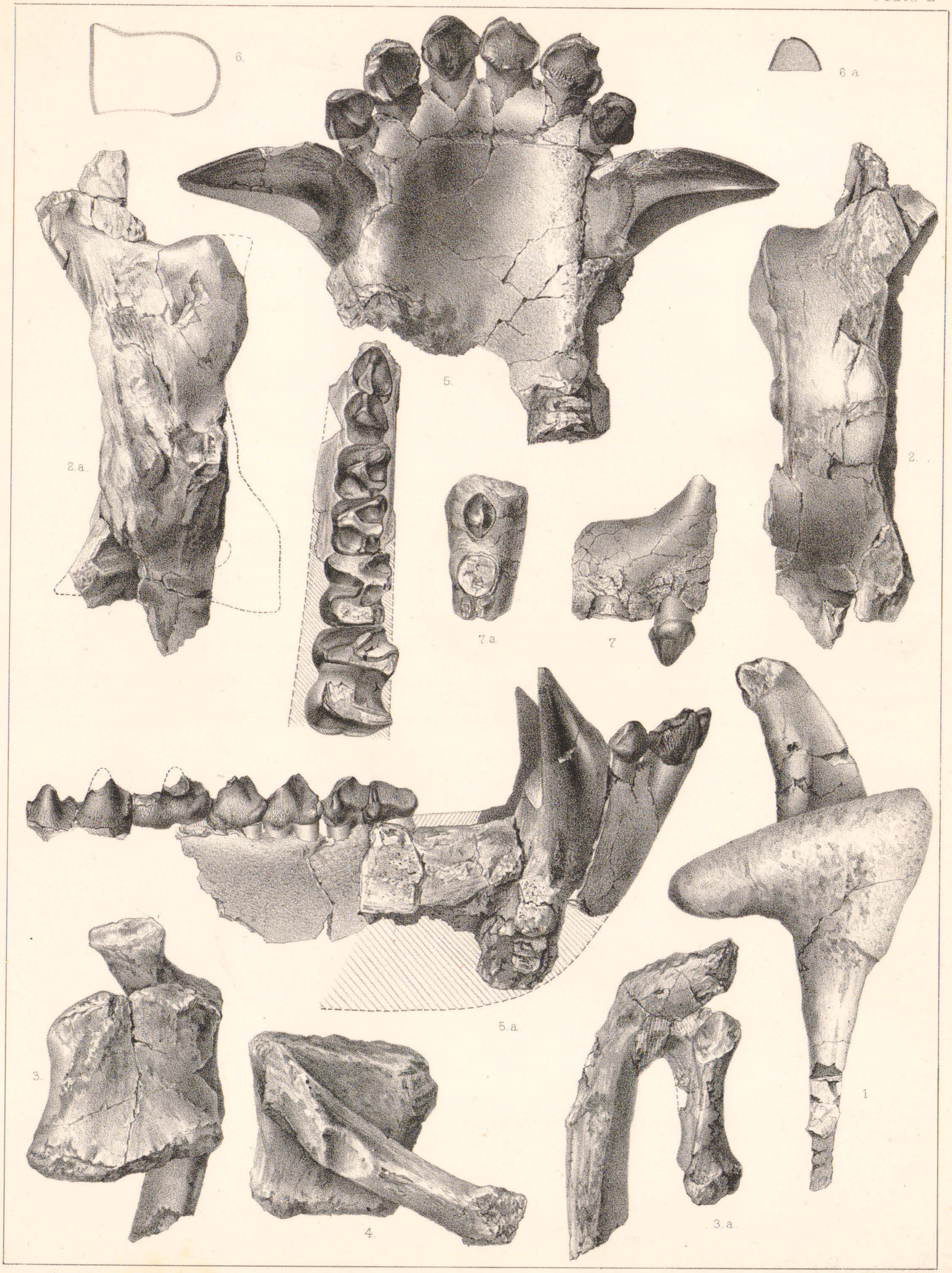
PLATE L.

FIGS. 1-4. *Coryphodon latidens*, two-thirds natural size.
FIG. 1. Mandibular ramus, posterior view.
FIG. 2. The atlas, from below; *a*, from above.
FIG. 3. Segment of sternum, with sternal rib slightly dislocated; *a*, edgewise view.
FIG. 4. Sternal segment with sternal rib.
FIGS. 5-6. *Coryphodon elephantopus*, ramus mandibuli, probably of the cranium figured on Plate LI. Page 217.
FIG. 5. Part of mandible, from above, a portion of left ramus wanting; *a*, profile of symphyseal portion, with view of the inside of the left ramus.
FIG. 6. Section of inferior right canine at the base of the crown, natural size; *a*, section of same near the apex.
FIG. 7. Premaxillary bone of the elongate type found alone; *a*, from below.



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1–4 Coryphodon latidens. $\frac{2}{3}$ 5–6 C. elephantopus.

PLATE LI.

FIG. 1. Cranium of *Coryphodon elephantopus*, one-half natural size, viewed from the side.

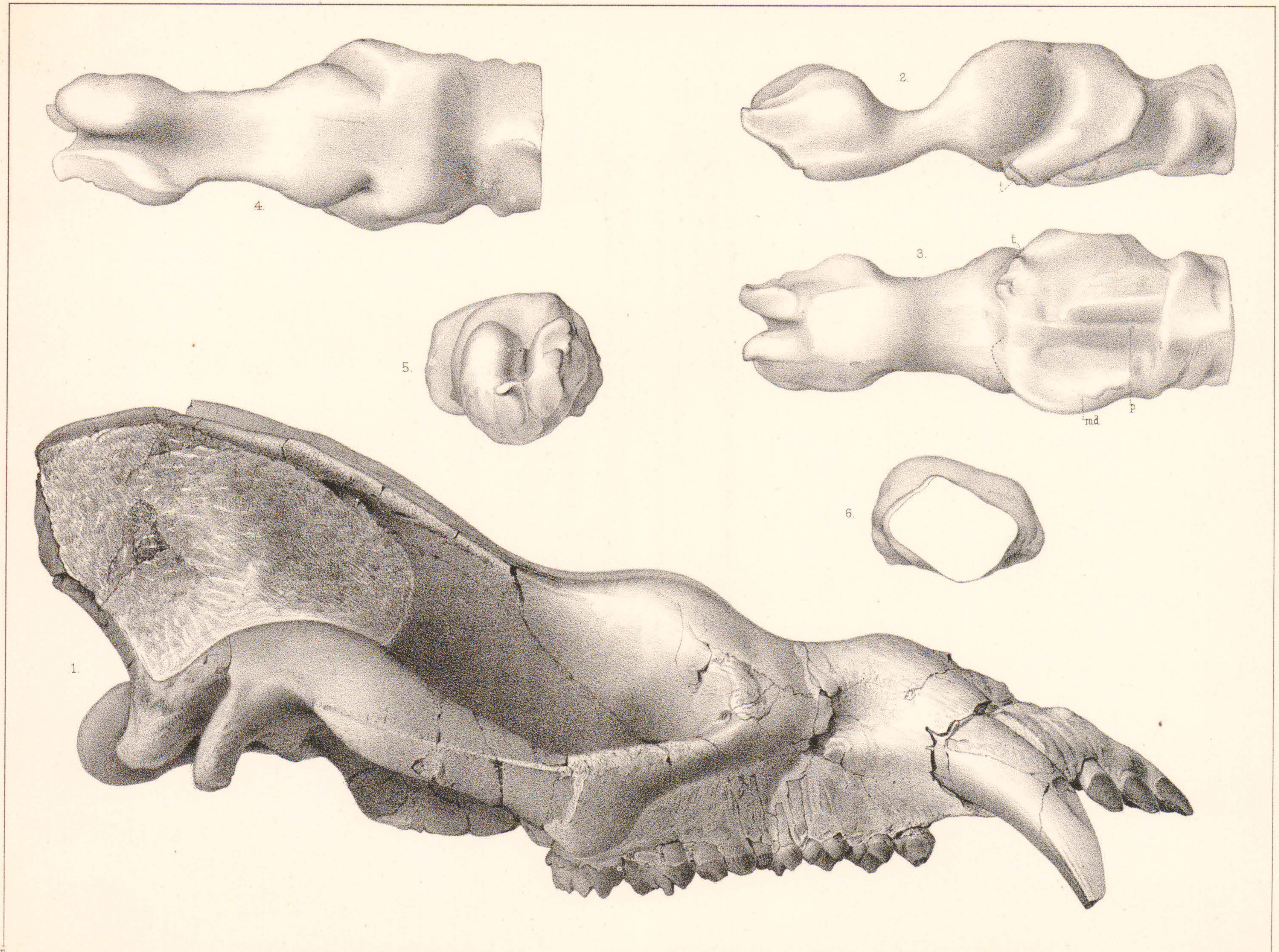
FIG. 2. A cast of the brain-cavity of the above cranium, two-thirds the natural size, representing the form of the brain from the left side.

FIG. 3. The same inferior view; *t*, origin of trigeminus nerve; *md*, base inferior maxillary branch; *p*, ribs in line with the anterior pyramids.

FIG. 4. The same, superior view.

FIG. 5. The same, anterior view.

FIG. 6. The same, posterior view, cut off at the superior margin of the foramera magnum.



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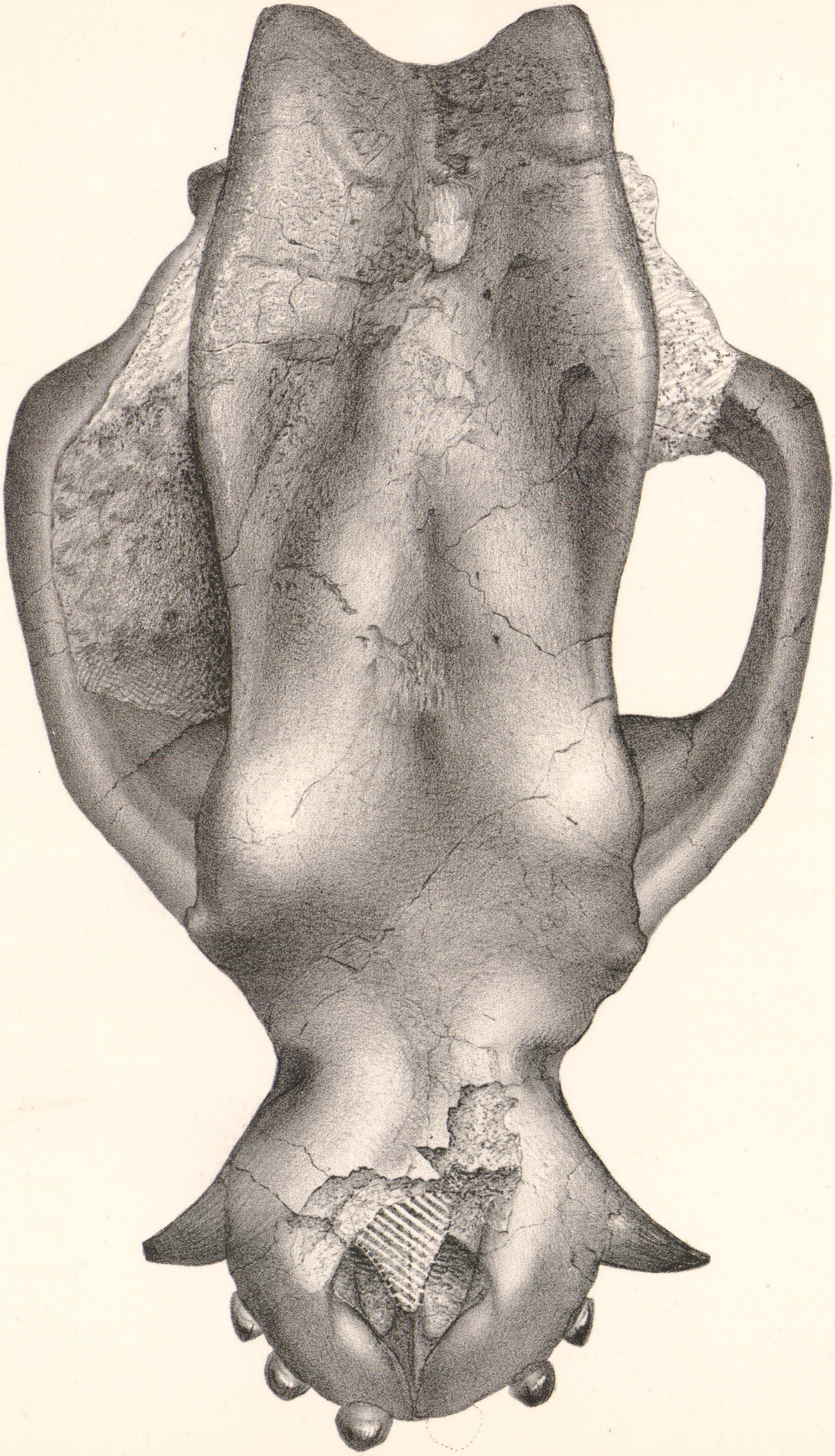
Coryphodon elephantopus.

PLATE LII.

Cranium of *Coryphodon elephantopus*, figured on Plate LI, viewed from above, one-half natural size.



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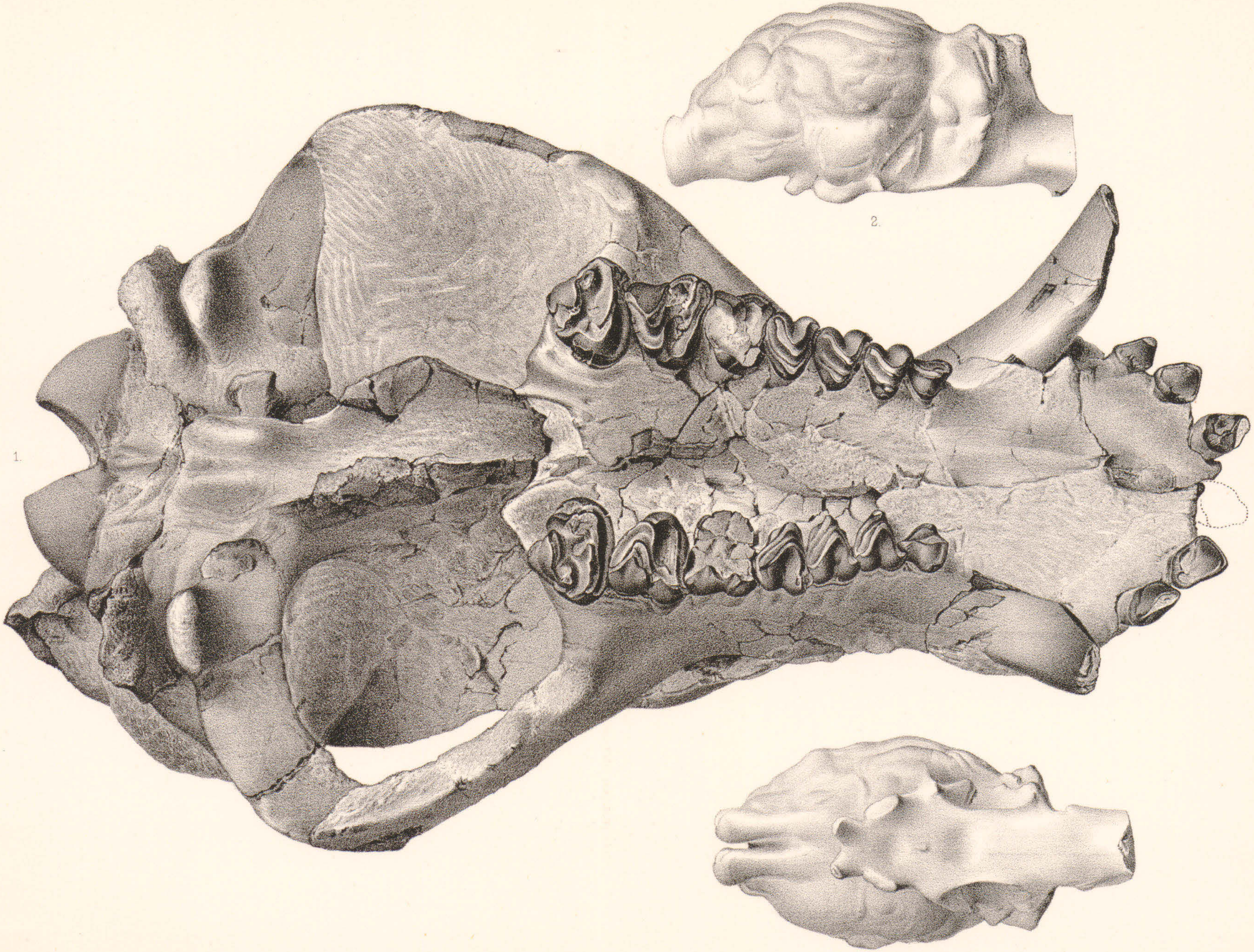
Coryphodon elephantopus $\frac{1}{2}$.

