DEPARTMENT OF THE INTERIOR.

REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY

OF

THE TERRITORIES.

F. V. HAYDEN,
UNITED STATES GEOLOGIST-IN-CHARGE.

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LETTER TO THE SECRETARY.

OFFICE OF THE UNITED STATES
GEOLOGICAL SURVEY OF THE TERRITORIES,
Washington, D. C., October 5, 1875.

SIR: The very valuable memoir, by Prof. E. D. Cope, on the "Vertebrata of the Cretaceous Formations of the West," is respectfully submitted for your approval and for publication. The great interest which has been excited among the people, as well as among scientific men, by the discoveries of the remarkable extinct vertebrate remains, within a few years past, in the numerous ancient lake-basins of the West, will render the publication very opportune at this time, and one of great value to the intelligent world. As a contribution of materials toward the solution of the numerous problems involved in the geological structure of our great West, as well as the unfolding of its ancient life, it must take the highest rank.

In a certain sense, Paleontology, or the history of ancient organic remains, lies at the very foundation of geological science. It oftentimes stands as the arbiter on doubtful questions, and is a very important aid to the stratigrapher in unfolding the age of strata, and in fixing the great time-boundaries of groups, as well as divisions or subdivisions. No geological survey can be considered complete without its coöperation. It has been with this idea that so much of the strength of the survey has been given to this department.

So far as the opinions expressed by the author in regard to the age of the Lignitic group are concerned, he alone is responsible to the scientific world. In all the publications of the survey under my charge, prepared by collaborators of established reputation, I have thought it best to permit the broadest latitude in the expression of opinions, whether they harmonize with my own conclusions or not. While Professor Cope reads, in the teachings of the extinct vertebrate fauna of the Lignitic group, its Cretaceous age, Professor Lesquereux, with equal sincerity and force, decides, from the lessons of the fossil vegetation, that it belongs to the Tertiary epoch.

The present volume will be followed in due time by two others by the same author, on the Vertebrata of the Tertiary Lake-Basins of the West.

I have the honor to be, your obedient servant,

F. V. HAYDEN,
United States Geologist.

Hon. B. R. Cowen,
Acting Secretary of the Interior.

UNITED STATES GEOLOGICAL SURVEY OF THE TERRITORIES.

THE VERTEBRATA

OF THE

CRETACEOUS FORMATIONS

OF

THE WEST.

BY E. D. COPE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1875.

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PHILADELPHIA, *January* 20, 1875.

SIR: The accompanying pages embrace my final report on the vertebrate paleontology of the Cretaceous formations of the West. The greater number of species described has been derived from the beds of the Niobrara (No. 3) and Fort Union (No. 6) epochs. The material has been obtained from the explorations in Kansas by the writer in 1871; from similar explorations in Kansas by Prof. B. F. Mudge in the years 1870 and 1872; from the explorations by the writer in Wyoming in connection with the United States Geological Survey in 1872; and from a similar expedition in Colorado in 1873. I wish to express here my indebtedness to various friends who have assisted me on these occasions; especially to General John Pope, commanding the Department of the Smoky Hill, and Captains Butler and Lyman, and Dr. King, stationed at Fort Wallace at the time of my expedition in 1871; to Dr. John H. Janeway, United States Army, of Fort Hays, and Profs. B. F. Mudge and George Merrill, of Kansas, for invaluable specimens of the fossils of the Niobrara group; and to Capt. E. O. Clift, Dr. Joseph Corson, and Judge W. E. Carter, of Fort Bridger, Wyoming, for many kindnesses. I am also under obligations to George M. Dawson, geologist of the British North American Boundary Commission, for the opportunity of examining fossils from the Fort Union beds of British America; and to the Smithsonian Institution for facilities in the use of specimens and books.

Where it has been possible to throw light on questions of stratigraphy, this subject has also been touched upon.

I am, with much esteem,

E. D. COPE,
Paleontologist.

DR. F. V. HAYDEN,
Director of the U. S. Geological Survey of the Territories.

INTRODUCTION.

ON THE GENERAL SIGNIFICANCE OF THE SCIENCE OF PALEONTOLOGY.

I.

Paleontology is an exact science. It embraces generalizations or laws obtained by induction, which may be deductively applied to the unknown. Its first law is an illustration of the uniformity of nature's methods, namely, the law of the persistence of type. An organized structure once created, and existing under circumstances not hostile to its working, is adhered to with the greatest fidelity, and extended in time and space. This constant law is the key to this as to the other biological sciences, and occasionally surprises the student of evolutionistic proclivities. On this basis, the possibility of reconstruction of the extinct forms of the past will always rest; and the certainty of the law is unconsciously admitted by every paleontologist who determines, names, or classifies a fossil from anything less than a perfect specimen. It is assumed every day, and universally allowed, although occasionally even an expert is found who sometimes questions it, and still more frequently an inexpert who does not read nature aright.

The application of the law is, however, various as the given terms, *i. e.*, the remains preserved, differ in significance. Thus, to illustrate, certain parts are common to all stoves, and distinguish them from all other articles of furniture; but certain other parts not only belong to a stove, but mark a given pattern of stove, since they belong only to it. A still more minute range of appearances is found only in one man's make of stoves, and others in that of another man. Hence, a person acquainted with stoves, sewing-machines, &c., can readily determine the origin of a very small part by referring it to its proper kind and make.

The application of this law of persistence presupposes a knowledge of the pattern as essential to its deductive application. Hence, a difficulty at once suggests itself as arising when a portion of an animal belonging to a new pattern is discovered. That patterns quite distinct from those known to zoölogists have existed in past ages has been well proven by paleontologists. How can the structures of a species of such a kind be inferred from a fragment? Another law equally true with that of persistence has been developed from the facts, but it is much more difficult of application. This is the one already defined by the writer[1] under the name of the law of "successional relation." It is absolutely certain that the types of nature, whether primary or subordinate, form series of steps passing from one condition of relations to another. The natural deduction is, that if a portion of an animal exhibits a form intermediate between two known forms or types, the remainder of the animal's structure possesses the same kind of intermediacy. This law is tacitly admitted, and employed by paleontologists; but there is a difficulty of application in consequence of the existence of other laws now to be considered.

The first difficulty arises from our possible ignorance of one terminus of the series or line in which our fossil represents a stage. This objection is more theoretical than real, because the living classes and orders are the structural extremes of the lines of succession; nevertheless, among divisions of lesser range, many have reached their culmination, and disappeared in times past. These points of culmination must be known in order to ascertain the direction of the succession. Every discovery, however, is not that of an advanced position on such lines; intermediate positions being necessarily more numerous than termini. Hence, this difficulty is of only occasional recurrence.

The preceding considerations all express different phases of the law of uniformity. I now refer to the law of variation, which is in apparent conflict with it. It is the law which expresses evolution as opposed to persistence of types. It especially limits the application of the last law, that of uniformity in succession; *i. e.*, that when one portion of structure occupies a position intermediate between two already known types, the remaining parts of the same animal or system of organs will occupy the same relation of structure to the corresponding parts of the known. This is not uniformly true. The law of variation intervenes, which states that it may occur that, while one part of an organization occupies a relation of intermediacy, the other parts do not exhibit exactly the same relation. It is by the unequal mingling of structural points that new lines of succession are marked out. Thus it is

[1] Penn Monthly Magazine, 1872, p. 229.

that the power of reconstruction from fragments is limited, but not sufficiently so as to justify the epithet "pretension," which has been applied to the claim made. Besides, two other laws remain, which are of great importance to the paleontologist.

Illustrations of the preceding laws may first be given. If a fragment of an animal be found, which contains a certain type of teeth known as the true selenodont, it is certain, in accordance with the law of uniformity of type, that the first bone of the hind foot of that animal (the astragalus) possessed two pulley-grooved faces, one above and one below, and not one only, as in most animals; also, that the lower pulley-face was succeeded by two subequal toes, and that the lateral toes were either reduced in form or wanting. There is no mechanical relation between the structures of the teeth and foot; their accordance is simply a fact of type of a selenodont Artiodactyle.[1] Again, if I find a portion of a foot which presents a joint between the first and second rows of bones which form the sole, I am absolutely certain that the animal had the two outer ear-bones external to the skull, forming a part of the lower jaw and the connecting-rod by which the latter is attached to the skull. This is a type-law of the bird and reptile. Again, if I find a part of a foot of the structure just named, where the first row of bones of the sole is united into one mass, and closely embraces the leg-bone without being continuously united, I know that I have an animal with teeth, with a very long hip-bone and a very long series of united vertebræ (or sacrum) resting upon it—in other words, a Dinosaurian.

The law of uniformity in successional relation is well illustrated by the genus *Loxolophodon*. The first bone of the foot (astragalus) of this animal exhibits characters intermediate between that of the elephants (*Proboscidia*) and odd-toed hoofed mammals (example, tapir); the remainder of the skeleton does the same; the neck-vertebræ are similar to those of the former, while portions of the skull resemble corresponding ones of the latter. The foot of a dinosaur is intermediate between that of a reptile and that of a bird; so are the sacrum and pelvis. The sternum of a frog of the family *Discoglossidæ* is intermediate between those of ordinary frogs and salamanders; so are the vertebræ and ribs.

Examples of the limitation of the latter rule are still more numerous. They may be produced from the three cases cited. Thus, in the dinosaur, it

[1] Represented by a Ruminant.

might once have been said that the jaws did not partake of the intermediacy, because they all present teeth, and are never smooth, like those of birds. Yet birds with teeth have recently been discovered, which deprives us of the use of this character as a definition. In the discoglossid frog, the cranium is not intermediate in structure between the frog and salamander, but is that of a frog. In the *Loxolophodon*, the toothless front of the upper jaw is not a general character of either of the orders between which it stands.

These difficulties arise from the existence of the subordinate variations or subtypes of a general or major pattern, and, for their resolution, require only a new application of the first law of uniformity on the lower plane. If the subcharacters defining the subpattern be known, the existence of one presupposes that of the others. The structure of an artiodactyle astragalus will not enable me to infer the character of the incisor-teeth of the animal; for this I require some other more minutely-correlated portion. So I can infer the ribs and vertebræ from the sternum of the discoglossid frog, but not the cranium; for this I require some part correlated with discoglossid characters only, and not only significant of the relations to the orders of Batrachians, as are the characters mentioned, although it happens, by the accident of discovery, that none but such frogs are known to possess them to-day.

The two laws which further aid the deductions of the paleontologist are those of mechanical relations and of embryonic parallelism. One structure requires another in order that an animal be viable. Thus, long legs in a grazer presuppose a long neck to enable it to reach the ground with its lips. Hooked claws presuppose carnassial teeth or a hooked beak. For a *horizontal* body to be properly poised on two legs instead of four, the weight of the viscera must be transferred backward, and the anterior regions of the body lightened. This we find to be the case with birds and *Dinosauria.* The lower bones of the pelvis, with the contained organs, are thrown backward, while the fore-limbs are lightened and the head reduced in proportionate (not absolute) size.

The parallelism of types with transient embryonic conditions of other types, aids the paleontologist essentially in the classification or proper location of a specimen. Its relation to known series must be first determined, as this obviously precedes in reconstruction all application of the law of uniformity. Such reference having been made, either to a new series or to a place in a known series, the considerations heretofore adduced come into view, but not sooner. Hence, the law of parallelism is as essential to the paleontologist, as it is all-pervading and all-expressive of nature itself.