PLATE LIII.

FIG. 1. Cranium of *Coryphodon elephantopus*, figured on Plate LI, viewed from below, one-half natural size.
FIG. 2. Cast of brain cavity of *Procamelus occidentalis*, the right side; *a*, from below.



1. 2. 3.

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1. Coryphodon elephantopus. 2. 3 Procamelus occidentalis.

PLATE LIV.

FIG. 1. Cranium of *Coryphodon elephantopus*, occipital view, one-half natural size.

FIG. 2. Last inferior molar of the right side of *Coryphodon molestus*, type of the description of *Bathmodon lomas*, natural size; *a*, profile view.

FIG. 3. Temporary molars, with crown of unprotruded permanent first molar of an unknown species of *Coryphodon*, natural size.

FIG. 4. Tibia of an undetermined *Coryphodon*, two-thirds natural size, anterior view; *a*, posterior, *b*, exterior, and, *c*, distal views.

FIG. 5. Head of humerus of another *Coryphodon*, two-thirds natural size.

Plate. LIV

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Coryphodons.

PLATE LV.

Bones of Coryphodon simus, two-thirds natural size. Page 225.

FIGS. 1–4. Portions of the cranium described as typical in the present work.
FIG. 1. Left maxillary bone which supported the true molars and last two premolars.
FIG. 2. Right premaxillary bone without the apices, exterior side.
FIG. 3. Both mandibular rami supporting molars only, from above; *a*, right ramus, interior side.
FIG. 4. External side of the posterior or exoccipital bounding crest of the temporal fossa; *a*, posterior view.
FIGS. 5–10. Bones of a second individual.
FIG. 5. Adjacent portions of maxillary and premaxillary bones of the right side, the latter containing three alveoli and wanting apex; *a*, inferior view of the same.
FIG. 6. Portion of right mandibular ramus supporting Pm. 4 and M. 1, from above.
FIG. 7. A dorsal vertebral centrum, anterior view; *a*, inferior side of the same.
FIG. 8. Head of humerus, extremital view.
FIG. 9. Proximal end of radius, inferior view; *a*, proximal or humeral surface of the same.
FIG. 10. Distal extremity of femur, from above, *a*, from the outer side.

Coryphodon simus. 2/3

Coryphodon simus. 2/3

PLATE LVI.

Coryphodon molestus, drawn to different scales. Page 229.

FIG. 1. Cranium distorted by pressure, one-third natural size, seen from the right side.
FIG. 2. Posterior part of cranium, seen from below, one-half natural size.
FIG. 3. Left side of muzzle of the same cranium, two-thirds natural size.
FIG. 4. Inferior true molars of the right side, seen from above, two-thirds natural size.
FIG. 5. Apex of the right canine tooth, natural size, external side; *a*, section at base of fragment; *b*, front view.
FIG. 6. Atlas, left side, seen from behind, two-thirds natural size; *a*, the same, from below.
FIG. 7. Axis, from above, two-thirds natural size; *a*, from below.

Coryphodon molestus

T. Sinclair & Son, lith. Phila

PLATE LVII.

FIGS. 1–2. *Coryphodon molestus*, specimen figured in Plate LVI, two-thirds natural size.

FIG. 1. Posterior part of palate, with the molar teeth.

FIG. 2. Anterior left foot, without the scaphoid and trapezium and some of the phalanges, the remaining elements somewhat dislocated and adhering by the matrix as they were exhumed. The fifth metacarpus is pushed back on the under side of the carpus.

FIGS. 3–7. *Coryphodon*, No. I, two-thirds natural size.

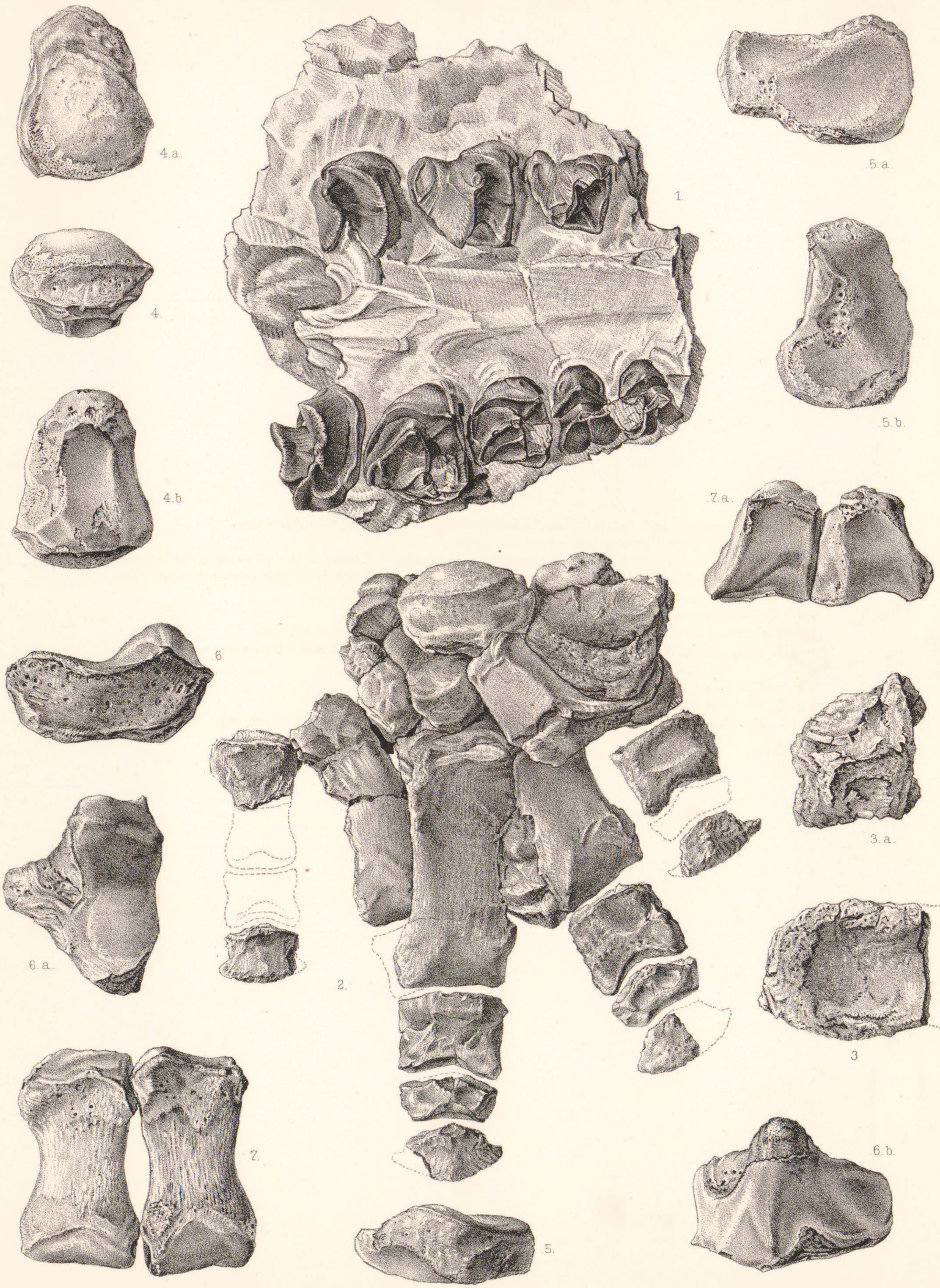
FIG. 3. Cervical vertebra, left moiety, from behind; *a*, the same, from the left side.

FIG. 4. Lunar carpal bone, from front; *a*, from above; *b*, from below: *a* and *b* have same significance in Figs. 5 and 6.

FIG. 5. The cuneiform bone.

FIG. 6. The unciform bone.

FIG. 7. The third and fourth metacarpals of the right side, anterior surface; *a*, the same, proximal extremities.



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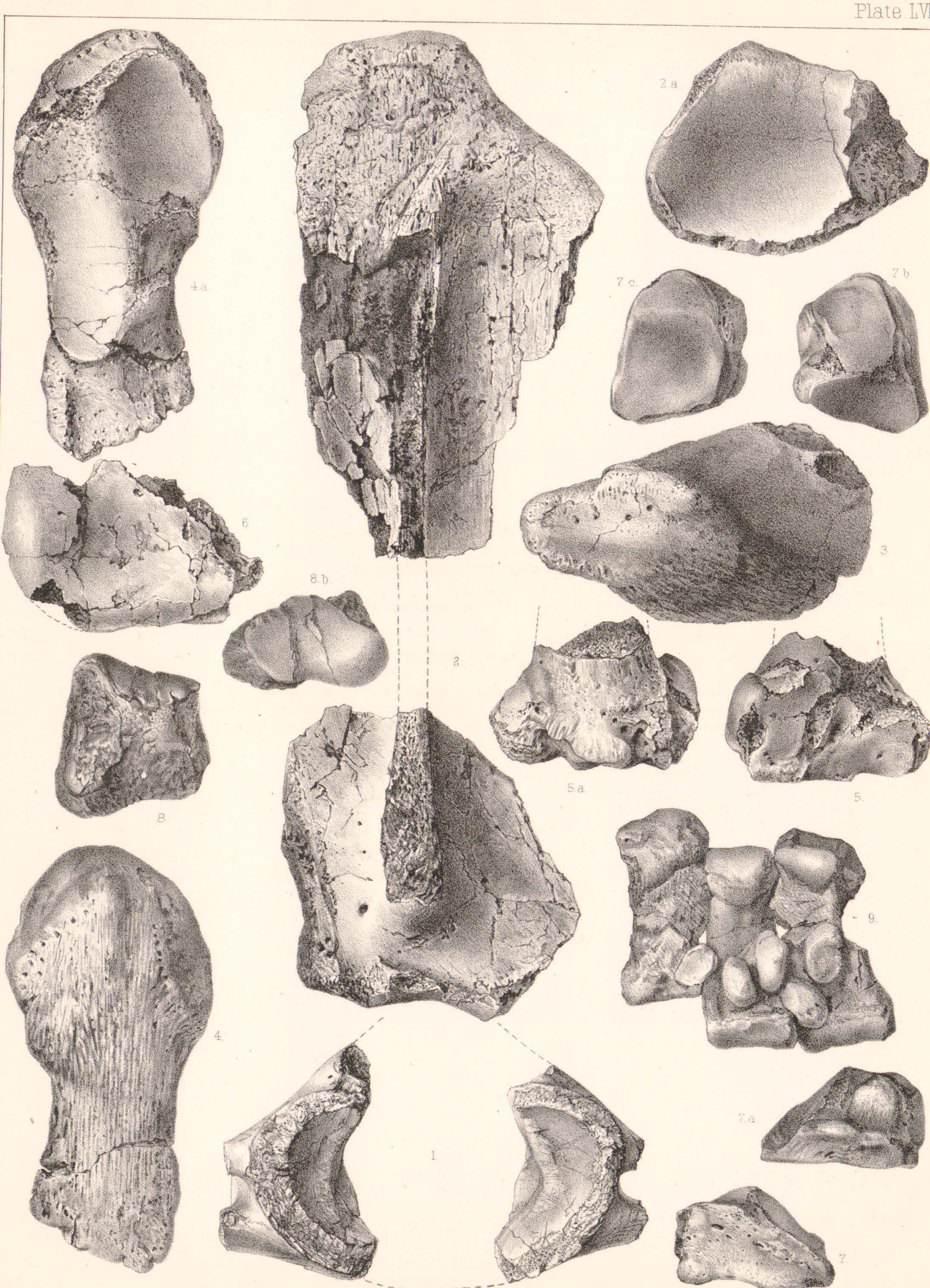
1-2 Coryphodon molestus $\frac{2}{3}$

PLATE LVIII.

FIGS. 1-7. Bones of *Coryphodon*, No. I, two-thirds natural size. Page 237.
FIG. 1. Atlas, the median portion wanting, anterior view.
FIG. 2. Scapula, median part wanting, external view; *a*, proximal end, the coracoid process broken off.
FIG. 3. Olecranon, oblique posterior view.
FIG. 4. Patella, external, *a*, internal views.
FIG. 5. Proximal portion of calcaneum, from above; *a*, from below.
Fig. 6, Astragalus, from above; injured.
FIG. 7. Cuboid bone, anterior face; *a*, posterior face; *b*, superior face; *c*, inferior face.
FIG. 8. Distal extremity of an ulna, from another locality, superior face; *b*, articular extremity.
FIG. 9. Metacarpals III, IV, and V, of *Coryphodon*, No. II, posterior view, showing sesamoid bones.



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Coryphodons Nos. I-II $\frac{2}{3}$

PLATE LIX.

Bones of the feet of Coryphodons described under the head of No. II, two-thirds natural size. Page 241.

FIG. 1. Left fore foot, antero-superior view; the cuneiform, magnum, and unciform adherent and somewhat dislocated; the remaining bones separate. *Sc*, Scaphoid; *Cu*, Cuneiform; *Ps*, Pisiform; *Tz*, Trapezium; *To*, Trapezoides; *Mg*, Magnum; *Unc*, Unciform.

FIG. 2. Proximal view of the first series of carpal bones of the same foot.

FIG. 3. Scaphoid of same, from below.

FIG. 4. Lunar of same, from below.

FIG. 5. Pisiform of same, external view; *a*, pisiform of same, inferior view.

FIG. 6. Trapezium of same, exterior side: *a*, interior side; *b*, proximal end; *c*, inferior end.

FIG. 7. Trapezoides of same, internal side; *a*, external side; *b*, superior side; *c*, inferior side.

FIG. 8. Magnum, from below, attached to the cuneiform; *a*, internal side.

FIG. 9. Unciform, inferior view.

FIG. 10. View of proximal ends of the metacarpals of the same, from No. II to No. V inclusive

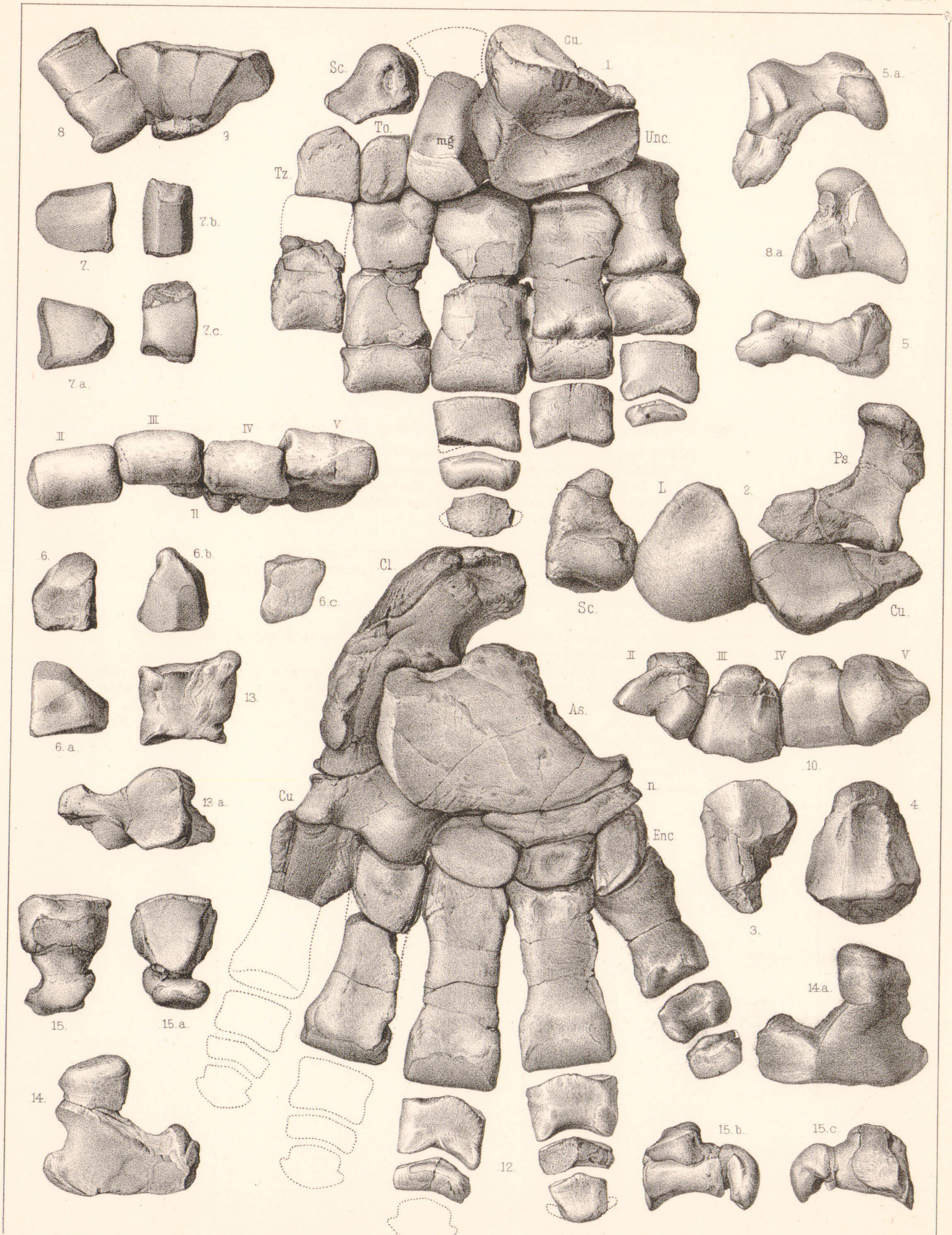
FIG. 11. Distal extremities of the same metatarsals.