II.

Paleontology in its relation to geology is as yet partially empirical. Thus, while its indications are definite for one locality, they have not identical significance for all localities on the earth's surface. The lower we descend in the scale of being, the more uniform over great areas are its phenomena; but, among higher animals, especially vertebrates, the greater the geographical peculiarities as compared with the stratigraphical. Professor Agassiz once said that the existing geographical faunæ are more distinct than the extinct faunæ of two consecutive epochs of geologic time; a statement justified by many facts. Hence, it has been believed by some, that fossil vertebrates cannot furnish conclusive evidence of the age of the rock-strata in which they occur; for, say they, we have to-day existing on the Australian continent, animals that approach more nearly to those found fossil in the Jurassic formations of Europe than to any now living on the latter continent; so that, were Australia to be presently submerged and her strata and fossils again brought to light, the paleontologist would assert that the sun had not shone on that land since the days of the Jura. And so he would were he not at the same time a zoölogist; just as the bare zoölogist would err in the opposite direction of assuming the modern age of the European Jurassic beds, because they contain the living types of Australia. Thus, a foundation-fact of zoölogy properly applied is essential to the paleontologist, namely, that the earth now presents four or more distinct faunal areas, the more prominent among which are the Australian, the South American, and the temperate lands of the northern hemisphere. Each of these possesses many peculiar forms of life not now found elsewhere. Has this distinction always prevailed? Paleontology answers decidedly in the affirmative, so far as extinct mammalia are concerned. There seems to be no doubt that the faunal distinctions have a very ancient origin, and are therefore to be first considered when estimating the age of strata from the contained mammalian remains. The explanation of this diversity is not yet attainable; but an important advance has been made by the discovery of the great similarity between the extinct forms of the northern hemisphere and the living or more modern ones of the southern hemisphere faunæ. The Jurassic character of much of the Australian fauna is known, while prevalent types of South America and Africa can be shown to have much relation to Eocene types of the north. In North America and Europe, tapirs, opossums, coatis, civets, kinkajous, lemurs, and allies of the toxodonts belong to the Eocene; now these animals characterize the southern continental life, or, as is the case with toxodonts, have but recently become extinct there. This mode of defining those faunæ is not, however, exact, since many modern types have found their way into them, especially in the case of Africa.

How, then, is life significant of chronological station in the earth's strata? Since very many forms of animals are so widely spread and at the same time so distinctly limited in range on the earth's surface to-day, the same order must have prevailed in past time, and have been of equal significance. That this law of uniformity has prevailed in the past as in the present is amply proven by the paleontology of a single zoölogical area taken by itself. The apparition of types over the northern land-area has been nearly universal. This fact has only been placed within our reach by modern investigations in North America; for, until the sister continent of Europe-Asia was explored, no one could be sure what degree of individual peculiarity her extinct life might present. Now it is certain that the succession of Tertiary beds was mutually similar, and that the contemporaneous deposits contained in a large degree similar life, and that intermediate stages of the one can be properly intercalated in the vacant interspaces of the other. The resemblances between the Lower Eocenes of New Mexico and Wyoming and that of France are marked; similarity between the Pliocenes of the respective continents is evident. Descending in the scale, the parallels between the North American and New Zealand Cretaceous are very apparent, and the faunæ of the Carolinian and Würtembergian Trias were the same. The interruptions in the record of life marked by the appearance of great land-areas near the close of the Carboniferous and Cretaceous periods are universally observed in the zoölogical areas of the northern hemisphere, or Arctogæa. The close of the Cretaceous everywhere saw the end of ammonites, rudistes, and sauropterygian and dinosaurian reptiles, in spite, in North America at least, of physical continuity of deposits.

Was this succession of interruptions of life universal over the globe, and do these trenchant lines justify the old assumption of repeated destructions and re-creations of animal life? The former question has already been answered in the negative by the explanation of the characters of the existing faunæ of the southern hemisphere, where ancient types still remain in considerable numbers. Moreover, some of the later periods of both North

America and Europe are characterized by a large predominance of forms of the corresponding southern continent. It is, indeed, evident that migration from the one continent to the other has taken place, and is amply sufficient to account for the abrupt changes in the life of each, without necessitating the intervention of creative acts. If glacial periods be dependent on cosmic movements, the increased obliquity of the earth's axis to the sun, at periods 25,000 years apart, due to the same causes as precession, would cause a corresponding alternation of cold periods in the opposite hemispheres. This is well known as a most potent cause of migration and extinction, and the known relations of the faunæ would thus result from a greater or less alternate invasion of the one hemisphere by the life of the other.

But within the great time-boundaries are distinct land-faunæ whose striking distinction may not thus be accounted for. Thus, the Miocene and Loup Fork faunæ of Western America are entirely distinct, but with corresponding members. The alternate presence and absence of water-areas adapted for the preservation of the remains of the animals will abundantly account for such minor interruptions. Such changing topography is well known as due to the slow vertical oscillations of the earth's crust.

The original question, the exactitude of the chronological significance of structural types, has been momentarily held in abeyance. Is paleontology a science so far exact as to furnish a chronological scale of terrestrial strata? The admission that the known Tertiary faunæ, for instance, are but fragments of a continuous succession, would appear to invalidate any such claim. It would indicate that the restriction of a given type to a given horizon is only a matter of discovery, and that another accident may at any time give it a new range. This objection has but little weight. Fragments though they be, nearly-related formations, as the Tertiaries, are obviously the visible portions of a serial succession of life. Like the bright lines in a spectrum, the order is not disturbed by the temporary obliteration of a part of the colors, but the visible portions indicate the relations of the component parts with infallible certainty. The more universal the physical interruption, the more far-reaching the break in the succession of life in any one locality, the greater is the significance of remains of animals as indication of relation in time. The change of faunæ in Arctogæa at the close of the Cretaceous is a case in point. A dinosaur, sauropterygian, ammonite, or rudist are as definite indicators of the life that preceded the change as a tapir or civet-like carnivore is of the age that followed.

It has been stated that the life of the present period in the southern hemisphere is not homogeneous. The same is true though in a less degree of the northern. Thus, if we include India in the latter, the elephant is a Pliocene form, and the true rhinoceros Upper Miocene. In the northern hemisphere, the dogs are Miocene. In North America, the opossum, and probably the raccoon, are Eocene; the wolves and foxes are Miocene, and the weasels Pliocene. Perhaps, the cats first appeared in our Pliocene. Comparatively few mammalian types mark, by their origin, the latest geologic epochs. Such are the ruminants, as deer, and oxen, with the true horses, which all commence in the Upper Pliocene of Arctogaea. Finally, man alone signalizes the last or glacial period, and is to reach his culmination in the ages that intervene between that great time-boundary and one to come.

Thus, a certain proportion only of the life of a given epoch is characteristic of it, that is, originates in it; the remaining members being legacies from preceding ages. Hence, the latest forms of life embraced in an extinct fauna are the true indicators of the chronological relations of that fauna.

PART I.

THE CLASSIFICATION AND DISTRIBUTION OF THE CRETACEOUS DEPOSITS.

Messrs. Meek and Hayden have classified the vast thickness of the Cretaceous formations of the West from observation of the section made by the Missouri River from near its sources to the point where it enters the Carboniferous strata of Eastern Kansas. This classification has been found by Dr. Hayden to be applicable to the exposures of the rocks of this period along the eastern base of the Rocky Mountains; and I may add that an examination of the western flank of the same mountain-region in New Mexico, conducted by myself, under direction of Lieut. G. M. Wheeler, United States Engineers,[1] has extended the application of the same system.

The classification of Messrs. Meek and Hayden embraces five distinct epochs, all of marine deposits. The lowest is a sandstone, which rests unconformably on Azoic, Carboniferous, Jurassic, or other beds, as the case may be: it is succeeded by a series of usually dark-colored shales or clays, or No. 2, which is overlaid by a gray, white, or yellow chalk or calcareous marl, which forms the surface-rock of a large area; this is No. 3. The superincumbent divisions, Nos. 4 and 5, consist of laminated shaly clays and sandy beds respectively. Above this point, the character of the deposits becomes brackish and lacustrine, constituting an approximation to the overlying Tertiary formations. This physical change has been regarded by the stratigraphers as the boundary-line between the Cretaceous and Tertiary periods; and the indications derived from the vegetable fossils are not inconsistent with such a view. The vertebrate paleontology, on the other hand, shows the interruption in that kind of animal life to have taken place much higher up in the series; hence, in the present work, the Lignite, or Fort Union, epoch is included in the Cretaceous formations as No. 6.

[1] See Appendix F F 3 of Annual Report of the Chief of Engineers, Washington, 1874.

I.—THE DAKOTA EPOCH.

The sandstones of this division are light-brown, buff, or white, moderately soft or very hard, and varied with occasional conglomerates. They are extensively developed on the Missouri, reaching 1,500 to 2,000 feet in depth. They appear all along the eastern flank of the Rocky Mountains, and on the west side of the Sierra Madre or San Juan. No vertebrate fossils have yet been obtained from them.

II.—THE BENTON EPOCH.

This formation embraces dark, lead-colored shales and clays, and is found lying on the preceding in most regions where it occurs. It includes many mollusks, some of which are identical with those of No. 3. Among these are *Ostrea congesta* and *Inoceramus problematicus.* Four vertebrate species have been defined from the numerous remains discovered, viz: *Lamna ? cuspidata,* a shark; *Pelecorapis varius,* an ally of the flying-fish; *Apsopelix sauriformis,* a related fish; and *Hyposaurus vebbii,* a gavial-like crocodile.

III.—THE NIOBRARA EPOCH.

The exposures of this formation have a wide area between the Carboniferous and Lower Cretaceous beds of the east of the plains and the Rocky Mountains, and in Texas and Eastern New Mexico. Vertebrate fossils are very abundant, and I have received them from Kansas, Colorado, Texas,[1] and New Mexico. The following description is from the notes of my Kansas expedition of 1871:

"The geology of the regions marked by this formation is quite simple. The following description of the section along the line of the Kansas Pacific Railroad will probably apply to similar sections north and south of it. The formations referable to the Cretaceous period on this line are the Dakota, Benton, and Niobrara groups, or Nos. 1, 2, and 3. According to Leconte,[2] at Salina, one hundred and eighty-five miles west of the State line of Missouri, the rocks of the Dakota group constitute the bluffs, and continue to do so as far as Fort Harker, thirty-three miles farther west. They are "a coarse,

[1] From this region from Dr. A. R. Roessler.

[2] Notes on the Geology of the Survey for the Extension of the Union Pacific Road, Eastern Division, from the Smoky Hill to the Rio Grande. By John L. Leconte, M. D., Philadelphia, 1868.

brown sandstone, containing irregular concretions of oxide of iron," and numerous mollusks of marine origin. Near Fort Harker, certain strata contain large quantities of the remains (leaves, chiefly) of dicotyledonous and other forms of land-vegetation. Near this point, according to the same authority, the sandstone-beds are covered with clay and limestone. These he does not identify, but portions of it from Bunker Hill, thirty-four miles west, have been identified by Dr. Hayden as belonging to the Benton, or second, group. The specimen consisted of a block of dark bluish-gray clay-rock, which bore the remains of the fish *Apsopelix sauriformis*, Cope. That the eastern boundary of this bed is very sinuous is rendered probable by its occurrence at Brookville, eighteen miles to the eastward of Fort Harker, on the railroad. In sinking a well at this point, the same soft, bluish clay-rock was traversed; and, at a depth of about thirty feet, the skeleton of a saurian of the crocodilian order was encountered, the *Hyposaurus vebbii*, Cope.