FIG. 12. Right posterior foot found with Fig. 1, but perhaps belonging to *Coryphodon molestus*. The phalanges were found in place, and were marked before being separated from the metatarsals and each other, so as to secure their proper re-association. A supero-anterior view. *As*, Astragalus; *Cl*, Calcaneum; *Cu*, Cuboid; *N*, Navicular; *Ecc*, Ectocuneiform; *Msc*, Mesocuneiform; *Enc*, Entocuneiform.

FIG. 13. Cuboid of the same, inner side; *a*, inferior side.

FIG. 14. Navicular, from above; *a*, from below.

FIG. 15. Ectocuneiform, superior surface; *a*, inferior surface; *b*, interior side; *c*, external sides.



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Coryphodon No. II

PLATE LX.

FIGS. 1–11. Bones of the *Coryphodon* No. II, figured on Plate LVIX, two-thirds natural size.

FIG. 1. Posterior foot of right side, postero-inferior view.

FIG. 2. Astragalus and calcaneum in relation, but somewhat flattened by pressure.

FIG. 3. Calcaneum from above, flattened by pressure.

FIG. 4. Mesocuneiform and entocuneiform bones, from above; *a*, mesocuneiform, outer side; *b*, entocuneiform, inner side; *c*, inferior view of the conjoined bones.

FIG. 5. Proximal ends of the metatarsals, all found in place, excepting No. V, which was superficial and loose.

FIG. 6. First phalange of hallux, proximal end; *a*, distal extremity.

FIG. 7. Ungual phalange of hallux, proximal end.

FIG. 8. First phalange of second digit, proximal end; *a*, distal end.

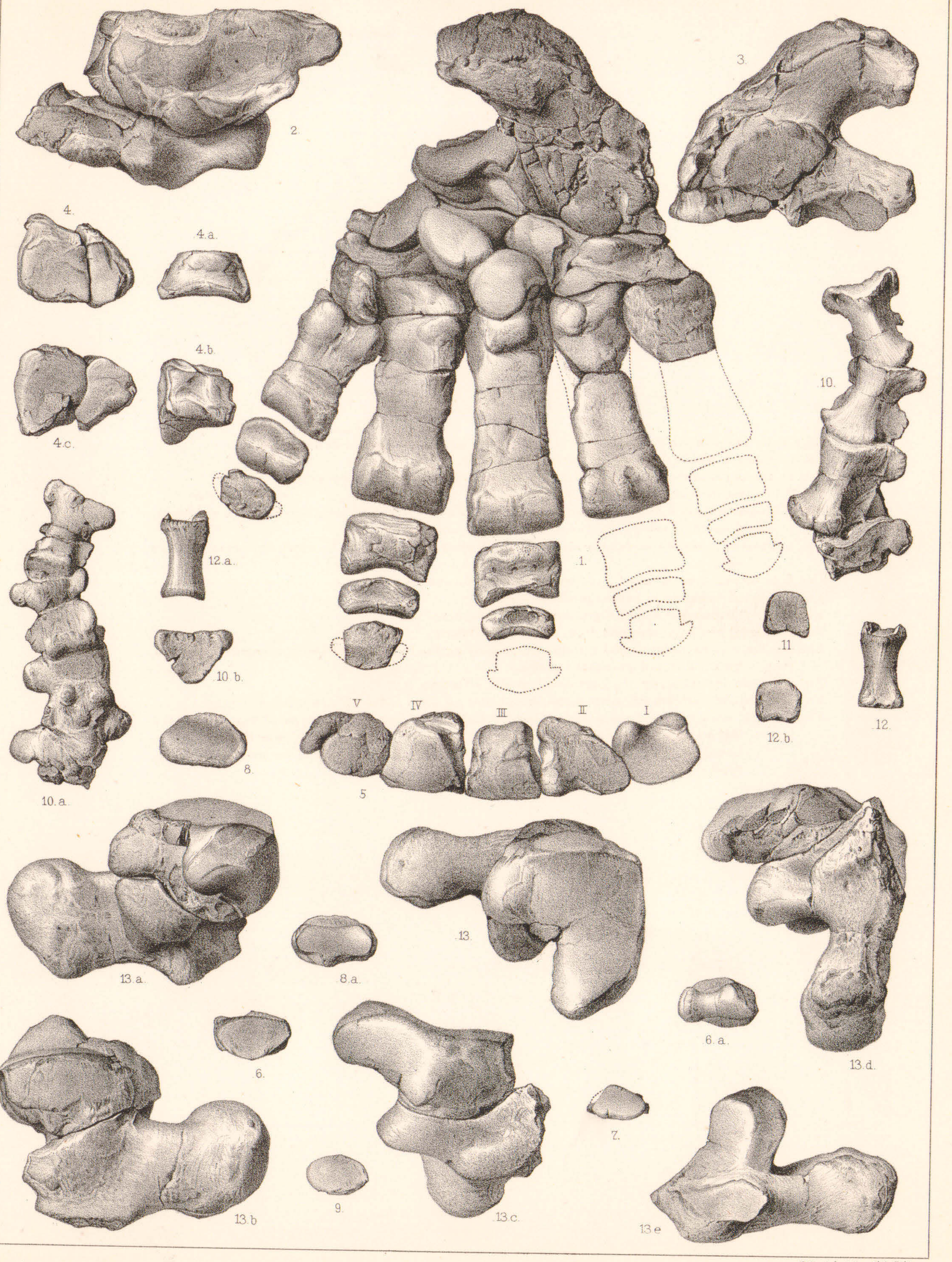
FIG. 9. Ungual phalange of second digit, proximal extremity.

FIG. 10. Three consecutive caudal vertebræ accompanying the feet, inferior view; *a*, superior view; *b*, proximal end of proximal vertebra.

FIG. 11. Articular extremity of a more distal caudal vertebra.

FIG. 12. A caudal vertebra still more distal, from below; *a*, from above; *b*, articular extremity.

FIG. 13. The astragalus and calcaneum of another individual, from the same locality as Nos. II and III, perhaps belonging to No. III, agreeing with it in color: Fig. 13, superior face; *a*, internal face; *b*, external face; *c*, anterior face; *d*, inferior face; *e*, the calcaneum alone, superior face.



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Coryphodon No. II

PLATE LXI.

FIGS. 1–15. Bones of a *Coryphodon*, of a black color, found together, and described as No. III; two-thirds natural size. Page 247.

FIG. 1. Right fore foot, antero-superior view; the carpal bones all present, but a portion of the anterior face of the os magnum broken away. The phalanges collated in accordance with their true relations, as exposed in excavating by the author.

FIG. 2. Posterior faces of the digits of the same foot, in natural relation.

FIG. 3. Distal view of distal extremity of third metacarpus.

FIG. 4. Proximal end of first phalange of third digit; *a*, distal end.

FIG. 5. Distal end of second phalange of third digit.

FIG. 6. Proximal end of ungual phalange of third digit.

FIG. 7. Distal view of distal end of first metacarpus.

FIG. 8. Proximal end of first phalange of pollex; *a*, distal end of the same.

FIG. 9. Proximal end of ungual phalange of pollex.

FIG. 10. Third digit, seen from the external side.

FIG. 11. Clavicle, with one extremity; *a*, extremital view; *b*, section at fracture.

FIG. 12. Extremity; perhaps the opposite one of the same clavicle.

FIG. 13. Portion of shaft, probably belonging to the clavicle represented in Fig. 11.

FIG. 14. Ulna of an animal apparently larger than that to which the fore foot belongs, seen from the side.

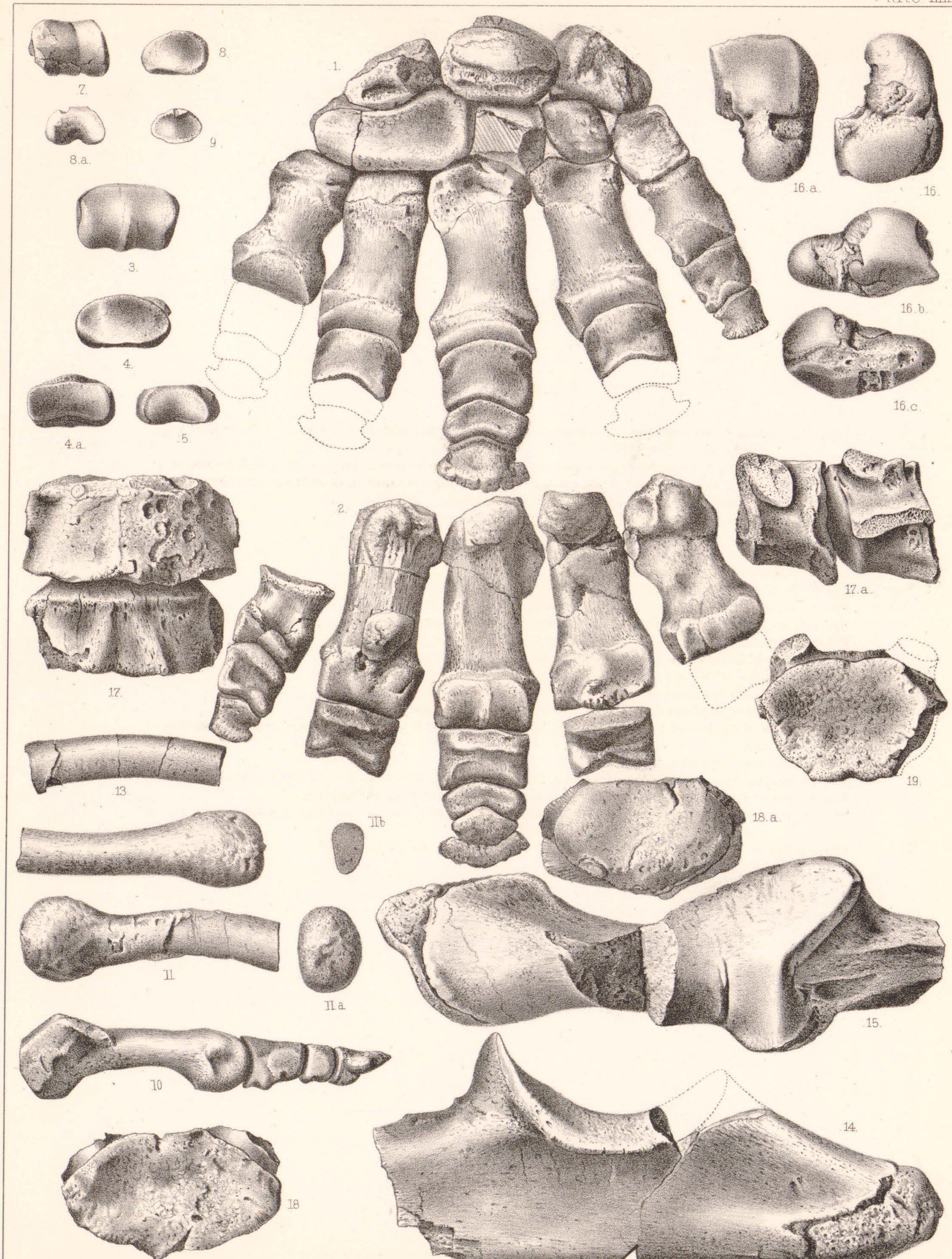
FIG. 15. The same, superior view.

FIG. 16. Scaphoid bone of another individual, from above; *a*, from below; *b*, inner side; *c*, outer side.

FIG. 17. Cervical vertebræ of another individual, from below; *a*, from the left side.

FIG. 18. The posterior articular face of the posterior of the two cervical vertebræ figured in Fig. 17, without epiphysis; *a*, anterior face of the same.

FIG. 19. Posterior face of the anterior of the two cervical vertebræ above figured.



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Coryphodon No III

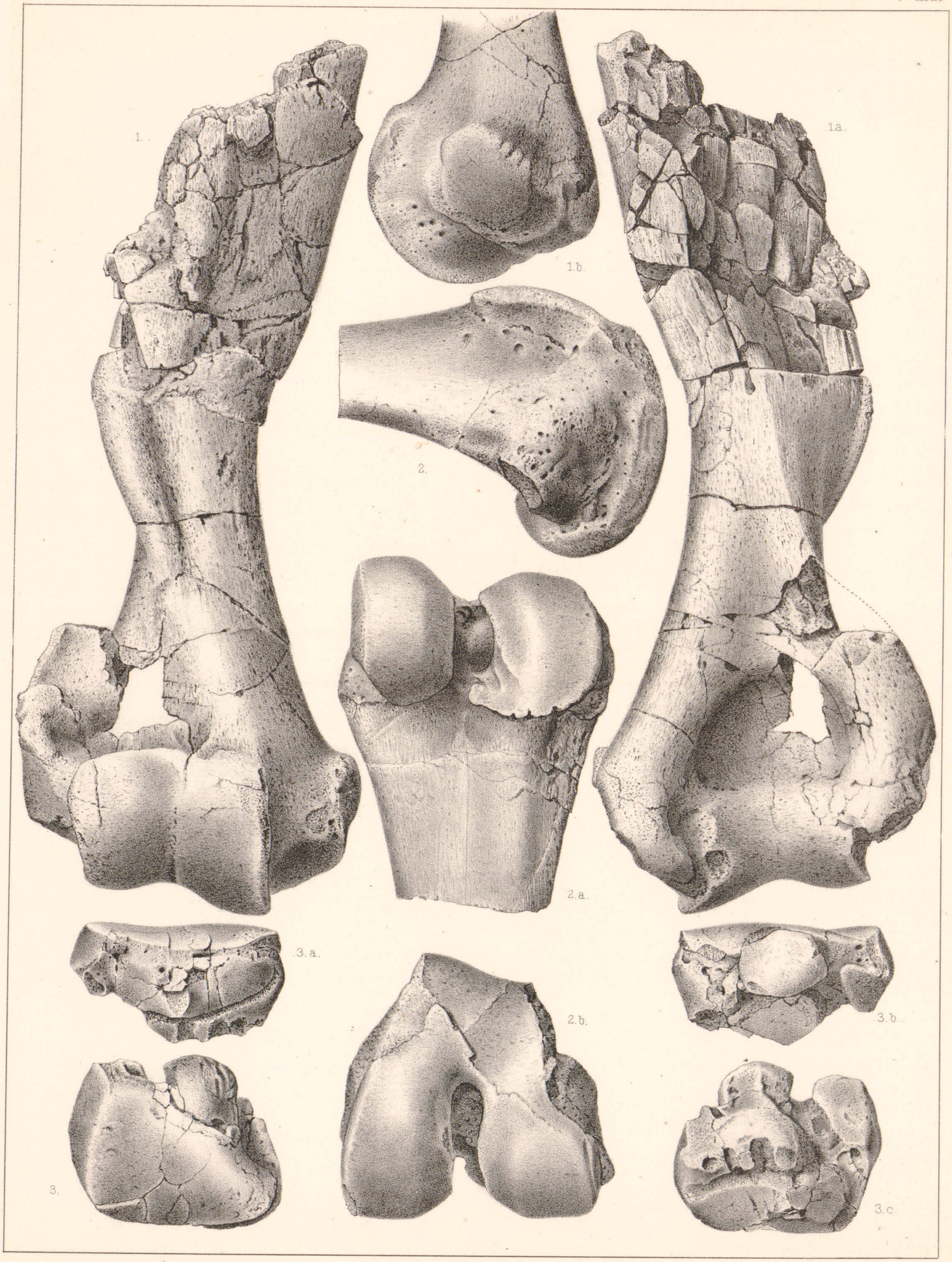
PLATE LXII.

Bones of Coryphodon, No. IV. Page 248.

FIG. 1. Right humerus, without the head, the proximal portion crushed by pressure, anterior view; *a*, posterior view; *b*, internal view.

FIG. 2. Distal end of left femur, inner side; *a*, inferior view; *b*, distal view.

FIG. 3. Right astragalus, from above; *a*, from the front; *b*, posterior aspect; *c*, inferior view.



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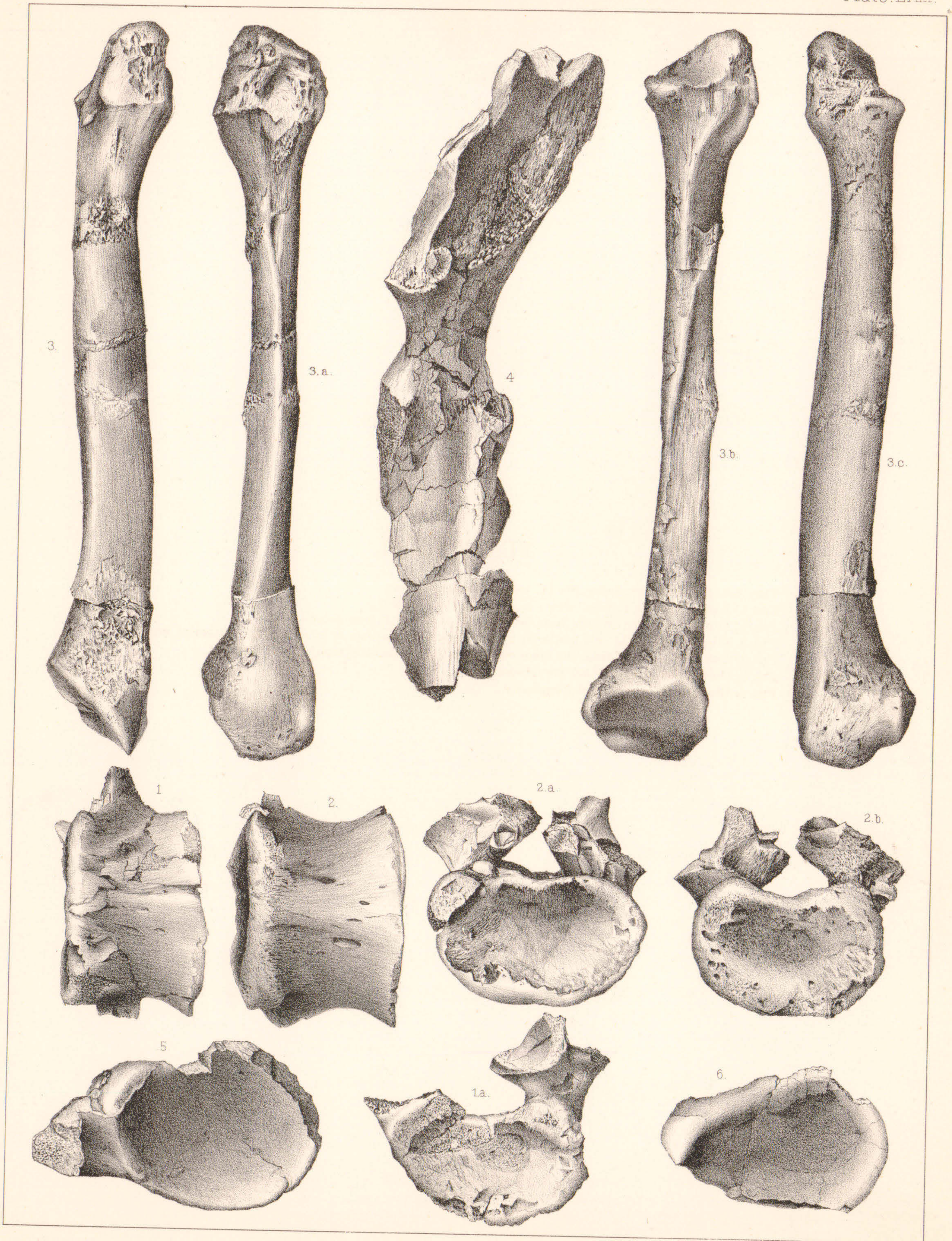
Coryphodon No IV

PLATE LXIII.

FIGS. 1–4. Bones of *Coryphodon*, No. IV, two-thirds natural size.
FIG. 1. Lumbar vertebra, from below; *a*, anterior articular face.
FIG. 2. Another lumbar vertebra, from below; *a*, from front; *b*, from behind.
FIG. 3. Fibula of the right side, posterior aspect; *a*, external aspect; *b*, interior side; *c*, anterior side.
FIG. 4. Left ilium, viewed from the inner edge, showing the sacral symphysis.
FIG. 5. Glenoid cavity of another *Coryphodon*.
FIG. 6. Glenoid cavity of a third *Coryphodon*.



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Coryphodons.

PLATE LXIV.

Fragments of different Coryphodons, one-half natural size.

FIG. 1. The anterior portion of an ilium, displaying both borders of the peduncle.
FIG. 2. The right ischium of the same specimen, from the inner side; *a*, posterior view.
FIG. 3. Right femur of another specimen, anterior view.
FIG. 4. Inner view of the same specimen.
FIG. 5. Distal view of distal end of the tibia of another individual.
FIG. 6. Distal end of supposed radius of another specimen, from above; *a*, distal view.
FIGS. 7–13. Fragments of *Trionyx ventricosus*, natural size; all belonging to one specimen, excepting Fig. 13.
FIGS. 7–10. Fragments of costal bones.
FIG. 12. Left hyosternal bone; *a*, from above.
FIG. 13. Left hyosternal bone of a second specimen, inferior surface.

1-6. Coryphodons. 7-13. Trionyx ventricosus.

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PLATE LXV.

FIGS. 1–11. *Orotherium vintanum*, natural size; portions of one individual. Page 255.

FIG. 1. Left maxillary bone with true molars and third premolar, viewed from below; 1*a*, the same, from the left side.

FIG. 2. *b*, first, and *a*, third inferior true molars of the right side, from above.

FIG. 3. First true inferior molar of the left side: *a*, from the inner, *b*, from the outer, side.

FIG. 4. The right humerus, intero-posterior view; *a*, extero-anterior view; *b*, proximal view of the fractured head.

FIG. 5. Distal end of the radius, inferior view; *a*, distal view.

FIG. 6. Proximal end of radius, proximal view.

FIG. 7. Olecranon of right ulna, from the inner side.

FIG. 8. The left femur, anterior view; *a*, from the inner side.

FIG. 9. Shaft of the tibia, viewed from the front; *a*, section, proximal view.

FIG. 10. Distal end of the left tibia, posterior view; *a*, anterior, *b*, interior, and, *c*, distal views.

FIG. 11. Calcaneum, from above, the cuboid facet broken off; *a*, the same, inner view.

FIG. 12. *Orotherium vintanum*, fragment of right mandibular ramus of a second individual, the inner side, natural size.

FIG. 13. Mandible of *Orotherium cristonense*, viewed from above, natural size; *a*, viewed from the left side. Page 254.

FIG. 14. Right ramus of the same jaw, viewed from the inner side.

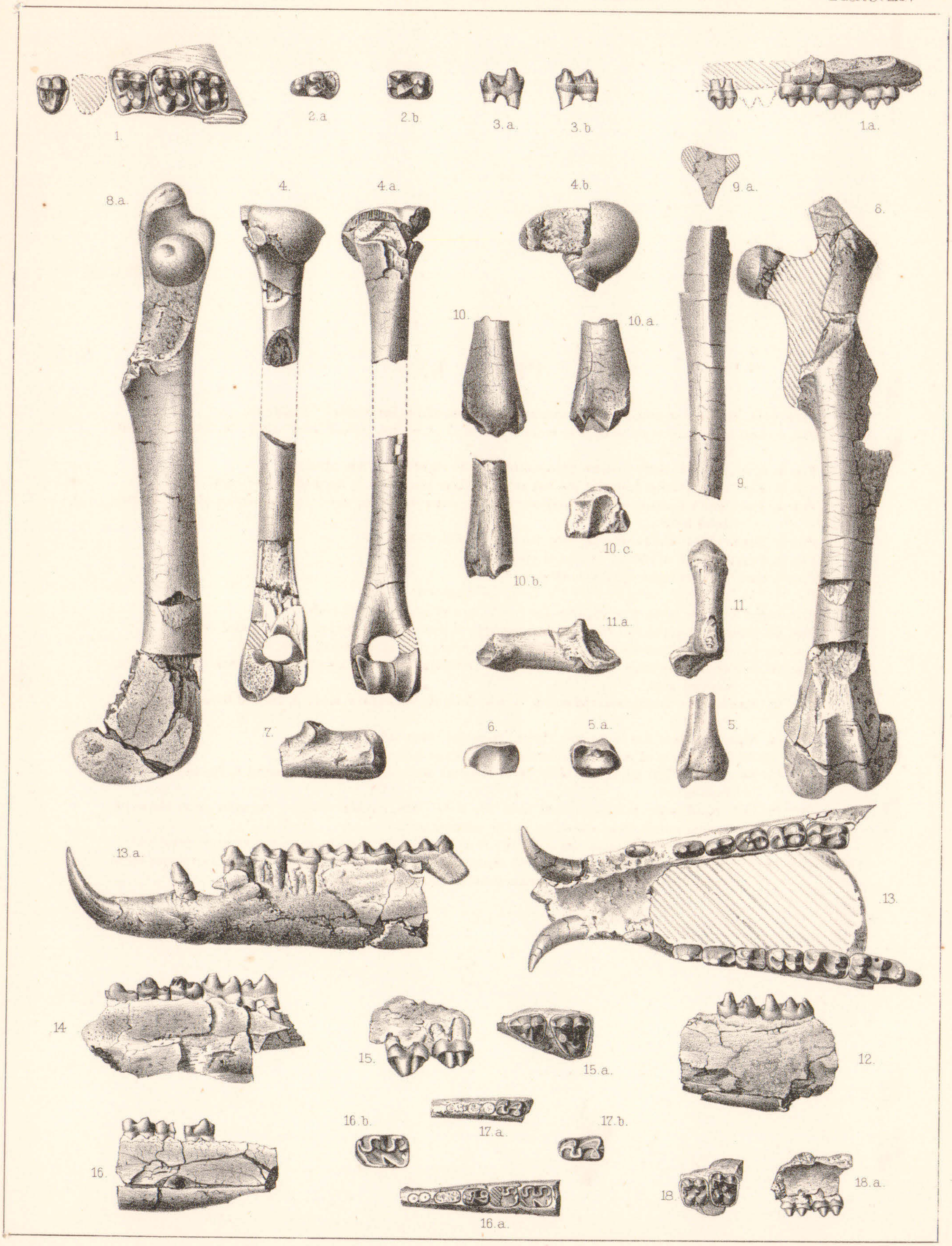
FIGS. 15–17. Fragments of jaws of *Orotherium loevii*. Page 257.

FIG. 15. Fragment of left maxillary bone, twice natural size, viewed from without; *a*, the same, viewed from below.

FIG. 16. Left mandibular ramus, viewed from the outer side, natural size; *a*, the same, from above; *b*, second molar, from above, twice the natural size.

FIG. 17. Right mandibular ramus, natural size; from above; 17*a*, fourth premolar, twice natural size.

FIG. 18. Fragment of left maxillary bone of *Hyracotherium cuspidatum*, supporting last two molar teeth viewed from below; *a*, the same, from the outer side. Page 267.



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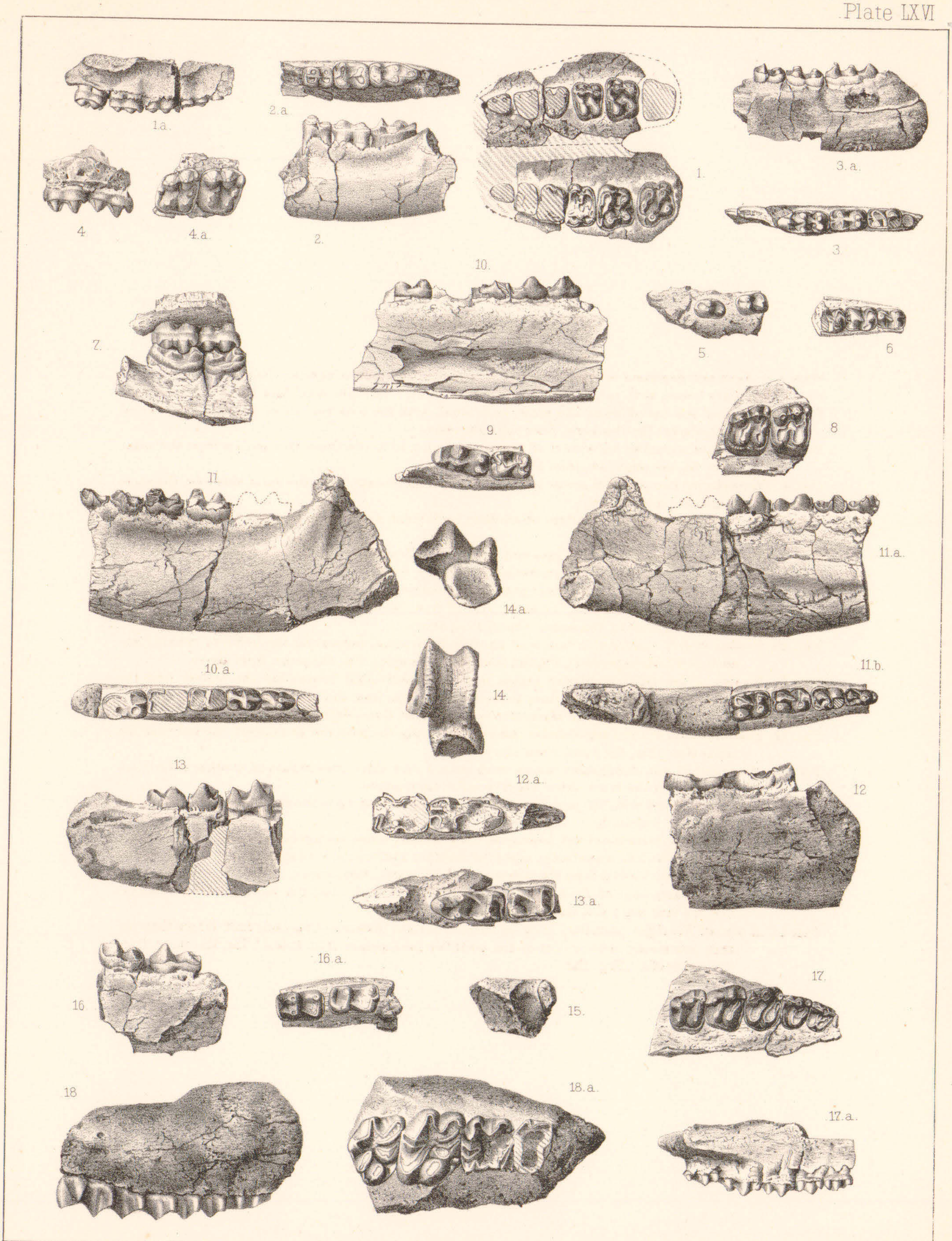
1-12 Orotherium vintanum. 13-14 O. cristonense. 15-17 O. loevii
18 Hyracotherium cuspidatum.

PLATE LXVI.