"The boundary-line, or first appearance, of the beds of the Niobrara division has not been pointed out; but, at Fort Hays, seventy miles west of Fort Harker, its rocks form the bluffs and outcrops everywhere. From Fort Hays to Fort Wallace, near the western boundary of the State, one hundred and thirty-four miles beyond, the strata present a tolerably uniform appearance. They consist of two portions: a lower, of bluish calcareo-argillaceous character, often thin-bedded; and a superior, of yellow and whitish chalk, much more heavily-bedded. Near Fort Hays, the best section may be seen at a point eighteen miles north, on the Saline River. Here the bluffs rise to a height of two hundred feet, the yellow strata constituting the upper half. No fossils were observed in the blue bed; but some moderate-sized *Ostreæ*, frequently broken, were not rare in the yellow. Half-way between this point and the fort, my friend N. Daniels, of Hays, guided me to a denuded tract, covered with the remains of huge shells described by Mr. Conrad, at the close of this section, under the names of *Haploscapha grandis* and *H. eccentrica.* They may have affinities to the oysters; some of them were 27 inches in diameter. They exhibited concentric obtuse ridges on the interior side, and one species a large crest behind the hinge. Fragments of fish-vertebræ of the *Anogmius* type were also found hereby Dr. J. H. Janeway, post-surgeon. These were exposed in the yellow bed. Several miles east of the post, Dr. Janeway pointed out to me an immense accumulation of *Inoceramus problematicus* in the blue stratum. This species also occurred in abundance in the bluffs west of the fort, which were composed of the blue bed, capped by a thinner layer of the yellow. Large globular or compound globular argillaceous concretions coated with gypsum were abundant at this point.

"Along the Smoky Hill River, thirty miles east of Fort Wallace, the south bank descends gradually, while the north bank is bluffy. This, with other indications, points to a gentle dip of the strata to the northwest. The yellow bed is thin or wanting on the north bank of the Smoky, and is not observable on the north fork of that river for twenty miles northward, or to beyond Sheridan station on the Kansas Pacific Railroad. Two isolated hills, 'The Twin Buttes,' at the latter point, are composed of the blue beds, here very shaly, to their summits. This is the general character of the rock along and north of the railroad between this point and Fort Wallace.

"South of the river, the yellow strata are more distinctly developed. Butte Creek Valley, fifteen to eighteen miles to the south, is margined by bluffs of from twenty to one hundred and fifty feet in height on its southern side, while the northern rises gradually into the prairie. These bluffs are of yellow chalk, except from ten to forty feet of blue rock at the base, although many of the cañons are excavated in the yellow rock exclusively. The bluffs of the upper portion of Butte Creek, Fox and Fossil Spring (five miles south) Cañons are of yellow chalk; and the reports of several persons stated that those of Beaver Creek, eight miles south of Fossil Spring, are exclusively of this material. Those near the mouth of Beaver Creek, on the Smoky, are of considerable height, and appear, at a distance, to be of the same yellow chalk.

"I found these two strata to be about equally fossiliferous, and am unable to establish any paleontological difference between them. They pass into each other by gradations in some places, and occasionally present slight laminar alternations at their line of junction. I have specimens of *Empo semianceps*, Cope, from both the blue and yellow beds; and vertebræ of the *Platecarpus glandiferus*, Cope, were found in both. The large fossil of *Liodon dyspelor*, Cope, was found at the junction of the beds, and the caudal portion was excavated from the blue stratum exclusively. Portions of it were brought east in blocks of this material, and these have become yellow and yellowish on many of the exposed surfaces. The matrix adherent to all the bones has become yellow. A second incomplete specimen, undistinguishable from this species, was taken from the yellow bed.

"As to mineral contents, the yellow stratum is remarkably uniform in its character. The blue shale, on the contrary, frequently contains numerous concretions, and great abundance of thin layers of gypsum and crystals of the same. Near Sheridan, concretions and septaria are abundant. In some places, the latter are of great size, and, being imbedded in the stratum, have suffered denudation of their contents, and the septa, standing out, form a huge honey-comb. This region, and the neighborhood of Eagle Tail, Colorado, are noted for the beauty of their gypsum-crystals, the first abundantly found in the Cretaceous formation. These are hexagonal-radiate, each division being a pinnate or feather-shaped lamina of twin rows of crystals. The clearness of the mineral and the regular leaf and feather forms of the crystals give them much beauty. The bones of vertebrate fossils preserved in this bed are often much injured by the gypsum-formation, which covers their surface, and often penetrates them in every direction.

"The yellow bed of the Niobrara group disappears to the southwest, west, and northwest of Fort Wallace, beneath a sandy conglomerate of uncertain age. In color, it is light, sometimes white; and the component pebbles are small and mostly of white quartz. The rock weathers irregularly into holes and fissures, and the soil covering it is generally thin and poor. It is readily detached in large masses, which roll down the bluffs. No traces of life were observed in it; but it is probably the eastern margin of the southern extension of the Miocene Tertiary stratum. This is at least indicated by Dr. Hayden in his Geological Preface to Leidy's Extinct Mammals of Dakota and Nebraska.

"Economically, the beds of the Niobrara formation possess little value except when burned for use as a fertilizer. The yellow chalk is too soft in many places for large buildings, but it will answer well for those of moderate size. It is rather harder at Fort Hays, as I had occasion to observe at their quarry. That quarried at Fort Wallace does not appear to harden by exposure; the walls of the hospital, noted by Leconte on his visit, remained in 1871 as soft as they were in 1867. A few worthless beds of bituminous shale were observed in Eastern Colorado.

"The only traces of glacial action in the line explored were seen near Topeka. South of the town are several large, erratic masses of pink and bloody quartz, whose surfaces are so polished as to appear as though vitrified. They were transported, perhaps, from the Azoic area near Lake Superior."

The following species of *Vertebrata* have thus far been detected in the Niobrara formation:

Pachyrhizodus kingii.
Pachyrhizodus leptopsis
Pachyrhizodus sheareri.
Tethcodus pephredo.
Enchodus petrosus.
Enchodus dolichus.
Enchodus anceps.
Enchodus calliodon.
Enchodus shumardii.
Phasganodus dirus.
Phasganodus gladiolus.
Phasganodus carinatus.
Empo nepæolica.
Empo semianceps.
Empo contracta.
Empo merrillii.
Stratodus apicalis.

b. ELASMOBRANCHII.

Ptychodus janevaii.
Ptychodus polygyrus.
Ptychodus occidentalis.
Ptychodus mortonii.
Ptychodus whippleyi.
Galeocerdo crassidens.
Galeocerdo hartwellii.
Otodus divaricatus.
Oxyrhina extenta.
Lamna cuspidata.
Lamna mudgei.
Lamna macrorhiza.................................... 48

Total number of species.............................. 89

Of the preceding forty-eight species of fishes, the greater part are physostomous *Actinopteri;* and there is no species of a physoclystous family in the list. No trace of spines or scales of fishes of the latter character have been yet discovered in strata of this period in the West, though one (*Beryx* *insculptus*, Cope) has been discovered by Dr. Lockwood in the greensand-marl of New Jersey (No. 5).

In the second place, it is of importance to observe that the genera have nearly all been obtained from the chalk of Europe. *Portheus* is represented, perhaps, by some specimens referred to *Hypsodon;* one species of *Ichthyodectes* is figured by Dixon from Sussex, and one of *Cimolichthys*, *Erisichthe*, and *Pachyrhizodus*, each. *Enchodus* has long been known from Holland, &c., *Apsopelix* and *Stratodus* being, so far, the only ones not found in Europe. This is of much interest in every aspect, and points to the synchronism, as generally understood, between the chalk-formations of Kansas and of England.

Species of *Mollusca* are not numerous in the beds of the Niobrara epoch. They consist chiefly of *Inocerami* of two or more species. Through the kind assistance of my friends, N. Daniels of Hays, and Dr. J. H. Janeway, post-surgeon at Fort Hays, I was enabled to procure from the yellow chalk a number of very complete specimens of the remarkable shells already mentioned. I submitted them to my colleague, T. A. Conrad, and add herewith his account of them. He thinks they possess some resemblance to the *Rudistes;* but he doubts their being truly related to that division.

Fragments of these *Haploscaphæ* are common in the formation, and have been described by authors as portions of huge *Inocerami.*

"HAPLOSCAPHA, Conrad.

"Shell subovate or subtriangular; hinge long and straight, edentulous, oblique; curved, prominent ridges occupy the upper portion of the interior, the ridges beginning and ending at a distance from the margins of the shell; a singular twisted callus composes the hinge, the back of which is transversely ribbed.

"H. GRANDIS, Conrad.

"Length greater than height; hinge-line very long; ridges concentric, about twelve in number, extending into the cavity under the hinge.

"This shell, Professor Cope informs me, has been found 27 inches in diameter. The posterior side of the right valve is elongated and dilated, and the form of the shell is not unlike that of *Meleagrina.* The substance is fibrous, or rather columnar, and much resembles that of *Caprinella*, as figured by d'Orbigny, except that the fibers are transverse. The exterior is always concealed by a coating of rock and a crowded mass of *Ostrea congesta*, and, in some specimens, they line the cavity of the shell; the submargin is thick. No muscular impression can be traced, unless the ridged part indicates its station.

"Subgenus CUCULLIFERA.

"Shell with an upright hood-shaped process on the posterior end of the hinge.

"H. ECCENTRICA, Conrad.

"Ovato-triangular; hinge-line short, very thick; concentric ridges profound, six in number; hood strongly and irregularly plicated; cavity profound.

"This shell, with the same structure of substance as the preceding, is very unlike it in form, and is represented by one valve only, while a number of the preceding species were found. In all specimens of the two forms, the right valve only was obtained. Whether it is allied to the family *Rudistes* of Lamarck is a question I leave for others to decide. On the margin of one of the valves are attached some small shells, resembling *Hippurites*, and the fibers of which the shell is composed lie in broken masses on some valves, and even scattered like piles of pins.

"The hood of *H. excentricus* is 2½ inches in height, and the height of the valve 10 inches; length, 9 inches.

"Accompanying these fossils were many specimens of *Inoceramus problematicus*, and a fragment of an undetermined species of the same genus."

IV.—PIERRE GROUP.

In Nebraska and Dakota and Middle Colorado, south of the divide between the waters of the Arkansas and Platte Rivers; also, the lower bed of greensand of New Jersey; Weber River, Wyoming,[1] below the coal. Besides the numerous remains of reptiles and fishes found in NewJersey, this formation contains saurian (mosasauroid) remains in Colorado.

V.—THE FOX HILLS GROUP.

Extended in Central Dakota; on the Arkansas and tributaries; in Southern Colorado; and as the second greensand bed in New Jersey.[2]

[1] Hayden's Annual Report, 1870, p. 167.

[2] For a synopsis of the extinct *Reptilia* of this epoch and the preceding, see the author's "Extinct Batrachia," &c., N. America, Philadelphia, 1869–'70.

VI.—THE FORT UNION OR LIGNITE GROUP.