FIGS. 1–6. Jaws and dentition of *Hyracotherium angustidens*, Cope, natural size. Page 265.
FIG. 1. Maxillary bones, with teeth of both sides, from below; 1*a*, right maxillary from the outer side.
FIG. 2. Portion of the mandible of the same individual, with the posterior three molar teeth viewed from above; 2*a*, the same, from the outer side.
FIG. 3. Mandible of a smaller individual of the same species, with the three true molars from the outer side; 3*a*, the same jaw, from above.
FIG. 4. The posterior two superior molar teeth of another individual, from the outer side; 4*a*, the same fragment, from below.
FIG. 5. The third and fourth premolars of another individual, abnormally separated from each other, viewed from above.
FIG. 6. The fourth premolar, with the first and part of the second true molars, viewed from above.
FIGS. 7–11. Jaws and dentition of *Hyracotherium vasacciense*, Cope, natural size. Page 264.
FIG. 7. Last two molars of the right side of both jaws, closed in natural relation, viewed from the outside.
FIG. 8. Maxillary bone, with teeth of the same, viewed from below.
FIG. 9. Mandibular fragment of the same, viewed from above.
FIG. 10. Portion of left mandibular ramus of another individual, supporting the last five molars (seventh and fifth imperfect), viewed from the inner side; 10*a*, the same, from above.
FIG. 11. Portion of the left mandibular ramus of another individual, containing the molars from the third to the sixth, viewed from the outer side; 11*a*, from the inner side; 11*b*, from above.
FIGS. 12–16. Jaws and other bones of *Hyracotherium tapirinum*, Cope, natural size. Page 263.
FIG. 12. Posterior part of right mandibular ramus, supporting the posterior two molars, viewed from the inner side; 12*a*, the same, from above.
FIG. 13. Fragment of left mandibular ramus, with second and third true molars of another individual, viewed from the inner side; 13*a*, the same, from above.
FIG. 14. Astragalus found with the jaw, Fig. 13, and perhaps belonging to the same animal, from above; *a*, anterior extremity.
FIG. 15. Tibia, viewed on its distal end, belonging to the animal whose astragalus is represented in Fig. 14.
FIG. 16. Fragment of the left mandibular ramus of another individual, containing the first and second true molars, viewed from the outside; 16*a*, the same, from above.
FIG. 17. Right maxillary bone of *Hyrachyus singularis*, Cope, with the last five molars, viewed from below, natural size; 17*a*, from the outer side. Page 267.
FIG. 18. A part of the right maxillary bone of *Meniscotherium chamense*, Cope, one-half larger than nature, containing more or less of the posterior four molars from below; 18*a*, the same, from the right side. Page 252.



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1-6 Hyracotherium angustidens. 7-11 H. vasacciense. 12-16 H. tapirinum.
17 Hyrachyus singularis. 18 Meniscotherium chamense.

PLATE LXVII.

FIGS. 1–6. Tortoises, one-third the natural size.

FIG. 1. Posterior marginal bones of *Testudo undata*, typical specimen; *a*, posterior border of tenth marginal bone. Page 283.

FIG. 2. Acetabulum and parts of pelvis of the same specimen.

FIG. 3. Caudal marginal bone of *Testudo klettiana*, superior face. Page 285.

FIG. 4. A vertebral bone of another specimen, from above; *a*, from the side.

FIG. 5. Pygal bone of another specimen, from above; *a*, from below.

FIG. 6. Costal bone of another specimen, from above; *a*, from below.

FIGS. 7, 8, 9. Portions of tortoises from the same region as the last, natural size.

FIG. 7. Anterior caudal vertebra of *Testudo*, from below; *a*, from the left side.

FIG. 8. Median and distal caudal vertebræ of the same animal, from below.

FIG. 9. A metapodial bone of the same animal, from above; *a*, proximal extremity.

FIGS. 10–18. Bones of the typical specimen of *Vultur umbrosus*, mostly figured on the following plate, natural size. Page 287.

FIG. 10. Proximal part of left limb of the furcula.

FIG. 11. Left coracoid bone, from behind; *a*, from inner side; *b*, proximal end; *c*, distal end.

FIG. 12. Proximal part of ulna, from above.

FIG. 13. Distal extremity of compound metacarpal bone, with first phalange lacking its inner border; *a*, distal view of metacarpals; *b*, proximal view of phalange; *c*, distal view of the same phalange of the other wing.

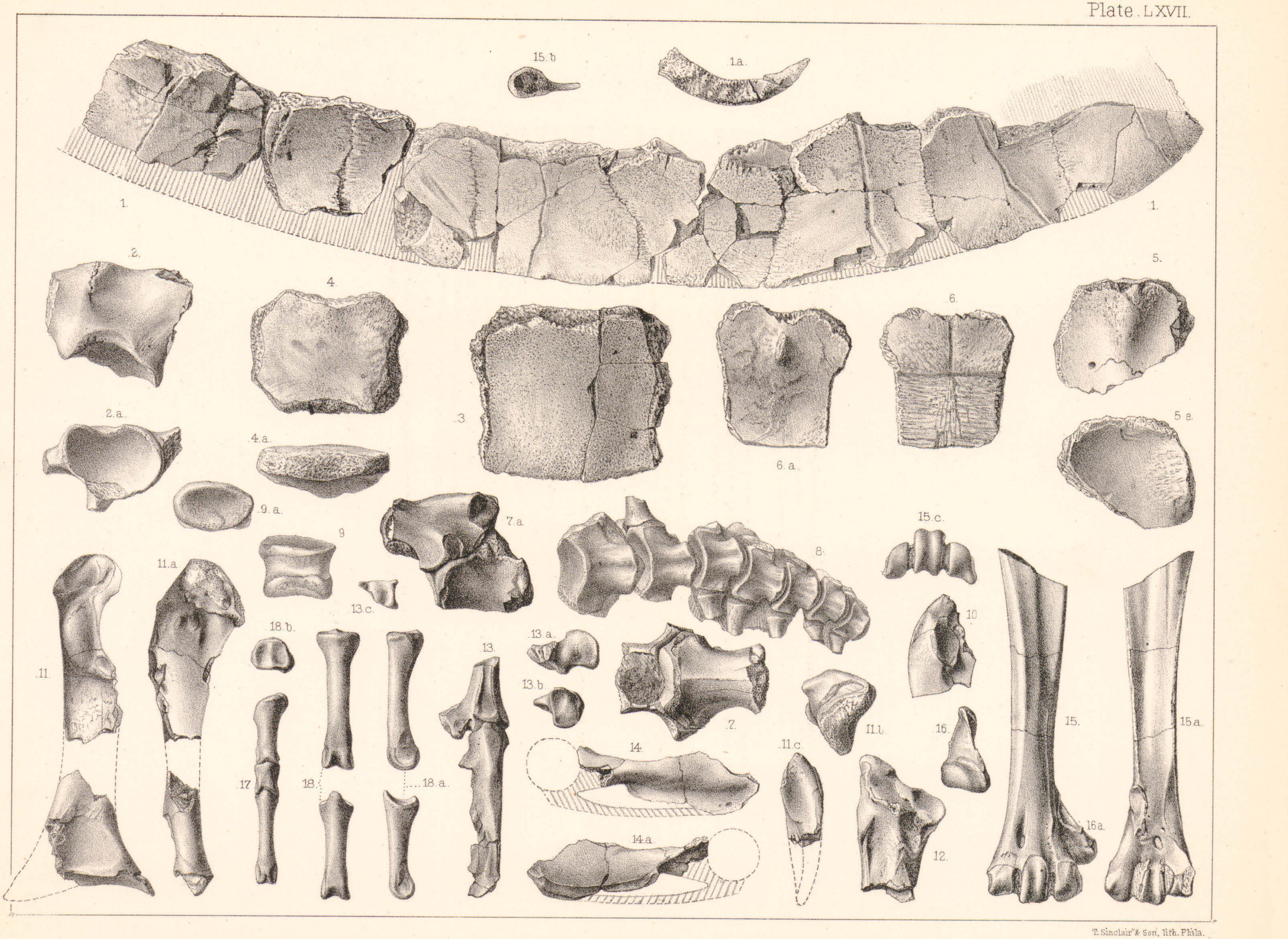
FIG. 14. Ischium, retaining part of acetabular face, outer side; *a*, inner face.

FIG. 15. Tarso-metatarsus, lacking the proximal extremity, with the inner free metatarsus, front view; *a*, posterior view, without free metatarsus; *b*, view of proximal end of fragment; *c*, view of distal extremity, from below.

FIG. 16. Lateral view of free metatarsus; *a*, anterior view in place.

FIG. 17. External digit of foot, wanting the ungual phalange.

FIG. 18. Third digit of foot, wanting second and fourth phalanges, from above; *a*, from the side; *b*, proximal view of first phalange.



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1-2. Testudo undata. 3. T. klettiana. 10-18. Vultur umbrosus.

PLATE LXVIII.

Bones of the skeleton of the typical specimen of Vultur umbrosus, natural size.

FIG. 1. Beak, including nares and part of mandible, right side; *a*, left side; *b*, superior, and, *c*, inferior, views.

FIG. 2. Inferior extremity of the left quadrate bone, from behind; *a*, from below.

FIG. 3. Posterior extremity of left mandibular ramus, external view; *a*, from above.

FIG. 4. Two cervical vertebræ, left side; *a*, from below; *c*, posterior of view of the posterior vertebra.

FIG. 5. First dorsal, profile; *a*, from below; *b*, from before; *c*, from behind.

FIG. 6. Third dorsal, lettering as in last.

FIG. 7. Fourth dorsal, lettering as in last.

FIG. 8. Sixth dorsal, lettering as in last.

FIG. 9. Seventh dorsal, lettering as in last.

FIG. 10. Sacrum, without posterior extremity, lettering as above; *d*, superior view.

FIG. 11. Four proximal caudal vertebræ; *a*, from below.

FIG. 12. Plowshare-bone, lettering as above.

FIG. 13. Anterior view of left humerus, partially restored in outline, with the omission of a portion of the middle of the shaft; *a*, posterior aspect of proximal extremity of the same; *b*, proximal view of the same.

FIG. 14. Posterior view of right humerus, which lacks the head, the shaft restored.

FIG. 15. Postero-exterior view of left ulna, the proximal portion.

FIG. 16. Proximal view of proximal extremity of left ulna.

FIG. 17. Anterior view of right femur, the shaft restored in outline; *a*, proximal view of proximal extremity; *b*, distal view of distal extremity; *c*, posterior view of distal portion.

FIG. 18. Anterior view of left tibia, restored in outline; *a*, external view of same; *b*, proximal view of head.

FIG. 19. Proximal view of head of fibula.

Plate LXVIII.

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Vultur umbrosus. Cope.

PLATE LXIX.

FIG. 1. Right mandibular ramus of *Canis ursinus*, natural size, external view; *a*, from below; *b*, from above; *c*, posterior view. Page 304.

FIG. 2. Right mandibular ramus of *Canis vheelerianus*, natural size, external view; *a*, inferior view; *b*, superior view. Page 302.

FIG. 3. Portion of mandibular ramus of *Putorius nambianus*, natural size; *a*, sideview, twice natural size; *b*, superior view, twice natural size. Page 305.

FIGS. 4–12. Teeth and bones of *Stencofiber pansus*, found together, natural size. Page 297.

FIG. 4. Right maxillary and mandible, external view.

FIG. 5. Right mandible, from above; *a*, from below.

FIG. 6. Right maxillary, from below.

FIG. 7. Inferior incisor, from the front; *a*, from the side.

FIG. 8. Otic bulla.

FIG. 9. Humerus, without distal end or proximal epiphysis.

FIG. 10. Right ulna, proximal portion.

FIGS. 11–12. Long bones.

FIGS. 13–14. Teeth of a young *Steneofiber pansus:* 13, first inferior molar, external side; *a*, interior side.

FIG. 14. Inferior incisor, showing transverse lines.

FIG. 15. Right mandibular ramus of *Eumys loxodon*, natural size, external view; *a*, external view, one and one-half natural size; *b*, superior view, one and one-half natural size; *c*, superior view of inferior molar teeth, thrice natural size. Page 300.

FIGS. 16–20. Teeth of *Panolax sanctæfidæi.* Page 296.

FIG. 16. Superior molars of right side, seen from below, twice natural size. The number is hypothetical, as they have not been found in place.

FIG. 17. Superior median molar, natural size, from the anterior side: *a*, inner border; *b*, external border.

FIG. 18. Penultimate molar in place, but scarcely protruded, inner side, natural size.

FIG. 19. First superior molar, twice natural size, front view; *a*, external view.

FIG. 20. Last superior molar, twice natural size, anterior view; *a*, posterior view.

FIG. 21. Distal end of a femur found at a distance of six feet from the teeth of *P. sanctæfidæi*, and supposed to belong to the same animal, natural size, superior view.

FIG. 22. Proximal end of tibia, found with the preceding femur, natural size.

FIG. 23. Principal phalange of a Bird, side view, natural size; *a*, inner edge.

FIG. 24. ? Free metacarpal of an undetermined Bird, side view, natural size.

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1. Canis ursinus. 2. Canis veelerianus. 3. Mustela nambiana.
4-14. Steneofiber pansus. 16-22. Panolax sanctæfidæi.

PLATE LXX.

Mandible anterior to the coronoid process, of Mastodon productus, one-half natural size; the left posterior molar is the only one well preserved. Page 306.

FIG. 1. View from above.
FIG. 2. The left side.
FIG. 3. Distal view.
FIG. 4. Molar tooth of *Elephas primigenius columbi*, from Placita, one-half natural size, grinding face Page 25.

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1-3. Mastodon productus Cope. 4. Elephas primigenius Blum.

PLATE LXXI.

Teeth and bones of Mastodon productus, one-half natural size.

FIG. 1. Superior molars, from the first to the fourth, of both sides, seen from below ; the fourth not protruded.

FIG. 2. The same series of the right side, viewed from within.

FIG. 3. The last or sixth inferior molar of the lower jaw, figured in Plate LXX, from the inner side.

FIG. 4. The sixth inferior molar of a third individual, from above.

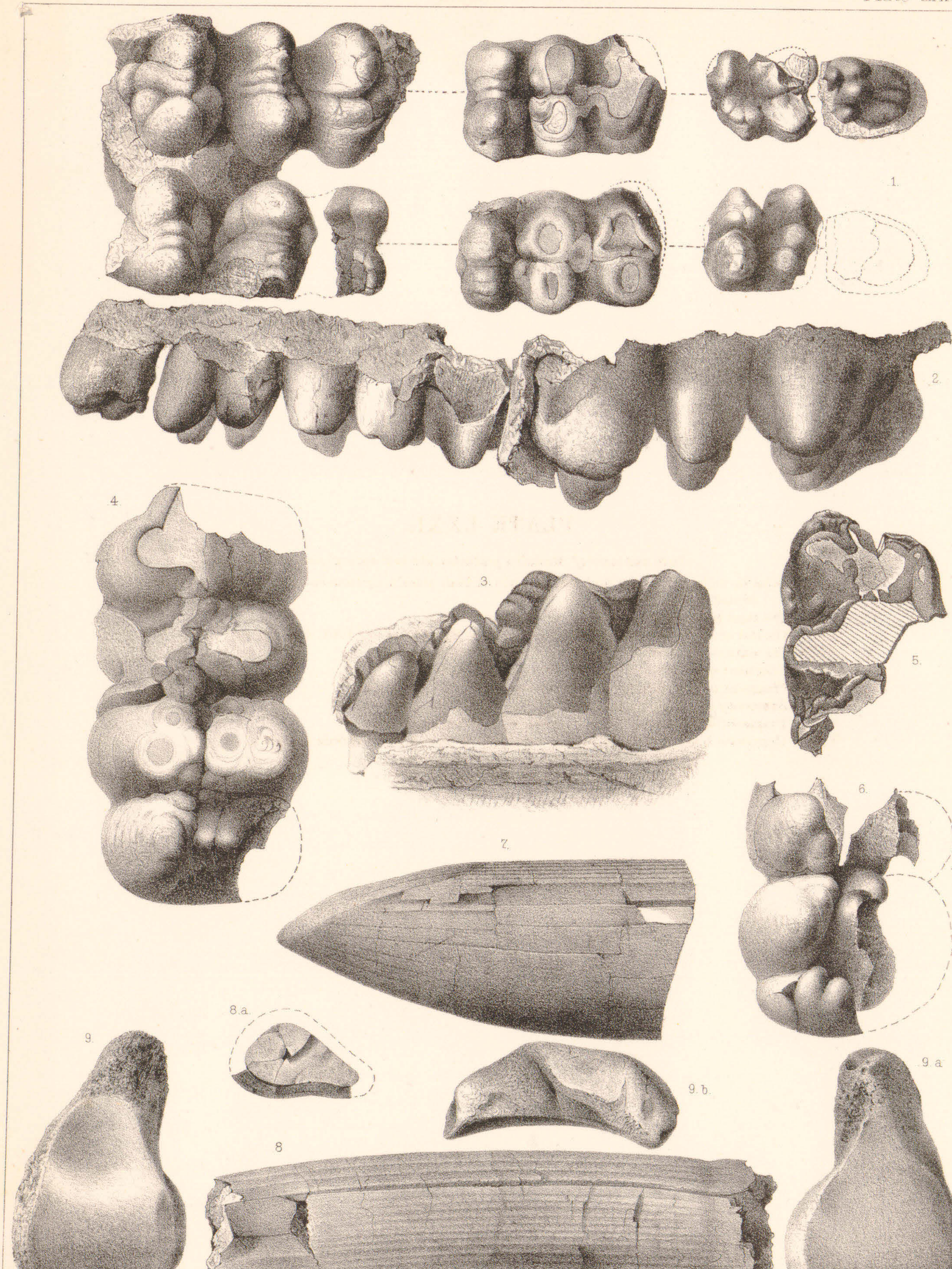
FIG. 5. Fragment of a worn third molar; the grinding face.