With this epoch we enter debatable ground, and begin to consider strata deposited in brackish or fresh waters, which were more or less inclosed by the elevation of parts of the Rocky Mountains and other western regions, and which are, therefore, more interrupted in their outlines than the marine formations which underlie them. Dr. Hayden has recognized and located a number of formations of this character, to some of which he has applied the name of "transition-beds." That the period of their deposit was one of transition from marine to lacustrine conditions is evident; and that a succession of conformities in position of beds may be traced from the lowest to the highest of them, and with the Tertiary strata above them at distinct localities, beginning at the south and extending to the north, is also proven by Hayden and others. It appears impossible, therefore, to draw the line satisfactorily without the aid of paleontology; but here, while evidence of interruption is clear, from the relations of the plants and vertebrate animals, it is not identical in the two cases, but discrepant. I therefore append a synopsis of the views expressed by authors, with a presentation of the evidence which is accessible in my department.

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

No vertebrate remains having come under the author's notice from the Placer Mountain and Cañon City formations, no further notice can be here taken of them beyond the statement that they are, as Meek indicates, of Cretaceous age, not far removed from the horizon of the coals of Weber River, Utah. The presence of ammonites and baculites above and below them had already indicated such a conclusion to Leconte,[2] as it has in the case of the

[1] Geological Survey of Colorado, 1869, p. 90.

[2] Report on the Geology of the Smoky Hill Pacific Railroad route, 1868, p. 66.

Weber River beds to Dr. Hayden.[1] To near the same horizon are perhaps to be referred the coal observed by Professor Marsh[2] on the south side of the Uintah Mountains in Utah, which were overlaid by strata containing *Ostrea congesta.* This may, indeed, be referred to a still older period, as that oyster is characteristic of No. 3, according to Meek and Hayden. The Placer Mountain and Cañon City groups are nearer to No. 5, but the precise relation to it has not yet been determined. I therefore proceed to the proper and original *Fort Union epoch* as defined by Hayden.

This extended deposit is stated by Hayden[3] to extend from the Missouri Valley to Colorado, passing under Tertiary beds by the way. That this is the case has been confirmed by the researches conducted in the northern and eastern portions of Colorado during the season of 1873 by the writer.[4] I present comparative lists of the vertebrate species known from the Platte and Missouri Valleys in the respective Territories.

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

The identity and correspondence of the species in the two columns indicate that these remote localities contain the remains of the same fauna. Further, the presence of *Dinosauria* and *Sauropterygia* demonstrates its mesozoic character.

A number of vertebrate remains was collected by George W. Dawson,

[1] Annual Report, 1870, p. 168.

[2] See an interesting article by Prof. O. C. Marsh on the Geology of the Eastern Uintah Mountains in the American Journal of Science and Arts for March, 1871.

[3] Annual Report Colorado, 1869, p. 89.

[4] See Bulletin of the United States Geological Survey, No. 1, 1874, p. 10.

of Montreal, geologist of the British American Boundary Commission, near the line of the northern boundary of the United States (latitude 49°), within the drainage-area of the Milk River. The formations are regarded by him as belonging to the Lignite or Fort Union of Dr. Hayden, and consist of greenish and greenish-brown arenaceous clays of various degrees of hardness, frequently including small gravel-stones, and sometimes forming a hard cement between them. The fossils were found near the base of the formation, and "not more than one or two hundred feet above yellow arenaceous beds, which I conceive represent Cretaceous No. 5, and which are rapidly followed in descending by well-marked No. 4 with characteristic fossils." (Extracted from letter of Mr. Dawson.)

The species are the following: *Clastes*, sp.; *Compsemys ogmius; C. ? victus; Plastomenus costatus;*[1] *P. coalescens; Trionyx ?vagans; Trionyx ?*sp.; *? Hadrosaurus ?*sp.; *Cionodon stenopsis.*

The dinosaurian remains are quite abundant, and indicate several species, but are mostly so fragmentary as to be unfit for determination. The diagnostic genera of this list are *Compsemys*, *Plastomenus*, and *Cionodon;* the species referred to *Hadrosaurus* being represented by caudal vertebræ only. The first-named genus is characteristic of the Fort Union epoch only; the fragment referred to *C. victus*, the only species of the list previously known, is too small for final specific reference. The *Plastomenus coalescens* is represented by a more perfect specimen than any other species referred to this genus from the Fort Union beds, but is not sufficiently complete to render the reference to this Eocene genus final. It is, in any case, not a member of any other known genus. One species of *Trionyx* is represented by a hyosternal bone, and is not definable; while the fragment referred to *T. vagans*, though closely resembling that species, is not large enough for final determination. The *Cionodon,* though based on incomplete remains, is quite sufficient for paleontological purposes.

In conclusion, it may be stated that there are present two genera in this collection which are diagnostic of the Fort Union epoch, but no species certainly so, though two species are probably identical with species of that epoch; also, that the presence of *Dinosauria* refers the fauna to the Mesozoic series; and that there is no satisfactory evidence of the co-existence of these reptiles

[1] Two species are provisionally referred to the Tertiary genus *Plastomenus*, but are too fragmentary for final determination.

with Tertiary forms; that the species referred to *Plastomenus* constitute an indication of affinity with corresponding Eocene forms. The presence of garfishes of the genus *Clastes* in this formation is as yet peculiar to this and the Judith River localities. As these gars have not heretofore been found in North America below the Eocene, they constitute the first case of apparent commingling of Tertiary and Cretaceous animal life yet clearly determined. Yet the evidence is far from being as weighty in indication of Tertiary relations as is the presence of the saurians in question as evidence of Mesozoic character; for the gars, though now living, are an ancient type, their allies having swarmed in the Jurassic seas, and it is therefore altogether reasonable that they should be found in fresh-water deposits of Cretaceous and Tertiary age. The rarity of the former deposits accounts for the late date of their discovery there.

The longest known of these transitional faunæ was discovered by Dr. Hayden near the mouth of Judith River, in Montana. As determined by Dr. Leidy, it embraces the following *Vertebrata: Hadrosaurus mirabilis; Palæoscincus costatus; Troödon formosus; Aublysodon horridus; Bottosaurus? humilis; Trionyx foveatus; Clastes occidentalis* (*Lepidotus*, Leidy); *Lepidotus haydenii.*

The first four species of this list are *Dinosauria*, and hence diagnostic of the Mesozoic age of the formation. The *Clastes* indicates relation to the Milk River fauna.

That the Judith River formation is Cretaceous would appear to have been the suspicion of Messrs. Meek and Hayden when they originally described the deposit and its invertebrate fossils. Leidy suspected that the species "indicate the existence of a formation like that of the Wealden in Europe."[1] Meek and Hayden[2] remark: "We are inclined to think with Professor Leidy that there may be, at the base of the Cretaceous system, a fresh-water formation like the Wealden. Inasmuch, however, as there are some outliers of fresh-water Tertiary in these lowlands, we would suggest that it is barely possible these remains may belong to that epoch." From the standpoint of the writer, these beds would be at the top of the Cretaceous, and more or less related to the Fort Union epoch. Mr. Meek expresses himself[3] cautiously with reference to the age of the Fort Union and Judith River formations, as follows:

[1] Proceedings of the Academy of Natural Sciences. Philadelphia, 1856, p. 73.
[2] *L. c.*, 1856, p. 111.
[3] Hayden's Annual Report for 1872, p. 460.

"The occurrence of [fossils specified] at the Judith River localities would certainly strongly favor the conclusion, not only that this Judith formation, the age of which has so long been in doubt, is also Cretaceous, but that even the higher fresh-water Lignite formation at Fort Clark and other Upper Missouri localities may also be Upper Cretaceous instead of Lower Tertiary. That the Judith River beds may be Cretaceous I am, in the light of all now known of this region of the continent, rather inclined to believe. But it would take very strong evidence to convince me that the higher fresh-water Lignite series of the Upper Missouri is more ancient than the Lower Eocene. That they are not is certainly strongly indicated not only by the modern affinities of their molluscan remains, but also by the state of preservation of the latter."

I presume it is now apparent that the presence of the orders *Sauropterygia* and *Dinosauria* establishes, conclusively, the Mesozoic and Cretaceous character of this fauna. This reference was made by the writer in 1869, and was, at that time, opposed to the views extant, both geological and paleontological. The following list exhibits the state of opinion on this point at that time and subsequently.

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

Meek and Hayden, *l. c.*, p. 265; Lignite, referred to the Miocene.

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

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

Leidy, *l. c.*, p. 89; *Ischyrosaurus* referred to the *Mammalia* as a sirenian.

1860. Hayden, Transactions of the American Philosophical Society, p. 123; repeats former conclusions; Leidy refers *Thespesius* more decidedly to the *Sauria*, and questions relations of *Ischyrosaurus.*

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

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

1869. Cope, Transactions of the American Philosophical Society, pp. 40, 98, 243; supposed mammalian remains proven to be reptilian, and the formation referred to the Cretaceous.

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

1874. Dawson, Report of Progress of the British North American Boundary Commission: on the Tertiary Lignite Formation, p. 20; Milk River beds regarded as lowest American Tertiary.

Cope, Bulletin of the United States Geological Survey of the Territories, No. 2 (April); Fort Union beds of Colorado referred to the Cretaceous.

1875. Cope, Proceedings of the Academy of Natural Sciences, Philadelphia (January); Milk River beds regarded as Cretaceous.

From the above, it appears that both paleontologists and stratigraphers, excepting the writer, have maintained the Tertiary age of the beds of the Fort Union epoch.

Whether the Bitter Creek and Bear River groups of Hayden present much difference of horizon remains to be determined. For the present, they are retained as distinct.

VII.—THE BITTER CREEK SERIES,

mentioned by the writer as a distinct group, in the Proceedings of the American Philosophical Society, 1872 (published on August 12), is apparently regarded by Mr. Meek also as representing a distinct epoch.[1] He says, "The invertebrate fossils yet known from this formation are, in their specific relations, with possibly two or three exceptions, new to science, and different from those yet found either at Bear River, Coalville, or indeed elsewhere in any established horizon, so that we can scarcely more than conjecture, from their specific affinities to known forms, as to the probable age of the rocks in which we find them." On this account, and because of the great stratigraphical differences exhibited by the Bear River and Evanston coal-strata, I have followed Hayden in regarding the Bear River group, on the west side of the Bridger basin, as representing a distinct series of rocks, with present knowledge. On this account I omit, as heretofore, allusion to determinations

[1] Hayden's Annual Report for 1872, pp. 459–461; published April, 1873.

of age of the latter formation as irrelevant in discussing the age of the Bitter Creek epoch.[1]

My own observations on the relations of these rocks, made during the summer of 1872, have been, in a measure, anticipated by the detailed reports of Messrs. Meek and Bannister,[2] which, with the older observations of Dr. Hayden and Mr. Emmons (of King's survey), leave little to be added. However, as none of these gentlemen paid especial attention to the vertebrate paleontology, the bearing of this department in relation to the stratigraphy remains to be explained.

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

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

[2] See Hayden's Annual Report for 1872, pp. 457, 525.

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

A section, carried for eight miles south of Black Butte station, exhibits the relation of the Bitter Creek series to the superincumbent Tertiaries very instructively. The whole series rise slightly to the southward, and more distinctly to the westward, so as to form an escarpment as the eastern border of an open valley, which extends south from the railroad, just west of the station. The heavy bed of sand-rock is here, as elsewhere, the landmark and stratigraphical base-line. Moving south from the railroad, we keep along the strike of the lower coal-beds. Just above the sand-rock, the softer stratum thickens, and six miles from the station is covered with the *débris* of immense numbers of *Leptesthes crassatelliformis.* Passing over the edges of the strata, toward the southeast, I counted eight beds of coal, separated by various short intervals, the eighth being the heaviest, and five or six feet thick. Above this one, three thin beds of lignite were crossed in succession, each accompanied with an abundance of leaves of chiefly dicotyledonous plants. Then came the ninth bed of coal, and then, in order, three more beds of lignite, with abundant leaves. During this time the ascent became less steep, and a number of short, level tracts were passed before reaching the upper bed of lignite. Beyond this, I passed another short flat, which was marked by a number of worn banks of the light-ash color that distinguishes the material of the bluffs of the Green River Tertiary which overlie the coal-series near Rock Springs. I had not ridden a quarter of a mile before reaching a low line, from which one of my men picked up a jaw of a small mammalian, allied to the Bridger *Hyopsodus* or to *Hyracotherium* of the Eocene of France and Switzerland, and a number of *Paludina*-like shells. I had thus reached the summit of the Bitter Creek formation, which did not appear to be much more than 350 feet above its base at the railroad. In full view, a mile or two to the south, rose the first of the benches which constitute the horizons of the Green River formation. Between this and the first mammal-producing bed, just described, rose three banks, one beyond the other, measuring, altogether, 120 feet; perhaps the lowest was 10 feet above the first bank, and this one not more elevated above the last lignite and leaf-bed. In all of these I found bones of Green River *Vertebrata* exceedingly abundant, but all dislocated and scattered, so as to be rarely in juxtaposition. These consisted of the following species: Fishes: *Clastes ? glaber;* Reptiles: *Emys megaulax; E. pachylomus; E. euthnetus; Trionyx scutumantiquum; Alligator heterodon;* Mammals: *Orohippus vasacciensis;* and fragments too imperfect for determination.

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

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

At a short distance to the southward, another line of white bluffs extends across the line of travel. This is not more elevated than the preceding one. I only found remains of tortoises on it. Several miles to the south we reach another bench, whose bluffy face rises four or five hundred feet in buttress-like masses, interrupted at regular intervals by narrow terraces. This line is distinguished for its brilliantly-colored strata extending in horizontal bands along the escarpment. They are brilliant cherry-red, white, true purple with a bloom shade, yellow, and pea-green, forming one of the most beautiful displays I ever beheld. The lower portions are bright-red, which color predominates toward the west, where the bluffs descend to a lower elevation. I found on them remains of a turtle (*Emys euthnetus*, Cope) and some borings of a ? worm in a hard layer. On top of these are clay and slate rocks of a muddy-yellow color, with their various ledges rising to perhaps two hundred feet. Continuing now to the southeastward, along the old stage-road, we cross South Bitter Creek at the old Laclede station. Some miles south and east of this point, a band of buff sandstones form a bluff of fifty or more feet in elevation. Below it lie more white or ashen beds, which contain remains of mammals and turtles, rather decayed. A short distance beyond these, and forty miles from Black Butte station, we reach the base of the enormous pile of sediment which I have called the Mammoth Buttes. These form a horse-shoe-shaped mass, the concavity presenting south and eastwardly, the summit narrow, serrate, and most elevated to the east, and descending and widening toward the south. I estimated the height of the eastern end to be at least one thousand feet above the plain surrounding it. Numerous mammalian remains[1] demonstrated that this mass is a part of the Bridger Eocene; although, as Mr. Emmons, of King's survey, informs me, no continuous connection with the principal area west of Green River can be traced. The total thickness of the Green River and Bridger formations on this section cannot be far from two thousand five hundred feet, at a very rough estimate.

The point of transition from the Cretaceous to the Tertiary deposits, as indicated by the vertebrate remains, is then in the interval between the last plant-bed at the summit of the buff mud-rocks and the mammal-bone deposit in the lowest of the ash-gray beds. Below this line, the formation must be accounted as Cretaceous, on account of the presence of the dinosaurian *Agathaumas sylvestris*, and those above it, as I have already pointed out, Eocene,[2] on account of the types of *Mammalia* contained in them.

The authorities on the Bitter Creek formation have presented views more or less at variance with those entertained by the writer, or of such a dubious character as to fall very far short of the requirements of evidence. Dr. Hayden has regarded them as Tertiary and as transitional from Cretaceous to Tertiary. Mr. King, in his very fall article on the Green River Basin, definitely refers the lower part of the series to the Cretaceous, in the following language:[3] "We have then here the uppermost members of the Cretaceous series laid down in the period of the oceanic sway, and quite freely charged

[1] See the Monster of Mammoth Buttes, Penn Monthly Magazine for August, 1873.

[2] On *Bathmodon*, an extinct genus of Ungulates, February 16, 1872, Hayden's Annual Report (1872), p. 431; Annual Report for 1872, p. 645.

[3] Exploration of the Fortieth Parallel, p. 458.

with the fossil relics of marine life; then an uninterrupted passage of conformable beds through the brackish period up, till the whole Green River basin became a single sheet of fresh water." He regards the line of the upper bed of oysters as the summit of the Cretaceous, and the superimposed beds as Tertiary, in the following language (page 453): "while the fresh-water species which are found in connection with the uppermost coal-beds seem to belong to the early Tertiary period." He thus places the line some distance within what I have regarded as the Cretaceous boundary.

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

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

In a paper on the age of these beds, published August 12, 1872, the writer asserted the Cretaceous age of the series. On this, Dr. Bannister, the companion of Mr. Meek, writes[1] "that Mr. Meek, and, I believe, Mr. Emmons also, had considered that these beds might be Cretaceous; but this was rather on account of the change in the fossil fauna from purely fresh-water, as in the characteristic Tertiary of this region, to brackish-water marine, and the specific affinities of a few of the fossils to California Cretaceous species, than from any very positive evidence. As far as I know, the only evidence of this kind is in the identification by Professor Cope of the saurian remains found by us at Black Butte."

It only remains to observe that the strata and coal of the Bitter Creek

[1] Annual Report for 1872, p. 524.

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

VIII.—THE BEAR RIVER GROUP,

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

The beds of the Green River epoch dip gently from the point where my last notes left them, near to Rock Spring station, toward the northwest, all the way to Green River. The upper strata become slaty in character, and descend to the water-level at the river, where they form a high bluff. In these slates occur the fish-beds discovered by Dr. Hayden, as well as the insect-beds noticed by Messrs. Denton and Richardson. They are worn into towers and other picturesque forms at Green River City (see Hayden's Annual Report for 1870). Passing north from the railroad, up the valley of Green River, the slates display a gentle dip to the north, and eighteen miles beyond have disappeared from view. On both sides of the river huge mesas of the Bridger formation come into view; those on the east extending to the

[1] See Hayden's Annual Report for 1870; Marsh, American Journal of Science and Arts, March, 1871.

Big Sandy River, and those on the west to Ham's Fork. At Slate Creek, further to the north twenty miles, a yellowish-brown sandstone rises into view, and continues to increase in importance toward the north. At the mouth of Fontanelle Creek, it rises on the east side of the river to a height of perhaps 250 feet, but sinks toward the north and east, from near the mouth of Labarge Creek, fifteen miles up the river. North of Labarge, a similar bed of sandstone rises again, and is immediately overlaid by white shales, resembling those of the Green River epoch, which have here a great thickness. Opposite the mouth of the Labarge, their lower strata are bright-red; but, on the west side of the river, the sandstone only is visible. All the beds rise to the north; the red beds forming the summits of the cliffs in that direction.

In passing up Fontanelle Creek to the westward, the heavy beds of buff sandstone gradually descend, and the white shales come into view. I examined the former for lignite and coal, but found none. There are several thin beds of a tough, carbonaceous material in the white shales (which I take to be of the Green River epoch). In the lower strata in this locality, as well as on the east side of Green River above the mouth of Labarge Creek, are numerous remains of fishes similar to those of Green River City, with insects and their larvæ, shells like *Pupa* and *Cyrena*, and millions of *Cypris*. The larvæ are dipterous, some nearly an inch long, and others minute and in prodigious numbers. With them are found stems of plants, but no leaves. These beds rise with a very gentle dip, and, twenty miles from the mouth of the creek, terminate against steeply-inclined strata of earlier age. At this point the lower beds exhibit the bright-red colors that are so often seen in the lower part of the formation at other points. The uplifted beds form a ridge of high hills, having a north by east and south by west trend, across which the Fontanelle cuts its way in a deep cañon. This range is monoclinal; the strata dipping 45° east, and their outcrop on the summit and western face. The first bed which forms the surface of the incline is rather thin, and is composed of a reddish quartzite without fossils, no doubt of Cretaceous age. Below it is a stratum of highly fossiliferous bluish limestone of Jurassic age, containing *Pentacrinus asteriscus*, M. and H.; *Trigonia*, &c. Below this, a reddish sandstone presented a similar thickness, which may represent the Trias, which rests on a bluish-shale formation. We have now reached the base of the western side of the hills; from their summit, we have had a beautiful and interesting view of geological structure. The valley, of three or four miles in width, is bounded on the west side by a range of low mountains, whose summits are well-timbered. The valley is excavated at an acute angle to the strike of the strata, so that, as far as the eye can reach to north and south, successive hog-backs issue, *en échelon*, from the western side, and run diagonally, striking the eastern side many miles to the southward. At the cañon of the Fontanelle, six of these hog-backs occupy the valley, and the number varies as we proceed down the valley. The structure changes from the same cause, as we explore in either direction. The dip of all these hog-back strata is, to the west and slightly north, less steep at the eastern side, but reaching 45°, and a still higher angle at the middle and west side of the valley. There appears to be an anticlinal near the base of the eastern range, which has been deeply excavated; from its western slope (in the valley), the upper beds, seen in the eastern range, have been carried away, leaving only probable Triassic and Carboniferous strata exposed. In one of the latter, I found a well-marked horizon of carbonaceous shales, extending as far as I explored them. Toward the western side of the valley, the descending strata are sandstones, but, whether identical with that of the eastern hills of Cretaceous age, I could not ascertain. Lower down the valley (to the south), similar beds form a high, vertical wall of very light color, the scenery resembling that of the Garden of the Gods in Colorado. I suspect that the existence of more than one fold can be demonstrated in these hog-backs and mountains.

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

The Ham's Fork Mountains form the divide between the waters of Green and Bear Rivers, respectively, and is passed by the Union Pacific Railroad at and west of Aspen station, as is described by Dr. Hayden (Annual Report for 1870, p. 149). He here points out that the distinctness of the two basins was marked during the Tertiary period, and hence names the deposits of the western area the Wahsatch group, regarding it, at the same time, as synchronous with those of the Green River epoch. The writer has attained the same opinion on paleontological grounds, and has hence employed the same name for both areas, viz, the Green River epoch.[1]

As already stated,[2] the upper or red-banded Tertiary beds of this locality yielded the following species: *Perissodactyle* bones, two species; *Orohippus vasacciensis; Crocodilus*, sp.; *Alligator heterodon; Trionyx scutumantiquum; Emys testudineus; E. gravis; Clastes glaber; Unio*, two species.