FIG. 6. Fragment of the posterior part of a molar tooth.

FIG 7. Extremity of a superior tusk.

FIG. 8. Fragment of an inferior tusk, from above; *a*, distal extremity.

FIG. 9. Cuneiform bone of the right side, from above; *a*, from below ; *b*, from behind.



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Mastodon productus

PLATE LXXII.

Bones of the extremities of Mastodon productus, one-fourth natural size.

FIG. 1. Right ulna, without epiphyses, outer side; *a*, the same, from above.
FIG. 2. Os magnum, from the front; *a*, from above; *b*, from below; *c*, external, *d*, internal side.
FIG 3. Left femur, from the front; *a*, from the outer side.

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Mastodon productus Cope.

PLATE LXXIII.

Bones of species of Aphelops, one-half natural size.

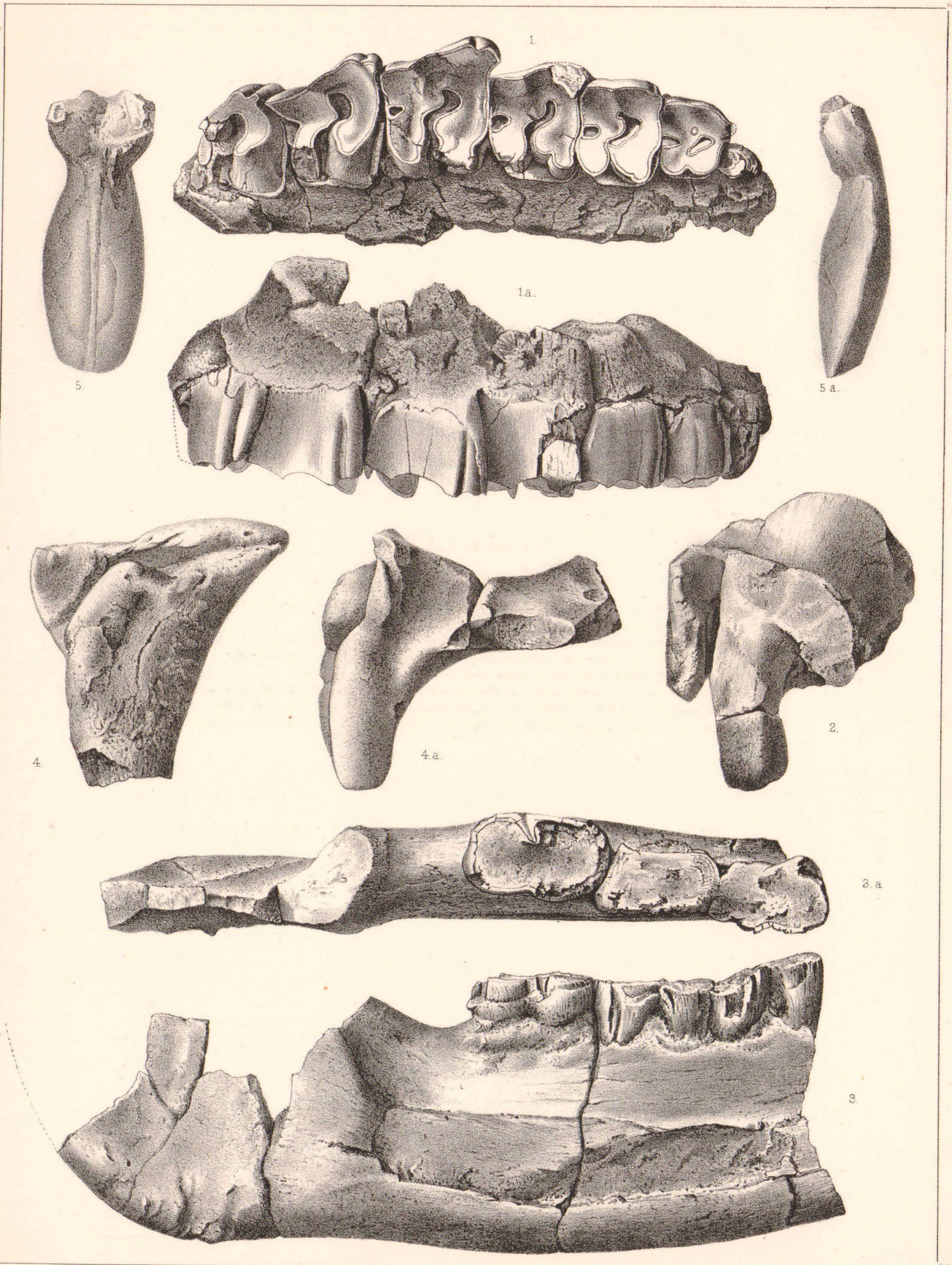
FIG. 1. Superior maxillary bone, with molar teeth, of *Aphelops meridianus*, viewed from below; *a*, from the external side. Page 317.

FIG. 2. Meatus auditorius externus and adjacent parts of the specimen represented in Fig. 1.

FIG. 3. Right mandibular ramus of *Aphelops jemezanus*, external view; *a*, superior view. Page 319.

FIG. 4. Condyle of the same mandible, viewed from behind; *a*, from above.

FIG. 5. Cast of part of the cranial cavity of specimen of *Oxyæna forcipata* figured on Plate XXXV, fig. 7, seen from above, natural size; 5*a*, the same, lateral view. The area within the irregular line represents the portion of the interior table of the skull which is not eroded.



T. Sinclair & Son, lith. Phila.

1-3. Aphelops meridianus. 4. A. jemezanus. 5 Oxyaena forcipata.

PLATE LXXIV.

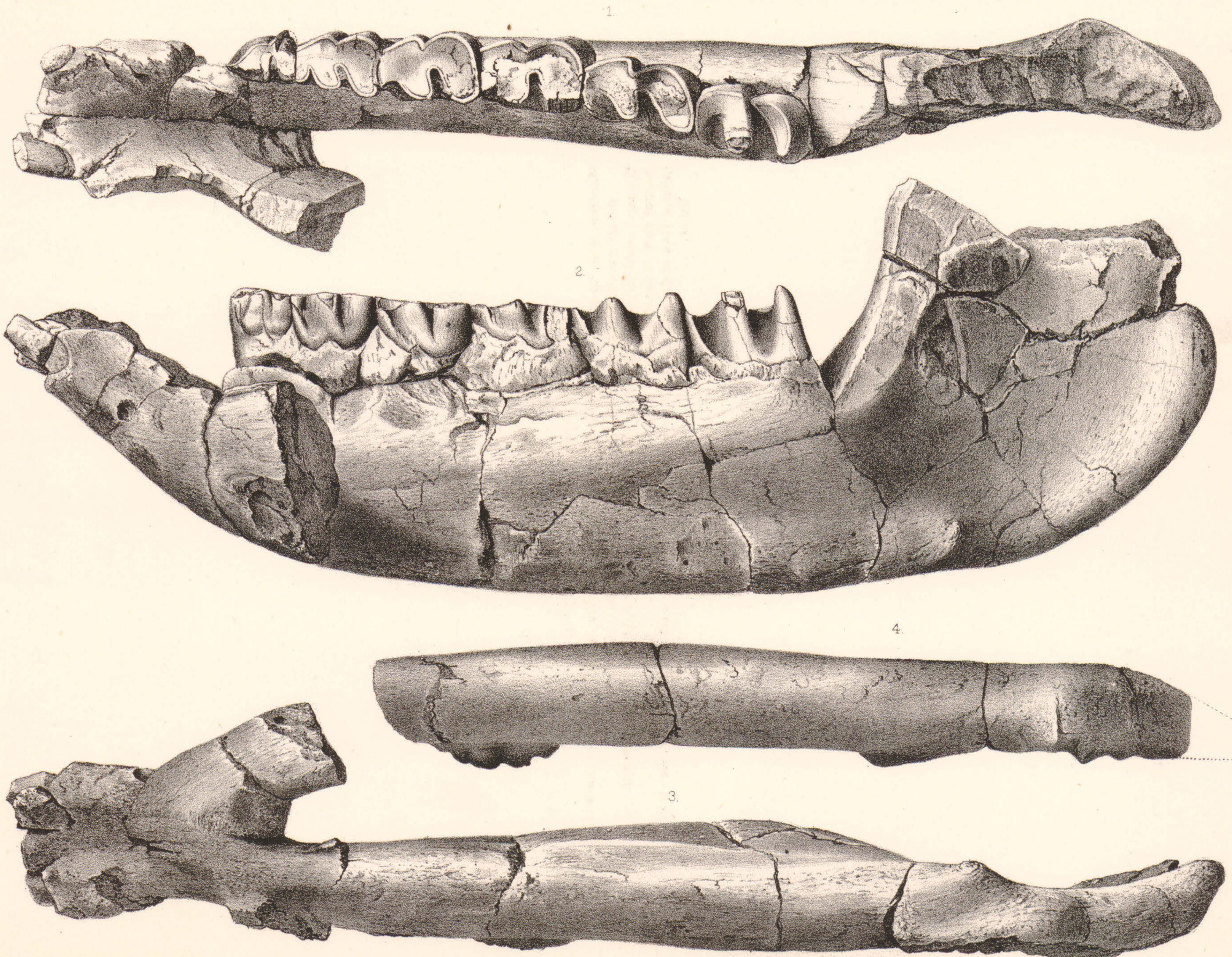
Mandibles of Aphelops, one-half the natural size.

FIG. 1. Mandible of the specimen of *A. meridianus*, figured on the preceding plate, from above. Most of the left ramus present in the fossil is omitted in the drawing.

FIG. 2. The same mandible, seen from the left side, the inner face of the right ramus being exposed.

FIG. 3. Inferior view of the same ramus.

FIG. 4. Inferior view of the right ramus of *Aphelops jemezanus*, figured on the preceding plate, seen from below.



T. Sinclair & Son, lith. Phila.

1-3. Aphelops meridianus. 4. A. jemezanus.

PLATE LXXV.

Teeth and jaw fragments of Horses, natural size.

FIG. 1. Inferior view of the superior molar teeth and palate of the typical specimen of *Hippotherium calamarium; a*, external view of maxillary bone, containing three anterior molars of left side. Page 321.

FIG. 2. Portion of the lower jaw of the individual of *Hippotherium calamarium*, figured in the preceding plate, containing the molar series, viewed from the outer side; *a*, the same, seen from above.

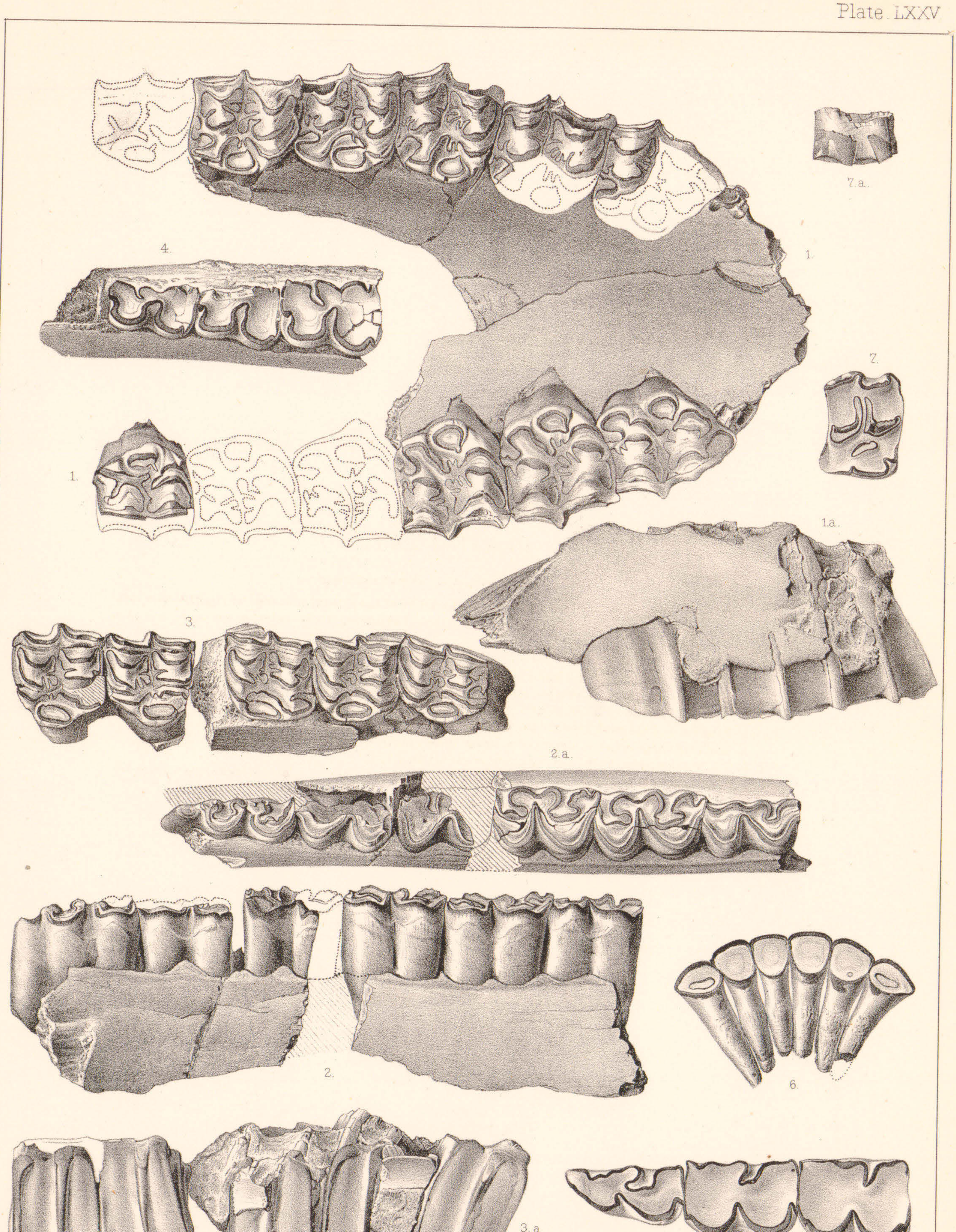
FIG. 3. Left superior molars of *Hippotherium speciosum*, seen from below; *a*, external side. The series is interrupted by a fragment of matrix between the fourth and fifth molars. Page 322.

FIG. 4. Fragment of the mandibular ramus of a Horse, with three molar teeth, from above.

FIG. 5. The first three inferior molars of a larger Horse, much worn, from above.

FIG. 6. The incisor series of the individual represented in Fig. 5.

FIG. 7. Worn superior molar tooth of a species of *Protohippus*, from below; *a*, the external face. Page 323.