The lower sandstone-beds yielded the following mammals: *Bathmodon radians; B. semicinctus; B. latipes; Orohippus index;*[3] *Phenacodus primævus.*

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

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

This is the nearest to a determination of the age of the Evanston coal-bed, which Hayden regards as the most important west of the Missouri River that I have been able to reach. From the limestone just described to the coal-bed two miles to the west, the strata are very similar in character, and apparently conformable, so that they appear to belong to the same series. Dr. Hayden confesses his inability to correlate them with those of Bear River City and Weber River, but discovered remains of plants which were identified with some of those known to occur in the Fort Union beds on the Laramie Plains and the Upper Missouri If this be the case to a sufficient extent, the Evanston coal must be referred to that division of the Cretaceous period. This conclusion is, however, only provisional, and Dr. Bannister's remarks[4] are much to the point. He says, of the upper beds northeast of Evanston (the ones I describe above): "There seems to have been a considerable disturbance besides the mere tilting of the beds; and, from the altered

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[1] Proceedings of the Academy of Natural Sciences, 1872, p. 279.
[2] Proceedings of the American Philosophical Society, 1872, p. 473.
[3] Cope, Paleontological Bulletin, No. 17, 1873; also, The Extinct Vertebrata of New Mexico.
[4] Hayden's Annual Report for 1872, p. 541.

direction of the strike,[1] we were led to suspect considerable lateral displacement with faulting, which might very possibly cause the appearance of the same beds both here and at the coal-mines, although at first sight these would appear much higher in geological position. * * I do not know the grounds of Professor Cope's reference of the coal at this point to the Cretaceous, while he admits the Tertiary age at least of some of the overlying sandstones; but, as we found no break nor line of demarkation in the whole 2,000 feet or more which we examined, and found our fossils in coal-bearing beds immediately above and conformable to the main coal, the facts, so far as they are known to me, do not seem sufficient for such identification." This point offers, therefore, a more complete continuity in stratification and mineral character, from the Cretaceous to Tertiary deposits, than any other which I have had the opportunity of examining.

CONCLUSION.

Having traced the transition series of the coal-bearing formations of the Rocky Mountain region from the lowest marine to the highest fresh-water epochs, it remains to indicate conclusions. I have alluded but cursorily to the opinions of Mr. Lesquereux and Dr. Newberry as based upon the study of the extinct flora. The former has, as is well known, pronounced this whole series of formations to be of Tertiary age, and some of the beds as high as Miocene. The material on which this determination is based is abundant, and it must be accepted as demonstrated beyond all doubt. I regard the evidence derived from the mollusks in the lower beds and the vertebrates in the higher as equally conclusive that the beds are of Cretaceous age. There is, then, no alternative but to accept the result *that a Tertiary flora was contemporaneous with a Cretaceous fauna*,[2] *establishing an uninterrupted succession of life* across what is generally regarded as one of the greatest breaks in geologic time. The appearance of mammalia and sudden disappearance of the large mesozoic types of reptiles may be regarded as *evidence of migration and not of creation*.[3] It is to be remembered that the smaller types of lizards and tortoises continue, like the crocodiles, from Mesozoic to Tertiary time

[1] Hayden's Annual Report for 1872, p. 541.

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

[3] Criticism of this conclusion by Professor Dawson is noticed in the Report U. S. Geol. Surv. Terrs. 1873, p. 444.

without extraordinary modification of structure. It is the *Dinosauria* which disappeared from the land, driven out or killed by the more active and intelligent mammal. Herbivorous reptiles like *Agathaumas* and *Cionodon* would have little chance of successful competition with beasts like the well-armed *Bathmodon* and *Metalophodon.*

It then appears that the Transition series of Hayden is such not only in name but in fact, and that paleontology confirms in a highly satisfactory manner his conclusion, "already shown many times, that there is no real physical break in the deposition of the sediments between the well-marked Cretaceous and Tertiary groups."[1]

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

PART II.

DESCRIPTIONS OF VERTEBRATE FOSSILS.

DESCRIPTION OF THE FOSSILIFEROUS LOCALITIES AND ANCIENT LIFE OF KANSAS.

The vast level tract of our territory occupied by the Niobrara Cretaceous, and lying between Missouri and the Rocky Mountains, represents a condition of the earth's surface which has preceded, in most instances, the mountainous or hilly type so prevalent elsewhere; and may be called, in so far, incompletely developed. It does not present the variety of conditions, either of surface for the support of a very varied life, or of opportunities for access to its interior treasures, so beneficial to a high civilization. It is, in fact, the old bed of seas and lakes, which has been so gradually elevated as to have suffered little disturbance. Consistently with its level surface, its soils have not been carried away by rain and flood, but rather cover it with a deep and wide-spread mantle. This is the great source of its wealth in nature's creations of vegetable and animal life, and from it will be drawn the wealth of its future inhabitants. On this account, its products have a character of uniformity; but, viewed from the standpoint of the political philosopher, so long as peace and steam bind the natural sections of our country together, so long will the plains be one important element in a varied economy of continental extent. But they are not entirely uninterrupted. The natural drainage has worn channels, and the streams flow below the general level. The ancient sea and lake deposits have neither been pressed into very hard rock beneath piles of later sediment, nor have they been roasted and crystallized by internal heat. Although limestone-rock, they easily yield to the action of water; and so the side-drainage into the creeks and rivers has removed their high banks to from many rods to many miles from their original positions. In many cases, these banks or bluffs have retained their original steepness, and have increased in elevation as the breaking-down of the rock encroached on higher land. In other cases, the rain-channels have cut in without removing the intervening rocks at once, and formed deep gorges or cañons, which sometimes extend to great distances. They frequently communicate in every direction, forming curious labyrinths; and, when the intervening masses are cut away at various levels, or left standing, like monuments, we have the characteristic peculiarities of "bad lands," or *mauvaises terres.*

In portions of Kansas, tracts of this kind are scattered over the country along the margins of the river and creek valleys and ravines. The upper stratum of the rock is a yellow chalk, the lower bluish, and the brilliancy of the color increases the picturesque effect. From elevated points, the plains appear to be dotted with ruined villages and towns whose avenues are lined with painted walls of fortifications, churches, and towers, while side-alleys pass beneath natural bridges or expand into small pockets and caverns, smoothed by the action of the wind carrying hard mineral particles. But this is the least interesting of the peculiarities presented by these rocks. On the level surfaces, denuded of soil, lie huge oyster-like shells, some opened and others with both valves together, like remnants of a half-finished meal of some titanic race, who had been frightened from the board never to return. These shells are not as much thickened as many fossil oysters, but contained an animal which would have served as a meal for a large party of men. One of them measured twenty-six inches across.

If the explorer searches the bottoms of the rain-washes and ravines, he will doubtless come upon the fragment of a tooth or jaw, and will generally find a line of such pieces leading to an elevated position on the bank or bluff where lies the skeleton of some monster of the ancient sea. He may find the vertebral column running far into the limestone that locks him in his last prison; or a paddle extended on the slope, as though entreating aid; or a pair of jaws lined with horrid teeth, which grin despair on enemies they are helpless to resist; or he may find a conic mound, on whose apex glisten in the sun the bleached bones of one whose last office has been to preserve from destruction the friendly soil on which he reposed. Sometimes a pile of huge remains will be discovered, which the dissolution of the rock has deposited on the lower level; the force of rain and wash having been insufficient to carry them away.

But the reader inquires, What is the nature of these creatures thus left stranded a thousand miles from either ocean? How came they in the limestones of Kansas, and were they denizens of land or sea? It may be replied that our knowledge of this chapter of ancient history is only about five years old, and has been brought to light by geological explorations set on foot by Dr. Turner, Professor Mudge, Professor Marsh, W. E. Webb, and the writer. Careful examinations of the remains discovered show that they are nearly all to be referred to the reptiles and fishes. We find that they lived in the period called Cretaceous, at the time when the chalk of England and the greensand-marl of New Jersey were being deposited, and when many other huge reptiles and fishes peopled both sea and land in those quarters of the globe. The thirty-seven species of reptiles found in Kansas up to the present time varied from ten to eighty feet in length, and represented six orders, the same that occur in the other regions mentioned. One only of the number was terrestrial in their habits, and four were fliers; the remainder were inhabitants of the salt ocean. When they swam over what are now the plains, the coast-line extended from Arkansas to near Fort Riley, on the Kansas River, and passing a little eastward traversed Minnesota to the British possessions, near the head of Lake Superior. The extent of sea to the westward was vast, and geology has not yet laid down its boundary; it was probably a shore now submerged beneath the waters of the North Pacific Ocean.

Far out on the expanse of this ancient sea might have been seen a huge, snake-like form, which rose above the surface and stood erect, with tapering throat and arrow-shaped head, or swayed about, describing a circle of twenty feet radius above the water. Then plunging into the depths, naught would be visible but the foam caused by the disappearing mass of life. Should several have appeared together, we can easily imagine tall, flexible forms rising to the height of the masts of a fishing-fleet, or like snakes, twisting and knotting themselves together. This extraordinary neck—for such it was—rose from a body of elephantine proportions, and a tail of the serpent-pattern balanced it behind. The limbs were probably two pairs of paddles like those of *Plesiosaurus*, from which this diver chiefly differed in the arrangement of the bones of the breast. In the best-known species, twenty-two feet represent the neck in a total length of fifty feet. This is the *Elasmosaurus platyurus*, Cope, a carnivorous sea-reptile, no doubt adapted for deeper waters than many of the others. Like the snake-bird of Florida, it probably often swam many feet below the surface, raising the head to the distant air for a breath, then withdrawing it, and exploring the depths forty feet below, without altering the position of its body. From the localities in which the bones have been found in Kansas, it must have wandered far from land; and that many kinds of fishes formed its food is shown by the teeth and scales found in the position of its stomach.

A second species of somewhat similar character and habits differed very much in some points of structure. The neck was drawn out to a wonderful degree of attenuation, while the tail was relatively very stout, more so, indeed, than in the *Elasmosaurus*, as though to balance the anterior regions while occupied in various actions; *e. g.*, while capturing its food. This was a powerful swimmer, its paddles measuring four feet in length, with an expanse, therefore, of about eleven feet. It is known as *Polycotylus latipinnis*, Cope.

The two species just described formed a small representation, in our great interior sea, of an order which swarmed, at the same time or near it, over the gulfs and bays of old Europe. There they abounded twenty to one. Perhaps one reason for this was the almost entire absence of the real rulers of the waters of ancient America, viz, the Pythonomorphs. These sea-serpents—for such they were—embrace more than half the species found in the limestone-rocks in Kansas, and abound in those of New Jersey and Alabama. Only four have been seen as yet in Europe.