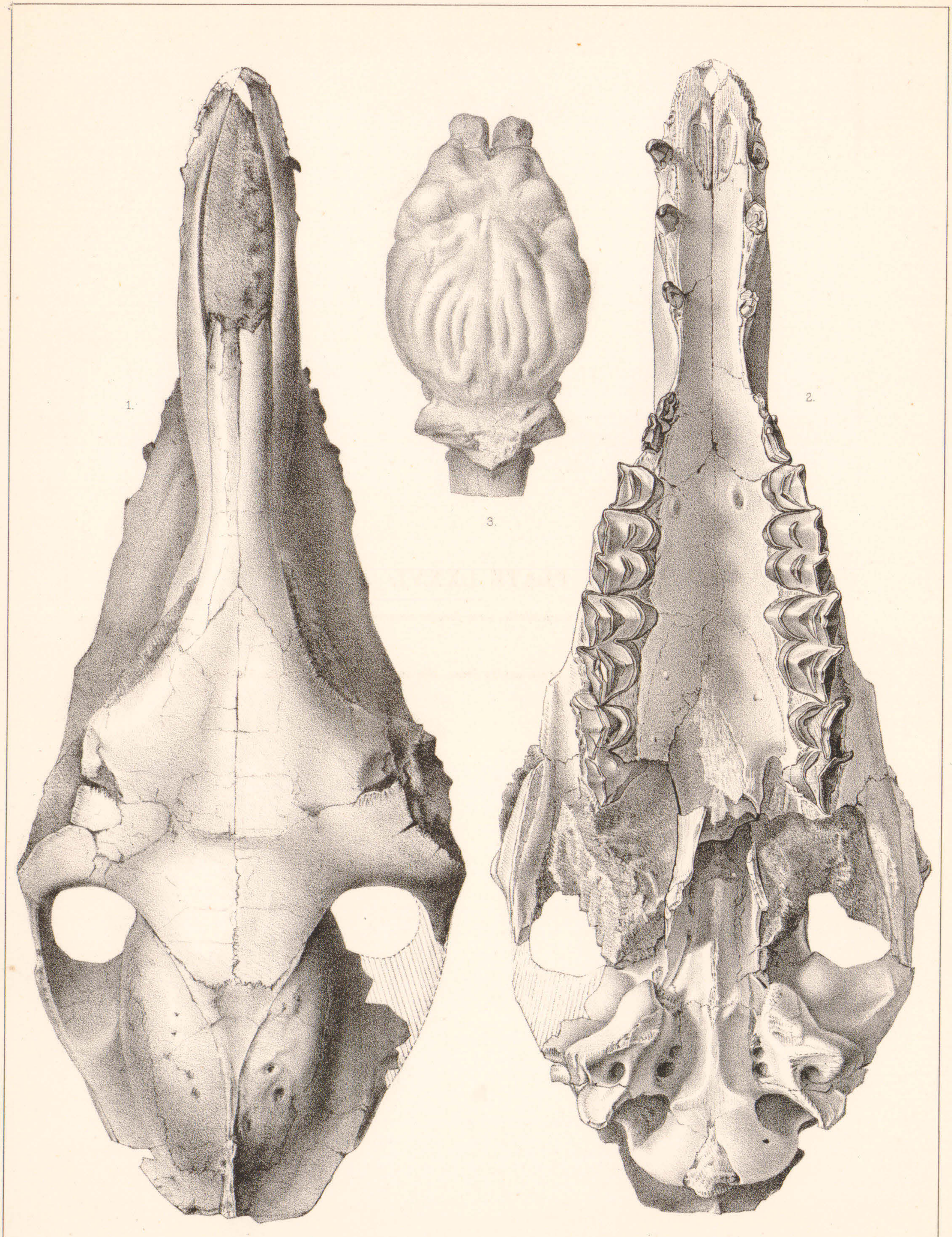
T. Sinclair & Son, lith. Phila.

1-2. Hippotherium calamarium. 3. H. speciosum.
7. Protohippus sp.

PLATE LXXVI.

Cranium of Procamelus occidentalis, three-fourths the natural size. Page 329.

FIG. 1. Superior surface.
FIG. 2. Inferior surface.
FIG. 3. Superior view of a cast of the brain-cavity from the same skull, two-thirds the natural size. Page 338.



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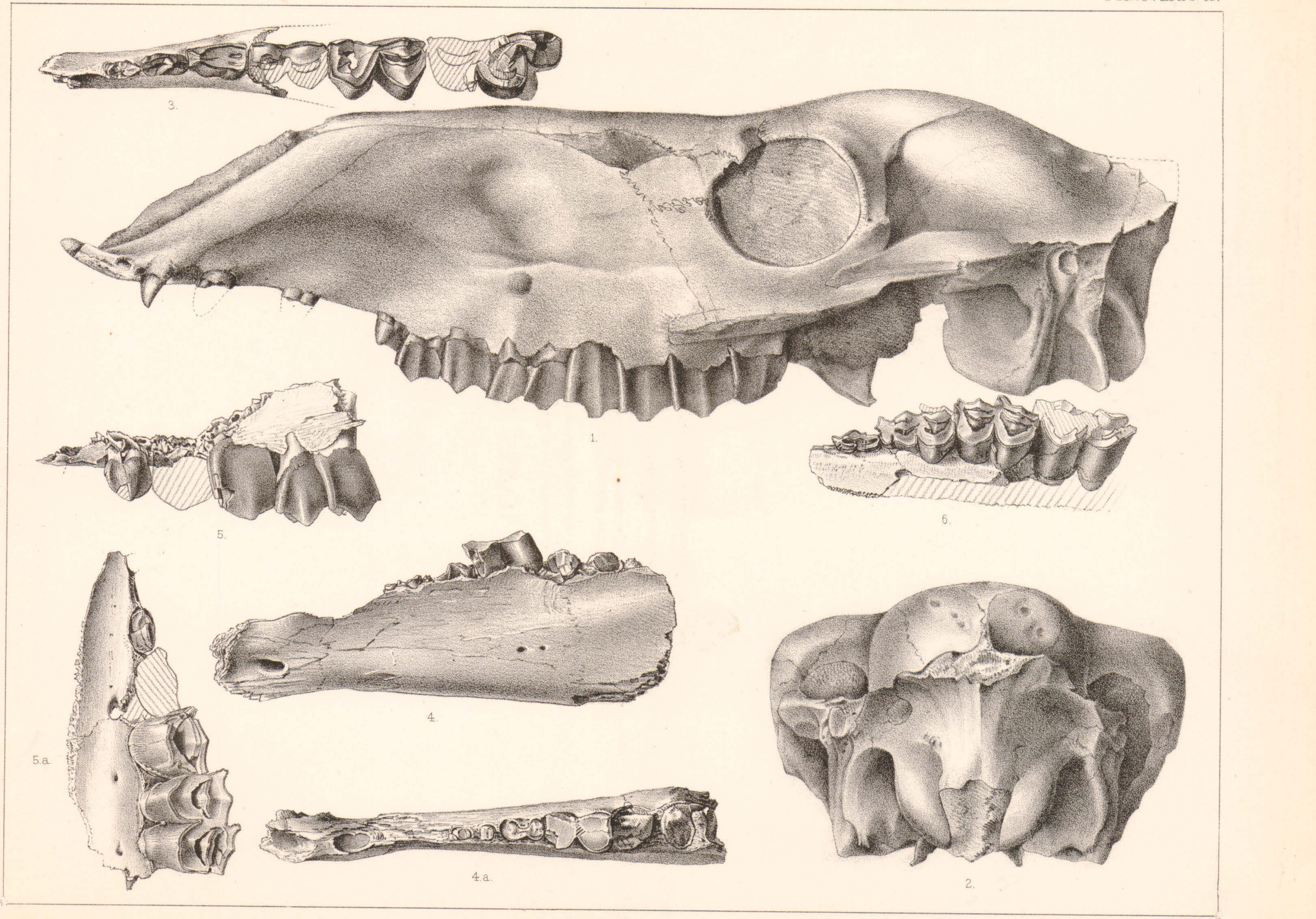
Procamelus occidentalis

PLATE LXXVII.

Cranium and teeth of Camels, three-fourths the natural size.

FIG. 1. View of the side of the cranium of *Procamelus occidentalis,* figured on the preceding plate.
FIG. 2. Posterior view of the same cranium.
FIG. 3. Fragmentary molar dentition of the lower jaw of a second individual, left side, from above.
FIG. 4. Portion of left mandibular ramus of *Pliauchenia humphresiana,* from the outer side; *a,* from above. Page 344.
FIG. 5. Portion of left superior maxillary bone, with molars of *Pliauchenia vulcanorum,* external view; *a,* inferior view. Page 345.
FIG. 6. Portion of superior maxillary bone of a Camel, with milk dentition. Page 345.

Plate. LXXVII.



T. Sinclair & Son, lith. Phila.

1_3. Procamelus occidentalis. 4. Pliauchenia humphresiana. 5. P. vulcanorum.

PLATE LXXVIII.

Bones of Camels, three-fourths the natural size.

FIGS. 1-9. Portions of the individual of *Procamelus occidentalis*, whose cranium is figured in the preceding plate.

FIG. 1. Atlas, from below; *a*, from the right side; *b*, from behind.

FIG. 2. The axis, from the front.

FIG. 3. An anterior cervical vertebra, from above; *a*, from behind.

FIG. 4. A cervical vertebra behind the last figured, from the right side; *a*, from front; *b*, from below.

FIG. 5. A dorsal vertebra, from the left side; *a*, from the front.

FIG. 6. A lumbar vertebra, from below; *a*, from behind.

FIG. 7. Proximal view of scapula.

FIG. 8. Distal view of humerus.

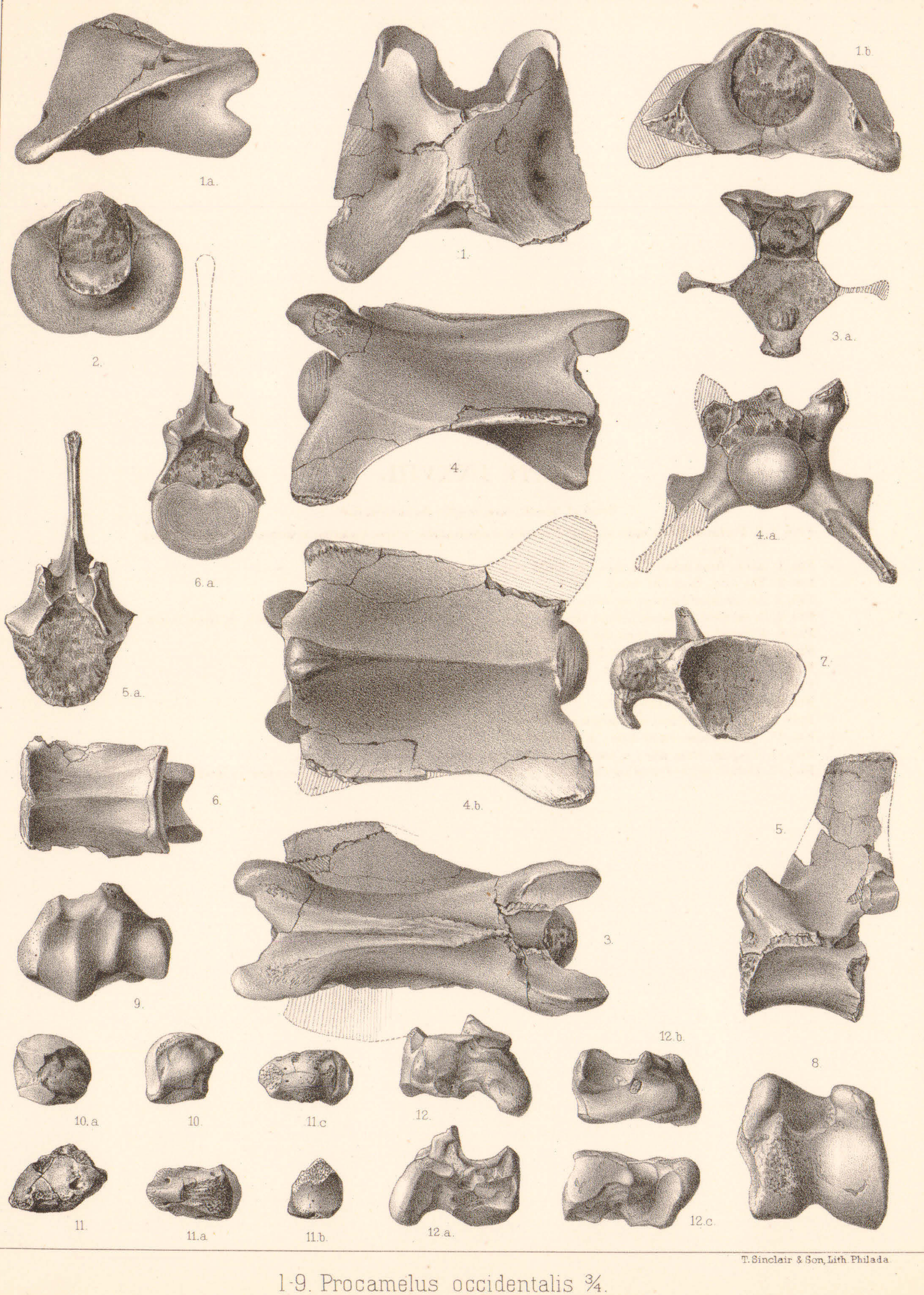
FIG. 9. Distal view of ulno-radius.

FIGS. 10–11. Bones of foot of a larger Camel, found together.

FIG. 10. Trapezoides, outer side: *a*, inner side.

FIG. 11. Unguis, from side; *a*, from above; *b*, from behind; *c*, from below.

FIG. 12. Cuboid bone of another Camel, external view; *a*, internal view; *b*, superior view; *c*, inferior view.



T. Sinclair & Son, Lith. Philada.

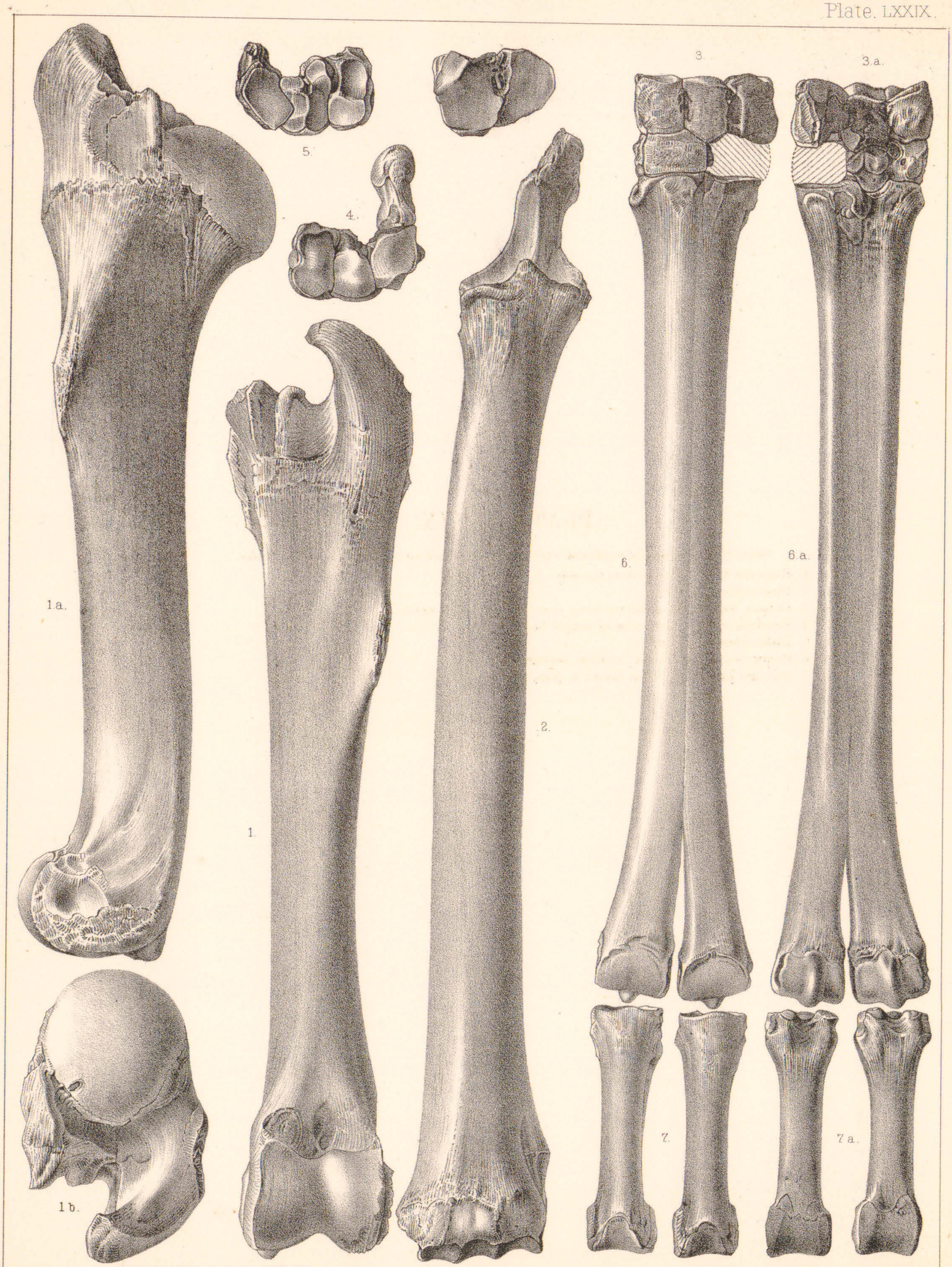
1-9. Procamelus occidentalis ¾.

PLATE LXXIX.

Bones of the Procamelus occidentalis of the individual figured on the two preceding plates.

FIG. 1. Humerus from front; *a*, from the side; *b*, view of head.
FIG. 2. Ulno-radius, from front.
FIG. 3. Carpus, lacking the unciform bone, from front; *a*, from behind.
FIG. 4. Proximal view of first series of carpal bones.
FIG. 5. Distal view of the same.
FIG. 6. Cannon-bone, from front; *a*, from behind.
FIG. 7. The first phalanges, from front; *a*, from behind.

Plate. LXXIX.



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Procamelus occidentalis ¾.