Researches into their structure have shown that they were of wonderful elongation of form, especially of tail; that their heads were large, flat, and conic, with eyes directed partly upward; that they were furnished with two pairs of paddles like the flippers of a whale, attached by short wide peduncles to the body. With these flippers and the eel-like strokes of their flattened tail, they swam, some with less, others with greater speed. They were furnished, like snakes, with four rows of formidable teeth on the roof of the mouth. Though these were not designed for mastication, and, without paws for grasping, could have been little used for cutting, as weapons for seizing their prey they were very formidable. And here we have to consider a peculiarity of these creatures, in which they are unique among animals. Swallowing their prey entire like snakes, they were without that wonderful expansibility of throat due in the latter to an arrangement of levers supporting the lower jaw. Instead of this, each half of that jaw was articulated or jointed at a point nearly midway between the ear and the chin. This was of the ball-and-socket type, and enabled the jaw to make an angle outward, and thus widen by much the space inclosed between it and its fellow. The arrangement may be easily imitated by directing the arms forward, with the elbows turned outward, and the hands placed near together. The ends of these bones were in the *Pythonomorpha* as independent as in the serpents, being only bound by flexible ligaments. By turning the elbows outward and bending them, the space between the arms becomes diamond-shaped and represents exactly the expansion seen in these reptiles, to permit the passage of a large fish or other body. The arms, too, will represent the size of jaws attained by some of the smaller species. The outward movement of the basal half of the jaw necessarily twists in the same direction the column-like bone to which it is suspended. The peculiar shape of the joint by which the last bone is attached to the skull depends on the degree of twist to be permitted, and therefore to the degree of expansion of which the jaws were capable. As this differs much in the different species, they are readily distinguished by the column or "quadrate" bone when found. These are some curious consequences of this structure, and they are here explained as an instance of the mode of reconstruction of extinct animals from slight materials. The habit of swallowing large bodies between the branches of the under jaw necessitates the prolongation forward of the mouth of the gullet; hence the throat in the *Pythonomorpha* must have been loose and almost as baggy as a pelican's. Next, the same habit must have compelled the forward position of the glottis or opening of the windpipe, which is always in front of the gullet. Hence these creatures must have uttered no other sound than a hiss, as do animals of the present day which have a similar structure; as, for instance, the snakes. Thirdly, the tongue must have been long and forked, and for this reason: its position was still anterior to the glottis, so that there was no space for it except it were inclosed in a sheath beneath the windpipe when at rest, or thrown out beyond the jaws when in motion. Such is the arrangement in the nearest living forms, and it is always in these cases cylindric and forked.

The giants of the *Pythonomorpha* of Kansas have been called *Liodon proriger*, Cope, and *Liodon dyspelor*, Cope. The first must have been abundant, and its length could not have been far from seventy-five feet; certainly not less. Its physiognomy was rendered peculiar by a long projecting muzzle, reminding one of that of the blunt-nosed sturgeon of our coast; but the resemblance was destroyed by the correspondingly massive end of the branches of the lower jaw. Though clumsy in appearance, such an arrangement must have been effective as a ram, and dangerous to his enemies in case of collision. The writer once found the wreck of an individual of this species strewn around a sunny knoll beside a bluff, and his conic snout pointing to the heavens formed a fitting monument, as at once his favorite weapon, and the mark distinguishing all his race. The *Liodon dyspelor* was probably the longest of known reptiles, and probably equal to the great finner-whales of modern oceans. The circumstances attending the discovery of one of these will always be a pleasant recollection to the writer. A part of the face, with teeth, was observed projecting from the side of a bluff by a companion in exploration, Lieut. James H. Whitten, United States Army, and we at once proceeded to follow up the indication with knives and picks. Soon the lower jaws were uncovered, with their glistening teeth, and then the vertebræ and ribs. Our delight was at its height when the bones of the pelvis and part of the hind limb were laid bare, for they had never been seen before in the species, and scarcely in the order. While lying on the bottom of the Cretaceous sea, the carcass had been dragged hither and thither by the sharks and other rapacious animals, and the parts of the skeleton were displaced and gathered into a small area. The massive tail stretched away into the bluff, and, after much laborious excavation, we left a portion of it to more persevering explorers. The discovery of a related species (*Platecarpus coryphæus*, Cope) was made by the writer under circumstances of difficulty peculiar to the plains. After examining the bluffs for half a day without result, a few bone-fragments were found in a wash above their base. Others led the way to a ledge forty or fifty feet from both summit and foot, where, stretched along in the yellow chalk, lay the projecting portions of the whole monster. A considerable number of vertebræ were found preserved by the protective embrace of the roots of a small bush, and, when they were secured, the pick and knife were brought into requisition to remove the remainder. About this time, one of the gales, so common in that region, sprang up, and, striking the bluff fairly, reflected itself upward. So soon as the pick pulverized the rock, the limestone-dust was carried into eyes, nose, and every available opening in the clothing. I was speedily blinded, and my aid disappeared in the cañon, and was seen no more while the work lasted. A handkerchief tied over the face, and pierced by minute holes opposite the eyes, kept me from total blindness, though dirt in abundance penetrated the mask. But a fine relic of creative genius was extricated from its ancient bed, and one that leads its genus in size and explains its structure.

On another occasion, riding along a spur of a yellow chalk-bluff, some vertebræ lying at its foot met my eye. An examination showed that the series entered the rock, and, on passing round to the opposite side, the jaws and muzzle were seen projecting from it, as though laid bare for the convenience of the geologist. The spur was small and of soft material, and we speedily removed it in blocks, to the level of the reptile, and took out the remains as they lay across the base from side to side.

A genus related to the last is *Clidastes.* They did not reach such a size as some of the Liodons, and were of elegant and flexible build. To prevent their contortions from dislocating the vertebral column, these had an additional pair of articulations at each end, while their muscular strength is attested by the elegant striæ and other sculptures which appear on all their bones. Ten species of this genus occur in the Kansas strata, the largest (*Clidastes cineriarum,* Cope) reaching forty feet in length. A smaller species, of elegant proportions, has been called *C. tortor,* Cope. Its slenderness of body was remarkable, and the large head was long and lance-shaped. Its lithe movements brought many a fish to its knife-shaped teeth, which are more efficient and numerous than in any of its relatives. It was found coiled up beneath a ledge of rock, with its skull lying undisturbed in the center. A species distinguished for its small size and elegance, is *C. pumilus,* Marsh. This little fellow was only twelve feet in length, and was probably unable to avoid occasionally furnishing a meal for some of the rapacious fishes which abounded in the same ocean.

The flying saurians are pretty well known from the descriptions of European authors. Our Mesozoic periods had been thought to have lacked these singular forms until Professor Marsh and the writer discovered remains of species in the Kansas chalk. Though these are not numerous, their size was formidable. One of them (*Pterodactylus occidentalis,* Marsh) spread eighteen feet between the tips of its wings, while the *P. umbrosus,* Cope, covered nearly twenty-five feet with his expanse. These strange creatures flapped their leathery wings over the waves, and, often plunging, seized many an unsuspecting fish; or, soaring at a safe distance, viewed the sports and combats of the more powerful saurians of the sea. At night-fall, we may imagine them trooping to the shore, and suspending themselves to the cliffs by the claw-bearing fingers of their wing-limbs.

Tortoises were the boatmen of the Cretaceous waters of the eastern coast, but none had been known from the deposits of Kansas until very recently. The largest species on record (*Protostega gigas,* Cope) is strange enough to excite the attention of naturalists. It is well known that the house or boat of the tortoise or turtle is formed by the expansion of the usual bones of the skeleton till they meet and unite, and thus become continuous. Thus the lower shell is formed of united ribs of the breast and of the breast-bone, with bone deposited in the skin. In the same way, the roof is formed by the union of the ribs with bone deposited in the skin. In the very young tortoise, the ribs are separate as in other animals; as they grow older, they begin to expand at the upper side of the upper end, and with increased age the expansion extends throughout the length. The ribs first come in contact, where the process commences, and in the land-tortoise they are united to the end. In the sea-turtle, the union ceases a little above the ends. The fragments of the *Protostega* were seen by one of the men projecting from a ledge of a low bluff. Their thinness and the distance to which they were traced excited my curiosity, and I straightway attacked the bank with the pick. After several square feet of rock had been removed, we cleared up the floor, and found ourselves well repaid. Many long, slender pieces of two inches in width lay upon the ledge. They were evidently ribs, with the usual heads, but behind each head was a plate like the flattened bowl of a huge spoon, placed crosswise. Beneath these stretched two broad plates, two feet in width, and no thicker than binder's board. The edges were fingered, and the surface hard and smooth. All this was quite new among fully-grown animals, and we at once determined that more ground must be explored for further light. After picking away the bank, and carving the soft rock, new masses of strange forms were disclosed. Some bones of a large paddle were recognized, and a leg-bone. The shoulder-blade of a huge tortoise came next, and further examination showed that we had stumbled on the burial-place of the largest species of sea-turtle yet known. The single bones of the paddle were eight inches long, giving the spread of the expanded flippers as considerably over fifteen feet. But the ribs were those of an ordinary turtle just hatched, and the great plates represented the bony deposit in the skin, which, commencing independently in modern turtles, unites with each other at an early day. But it was incredible that the largest of known turtles should be but just hatched, and for this and other reasons it has been concluded that this "ancient mariner" is one of those forms not uncommon in old days, whose incompleteness in some respects points to the truth of the belief that animals have assumed their modern perfections by a process of growth from more simple beginnings

The Cretaceous ocean of the West was no less remarkable for its fishes than for its reptiles. Sharks do not seem to have been so common as in the old Atlantic, but it swarmed with large predaceous forms related to the salmon and saury.

Vertebræ and other fragments of these species project from the worn limestone in many places. I will call attention to perhaps the most formidable as well as the most abundant of these. It is the one whose bones most frequently crowned knobs of shale, which had been left standing amid surrounding destruction. The density and hardness of the bones shed the rain off on either side, so that the radiating gutters and ravines finally isolated the rock mass from that surrounding. The head was some inches longer than that of a fully-grown grizzly bear, and the jaws were deeper in proportion to their length. The muzzle was shorter and deeper than that of a bull-dog. The teeth were all sharp cylindric fangs, smooth and glistening, and of irregular size. At certain points in each jaw they projected three inches above the gum, and were sunk one inch into deep pits, being thus as long as the fangs of a tiger, but more slender. Two pairs of such fangs crossed each other on each side of the end of the snout. This fish is known as *Portheus molossus*, Cope. Besides the smaller fishes, the reptiles no doubt supplied the demands of its appetite.

The ocean in which flourished this abundant and vigorous life was at last completely inclosed on the west by elevations of sea-bottom, so that it only communicated with the Atlantic and Pacific at the Gulf of Mexico and the Arctic Sea. The continued elevation of both eastern and western shores contracted its area, and when ridges of the sea-bottom reached the surface, forming long, low bars, parts of the water-area were inclosed, and connection with salt-water prevented. Thus were the living beings imprisoned and subjected to many new risks to life. The stronger could more readily capture the weaker, while the fishes would gradually perish through the constant freshening of the water. With the death of any considerable class, the balance of food-supply would be lost, and many larger species would disappear from the scene. The most omnivorous and enduring would longest resist the approach of starvation, but would finally yield to inexorable fate; the last one caught by the shifting bottom among shallow pools, from which his exhausted energies could not extricate him.

REPTILIA.

LITERATURE OF THE SUBJECT.

1834. Harlan, in Transactions of the American Philosophical Society, v. IV, p. 405, pl. xx, figs. 3–8. *Mosasaurus missuriensis.* Snout described.

1845. Goldfuss, in Nova Acta Acad. K. L. C. Nat. Cur., XXI, p. 179, pls. vi, vii, viii, ix. *Mosasaurus maximiliani* described (with malar arch) (possibly remaining part of Harlan's specimen).