PLATE LXXX.

Portions of horns of Dicrocerus furcatus, natural size. Page 350.

FIG. 1. Basal portion, with part of the frontal bone of the right side, exhibiting the burr ; *a*, posterior view, showing part of the scar left on the removal of part of the burr ; *b*, the same, from outer side ; *c*, section of broken apex.

FIG. 2. Distal portion of the same horn, front view ; *a*, inner view ; the intermediate part is lost.

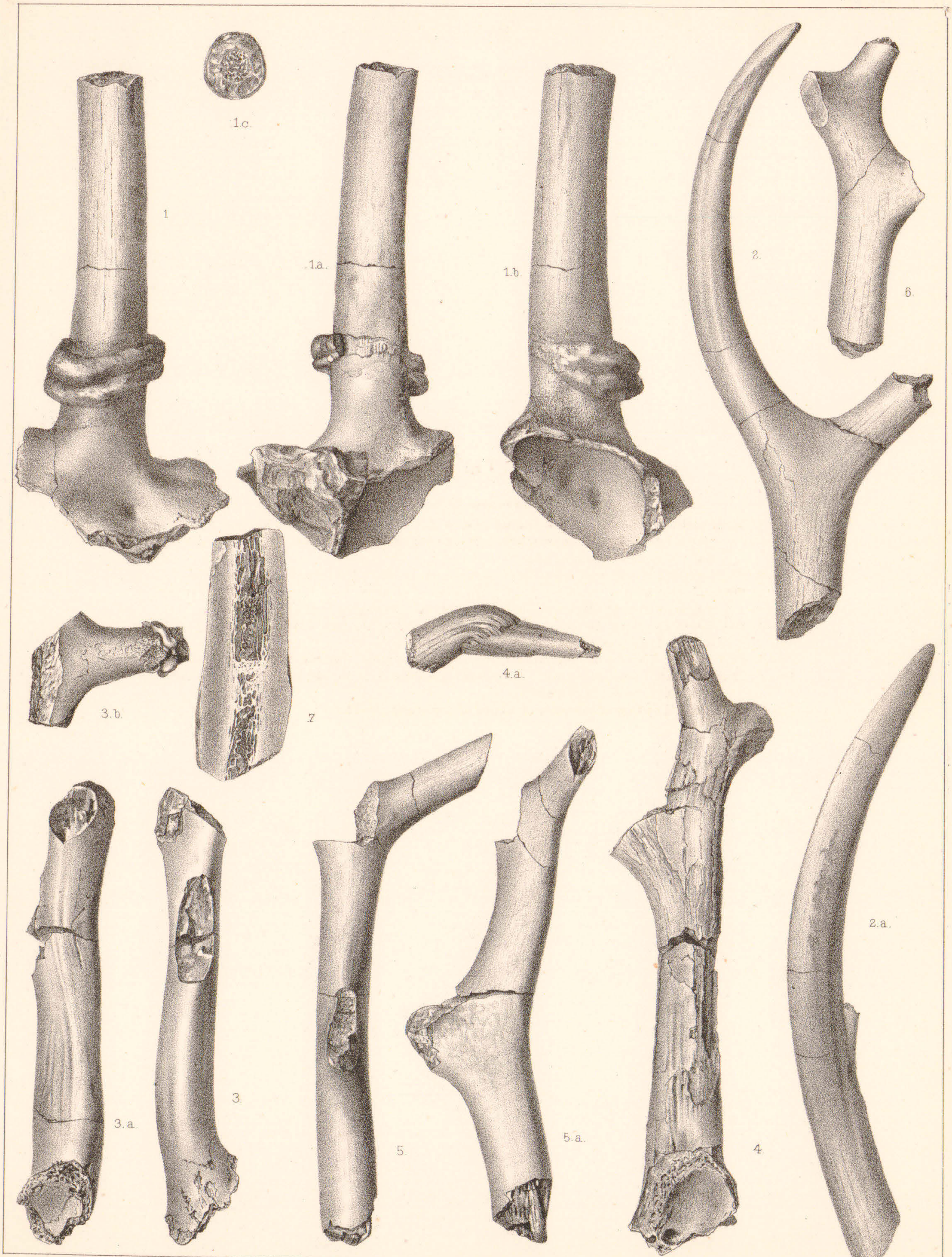
FIG. 3. Beam of right horn of specimen No. 2, with bases of antlers, from front ; *a*, from outer side ; *b*, fragment from opposite side of the same animal, displaying burr on an antler.

FIG. 4. The fourth specimen described in the text, belonging to the left side ; *a*, extremity of antler fractured and anchylosed.

FIG. 5. Horn of right side of a fifth individual, the base broken away, interior view ; *a*, anterior view.

FIG. 6. Fragment of left horn found with the preceding specimen, as though belonging to the same animal, but different in proportions.

FIG. 7. Longitudinal section of the beam of a horn of *Dicrocerus furcatus*.



T. Sinclair & Son, Lith. Philada.

Dicrocerus furcatus.

PLATE LXXXI.

Figures of the horns of Dicroceri, natural size.

FIG. 1. Beam of *Dicrocerus furcatus*, from within, showing the scar of the burr; *a*, section of the same, showing the spongy tissue uninterrupted and the dense tissue unbroken. Page 350.

FIGS. 2–6. *Dicrocerus necatus.* Page 353.

FIG. 2. Horn of the right side, inner view.

FIG. 3. Horn of the left side of the same animal, external view; *a*, the same horn, viewed from the front, displaying the left frontal bone distorted.

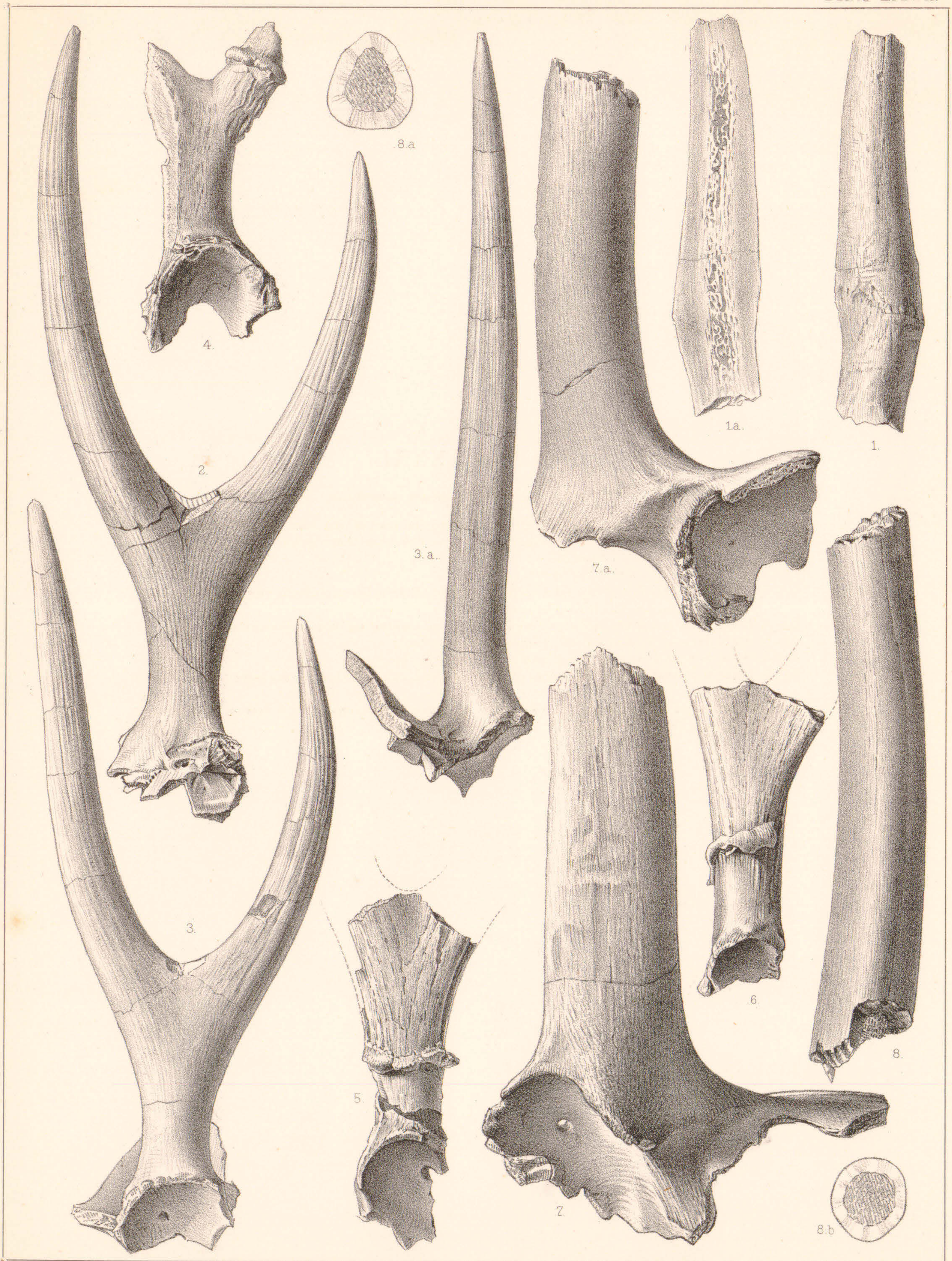
FIG. 4. Right horn, minus the antlers, of another specimen, exhibiting burr on the anterior antler.

FIG. 5. Right beam of another animal, displaying burr on beam.

FIG. 6. Beam of right horn of another individual, displaying burr.

FIG. 7. Parts of frontal and parietal bones of *Dicrocerus teres*, external view; *a*, the same piece, posterior view.

FIG. 8. Fragment of horn of *Dicrocerus trilateralis; a*, section of proximal end; *b*, section of distal end. Page 357



T. Sinclair & Son, lith. Phila.

1. Dicrocerus furcatus. 2-6. D. necatus. 7. D. teres. 8. D. trilateralis.

PLATE LXXXII.

Figures of Dicroceri, natural size, excepting Figs. 8 and 9, which are one-half natural size.

FIG. 1. Left mandibular ramus of *Dicrocerus furcatus*, exterior side; *a*, superior aspect. Page 352.

FIG. 2. Right mandibular ramus of *Dicrocerus necatus*, from the specimen figured in Plate LXXXI, figs. 2 and 3, external view; *a*, superior view. Page 354.

FIG. 3. Maxillary bone and teeth of *D. necatus*, of the specimen figured in Plate LXXXI, fig. 4; *a*, external view.

FIG. 4. Fragment of lower jaw, with last molar, of specimen represented by Fig. 3.

FIG. 5. Superior part of mandibular ramus of left side of another specimen, doubtfully referred to *D. necatus* (type of *D. ramosus*); *a*, superior view of the same.

FIG. 6. Anterior view of frontal bones and portions of horns of *Dicrocerus teres*; *a*, view of the same, from above. Page 356.

FIG. 7. Symphysis mandibuli of *Dicrocerus trilateralis*, external view; *a*, superior view. Page 357.

FIG. 8. Symphysis pubis and ischii of the same specimen, from below, one-half natural size.

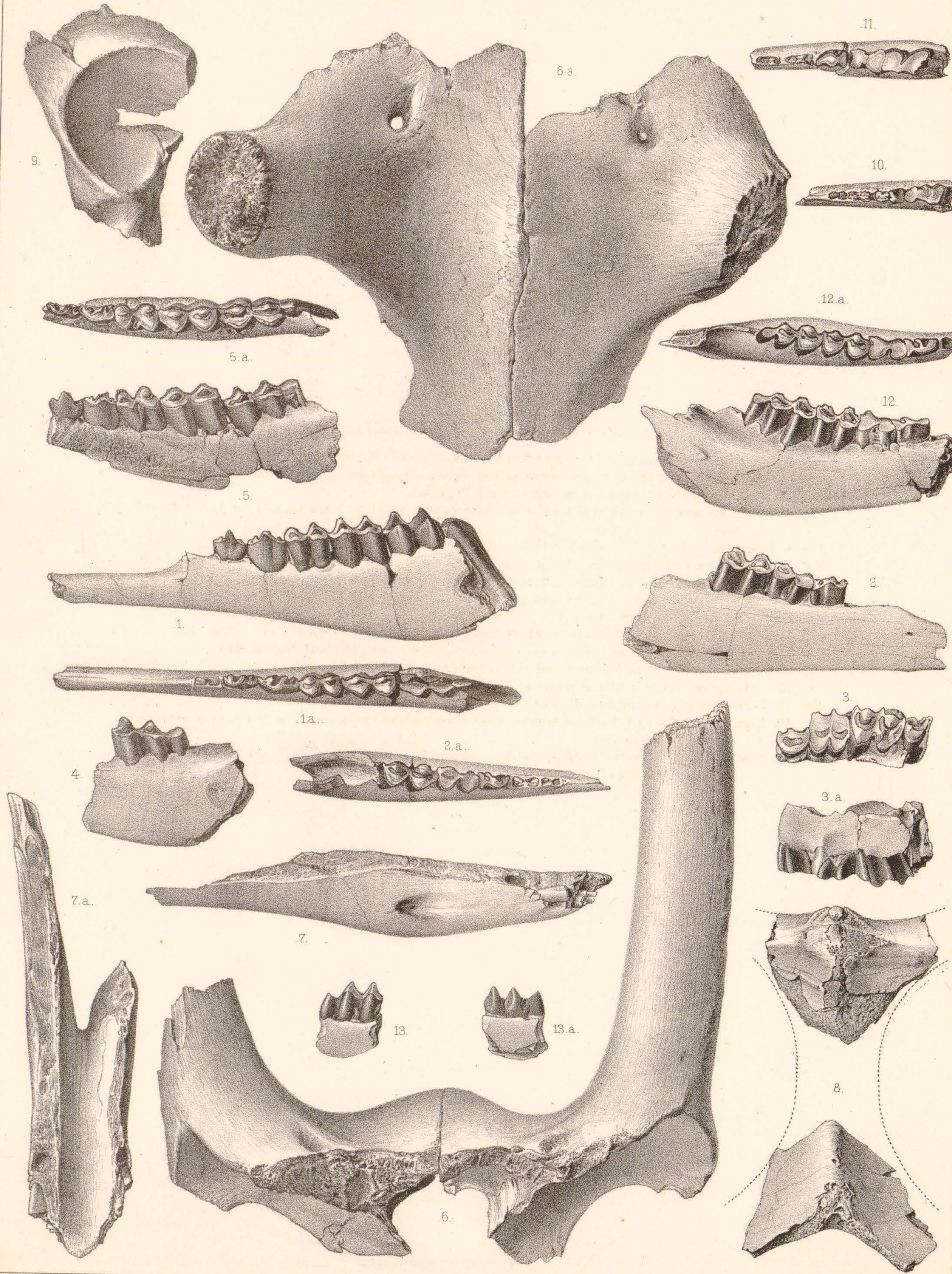
FIG. 9. External view of acetabulum of individual represented in Figs. 7 and 8.

FIG. 10. Anterior part of mandibular ramus of *Dicrocerus tehuanus*. Page 359.

FIG. 11. Corresponding part of an individual doubtfully referred to *D. tehuanus*.

FIG. 12. Right mandible, with teeth, of another individual, referred with doubt to *D. tehuanus*, external view; *a*, superior view.

FIG. 13. Posterior inferior molar tooth of *Dicrocerus gemmifer*, with a fragment of the jaw, outer side; *a*, inner side. Page 360.



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1. Dicrocerus furcatus. 2-5. D. necatus. 6. D. teres. 7-9. D. trilateralis.
10-12. D. tehuanus. 13. D. gemmifer.

PLATE LXXXIII.

Portions of the skeleton of Dystrophæus viæmalæ, from the Trias of Utah, collected by Prof. J. S. Newberry, one-fifth natural size.

FIG. 1. Supposed scapula, external side; *a*, section of the same from a transverse fracture near the middle of the length.

FIG. 2. Supposed left humerus, inner side; *a*, anterior, *b*, external sides; *c*, proximal end; *d*, distal end; *e*, section of shaft near the middle.

FIG. 3 Distal extremity of supposed ulna, distal view; *a*, view of fractured section of shaft of same, ten inches above the extremity.

FIGS. 4, 5, 6. Metapodial bones: *a*, proximal extremities; *b*, distal extremities.

FIG. 7. Inner face of the left half of the posterior portion of the cranium of *Coryphodon elephantopus* figured in Plate LI, displaying the left half of the brain-cavity and the air-chambers; one-fourth natural size.

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1-6. Dystrophaeus viaemalae 1/5. 7 Coryphodon elephantopus. 2/5.