1856. Leidy, in Proceedings of the Academy of Natural Sciences, Philadelphia, p. 89. *Ischyrosaurus antiquus* described.

Leidy, *l. sup. c.*, p. 73; six species of reptiles from the Fort Union beds of Judith River described.

Leidy, *l. sup. c.*, p. 311. *Hadrosaurus occidentalis* and two tortoises from the same beds described.

1860. Leidy, Transactions of the American Philosophical Society, p. 145. All the species of the Fort Union epoch redescribed and figured.

1868. Cope, in Leconte's Notes on the Geology of the Extension of the Union Pacific Railroad, Eastern Division, on the Smoky Hill, p. 68. *Elasmosaurus platyurus* described.

1869. Cope, in Proceedings of the Boston Society of Natural History, p. 250, January (*separata*). The order *Pythonomorpha* defined; the number of cervical vertebræ, structure of the posterior regions of the cranium, of the lower jaw, scapular arch, and fore-limb first determined; genus *Platecarpus* defined.

Cope, in Proceedings of the American Philosophical Society, June. Articulation of splenial bone in *Pythonomorpha* described; genus *Polycotylus* described.

Cope, Transactions of the American Philosophical Society. Part I of Synopsis of Extinct Batrachia, Reptilia, and Aves of North America (to p. 104), issued in August. *Elasmosaurus* and *Polycotylus* described and *Reptilia* of Fort Union epoch determined.

1870. Cope, in Transactions of the American Philosophical Society, same work, part II (to p. 235), issued in April. Order *Pythonomorpha* further described, its genera further defined, and *Liodon proriger* described.

Cope, Proceedings of the American Philosophical Society, p. 574. *Liodon dyspelor*, *Platecarpus mudgei*, *P. ictericus*, and *Clidastes cineriarum* described.

1871. Marsh, in American Journal of Science and Arts, p. 472 (*separata* June). Pelvis of *Pythonomorpha* first described, and the hind limbs for the first time stated to exist, and the species *Clidastes dispar*, *velox*, *vymanii*, and *pumilus*, and *Pterodactylus owenii* described.

Cope, in letter to J. P. Lesley, in Proceedings of the American Philosophical Society, p. 168 (*separata* October). Hind limb of a Pythonomorph first described, and *Platecarpus latispinus* and *P. crassartus* described.

Cope, *l. c.*, p. 172 (*separata* October). *Protostega* described, with hind limbs and pelvis of *Liodon dyspelor*. *Testudinata* first recorded.

Cope, *l. c.*, p. 264, December. Catalogue of *Pythonomorpha* found in the Cretaceous strata of Kansas. Pterygoid bones first determined, and hind limbs described; genera determined, and six new species described.

1872. Cope, *l. c.*, p. 308 (*separata* January). *Cynocercus incisus* and *Hyposaurus vebbii* described.

Marsh, American Journal of Science and Arts (*separata* March 9). *Pterodactylus ingens* and *P. velox* described. Name of *P. owenii* changed to *P. occidentalis*. Scuta of *Pythonomorpha* described.

Cope, Proceedings of the American Philosophical Society (*separata* March 11). *Pterodactylus umbrosus* and *P. harpyia* described.

Cope, *l. c.*, p. 403 (*separata* March). *Protostega gigas* fully described, and southern and eastern species named.

Marsh, American Journal of Science and Arts (*separata* May). Determination of position of phalanges of fore-limb, and of two additional bones connected with the opisthotic in *Pythonomorpha*; correction of position of the quadrate and confirmation of the previous locations of the malar arch and stapes; description of six new species, and better definition of the genera *Platecarpus* and *Liodon*.

Cope, in Proceedings of the Academy of Natural Sciences, Philadelphia (*separata* June 6th). Description of *Plesiosaurus gulo*.

Cope, in *l. sup. c.* (*separata* June 8th). Review of Professor Marsh's paper of May, 1872; corrections of questions of nomenclature and discovery.

Cope, in Proceedings of the American Philosophical Society (*separata* August 12). Genus *Agathaumas* described.

1873. Cope, Proceedings of the Academy of Natural Sciences, Philadelphia, p. 10. *Toxochelys latiremis* described.

Leidy, Report of the United States Geological Survey of the Territories, by F. V. Hayden. *Clidastes affinis* and *Plesiosaurus occiduus* described and other known species figured.

1874. Cope, in Hayden's Bulletin of the United States Geological Survey of the Territories, No. 2 (issued April). Species of *Cionodon*, *Polyonax*, *Bottosaurus*, *Trionyx*, *Plastomenus*, *Adocus*, *Clidastes*, and *Liodon* described; structure of *Dinosauria* of the Fort Union epoch elucidated.

DINOSAURIA.

AGATHAUMAS, Cope.

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

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

On eight (and, perhaps, nine) vertebræ, anterior to the sacrum, there is no indication of the capitular articular facet for the rib. This facet is found, as in *Crocodilia*, at or near the base of the elongate diapophyses. The centra are slightly concave posteriorly, and still less so on the anterior face, with gently convex margins. The neural canal is very small, and the neural arch short, and quite distinct from the centrum, having scarcely any suture. The neural arch has a subcubical form, partly truncated above by the anterior zygapophyses. In like manner, the base of the combined neural spine and diapophyses are truncated below by the square-cut posterior zygapophyses. The diapophyses are long, and directed upward; they are triangular in section.

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

The *ilium* is much more elongate than the corresponding element in *Hadrosaurus*, *Cetiosaurus*, or *Megalosaurus*. Its upper edge is turned and thickened inward above the anterior margin of the acetabulum, and here the middle of the conjoined diapophyses of the second and third sacral vertebræ was applied when in place. In front of this point, the ilium is produced in a straight line and a stout flattened form with obtuse end. Posterior to it, its inner face is concave to receive the second transverse rest of the sacrum, and the superior margin is produced horizontally toward the median line like the corresponding bone in a bird. The posterior part of the bone is the widest; for it is expanded into a thin plate and produced to a considerable length. From one of the margins (my sketch, made on the ground, represents it as the upper), a cylindric rod is produced still farther backward. This it is believed is only the shaft of a displaced rib. The base of the ischium is coossified with the ilium, and is separated behind its base from the iliac portion of the acetabulum. There is no facet nor suture for the pubis at the front of the acetabulum.

The ribs are compressed. There are no bones certainly referable to the limbs.

The form of the ilia distinguishes this genus from those known heretofore.

Agathaumas sylvestris, Cope.

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

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

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

Measurements.

	M.
Length of the nine posterior dorsal vertebræ	0.880
Length of the nine sacral vertebræ (36⅝ inches)	0.930
Length of right ilium (two pieces, 0.84+0.22), (41 inches)	1.060
Length of eighth dorsal from the sacrum	0.090
Length of the base of the neurapophysis	0.085
Depth of the articular face	0.153
Width of the articular face	0.123
Length of the second from sacrum	0.070
Depth of the articular face	0.155
Width of the articular face	0.137
Elevation of the neural canal	0.045
Width of the neural canal	0.028
Elevation to the face of the zygapophyses	0.104
Elevation to the base of the neural spine	0.150
Length of the diapophysis from the lower base	0.200
Length of the diapophysis from the capitular articulation	0.125
Antero-posterior width above	0.050
Antero-posterior width of the base of the neural spine	0.070
Antero-posterior width at the zygapophysis	0.078
Length of the neural spine (fragment)	0.200
Width of the centrum of the first sacral	0.160
Depth of the centrum of the first sacral (to the neurapophysis)	0.145
Length of the centrum of the first sacral	0.100
Length of the centrum of the seventh sacral	0.100
Depth of the centrum of the seventh sacral (behind)	0.085
Width of the centrum of the seventh sacral (behind)	0.100
Expanse of the second sacral transverse support (22 inches)	0.560
Length of the ilium anterior to the acetabulum	0.470
Length of the acetabulum	0.200
Length of the ilium posterior to the acetabulum	0.390
Width of the ilium at the anterior extremity	0.140

	M.
Width of the ilium at the front of the acetabulum	0.210
Width of the ilium at the posterior expansion	0.250
Thickness above the acetabulum	0.060
Width of the acetabulum	0.105
Width of the basis of the ischium	0.085
Width of the shaft of a rib	0.062

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

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

HADROSAURUS, Leidy.

Hadrosaurus mirabilis, Leidy.

Numerous bones of *Dinosauria*, from the Milk River, British America, submitted to me by Dr. G. M. Dawson, of the British North American Boundary Commission, embrace specimens appropriate to this species, but not certainly referable to it. The locality is nearer to the bad lands of Judith River, from which the *H. mirabilis* was procured, than to any other exposure of the Fort Union beds.

There are portions of femora, humeri, and ilia, but the only piece sufficiently characteristic for description is a median caudal vertebra. The inferior ridges and facets for chevrons are strongly developed; the latter appearing at both ends. The anterior articular face is plane; the posterior, concave. The centrum is deeper than wide, slightly narrowed below; no traces of diapophyses. Length, $0^{m}.060$; depth of articular face, $0^{m}.077$; width of articular face, $0^{m}.071$; length of base of neural arch, $0^{m}.038$. The reference of this vertebra is uncertain, but it seems too small for the *H. occidentalis*, although in the opisthocœlian character it is similar.

Hadrosaurus occidentalis, Leidy.

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

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

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

Measurements.

	M.
Length of the centrum of the fourth sacral vertebra	0.092
Transverse diameter:	
In front	0.103
At middle	0.072
Posteriorly	0.121
Vertical diameter, posteriorly	0.092
Diameter of the head of the tibia, antero-posteriorly	0.250

CIONODON, Cope.

Bulletin of the United States Geological Survey of the Territories, No. 1, 1874, p. 2.

Remains of species of *Dinosauria* were obtained at two localities in Colorado, not many miles apart; the greater number at one of them, from which also all the crocodilian and turtle remains were derived. Those from the other deposit consist of portions of limb-bones, apparently of a single individual of gigantic size. The more abundant fragments are referable to three species. A fragment of a limb-bone is very similar to portions from the other locality, and associated is a sacral vertebra of appropriate size and characters. All of these were, therefore, referred provisionally to a single species under the name of *Agathaumas milo*, but are here described under *Hadrosaurus occidentalis*. The remaining specimens fall into two series. In the one, the bones are occupied by a heavy mineral, and the surfaces covered by a white layer, which is marked by irregular ridges, as though produced by deposit along the lines of small adherent foreign bodies. In the other set, the bones are lighter, more spongy, and not covered with the white layer; some of them are stained by the sesquioxide of iron. Both present vertebræ and limb-bones, which are related appropriately as to size and structure; that is, the larger limb-bones have the same mineral character as the larger vertebræ, and the smaller as the smaller. These limb-bones represent corresponding parts in the two, and, differing widely, confirm the belief in the existence of two species derived from the different types of vertebræ. In these fossils, then, I see evidence for the existence of two species of two genera, which I name—the larger, *Polyonax mortuarius;* the smaller, *Cionodon arctatus.* Both genera present a solid, cancellous filling of femora, tibiæ, and other long bones, and hence differ from such genera as *Hadrosaurus*, *Hypsibema*, *Lælaps*, and others. *Cionodon* differs in dentition from all *Dinosauria* where that part of the structure is known; but it remains to compare *Polyonax* with *Troödon* and *Palæoscincus* of Leidy, which are known from the teeth only, while no portions of dentition are preserved with the specimens at my disposal.

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

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

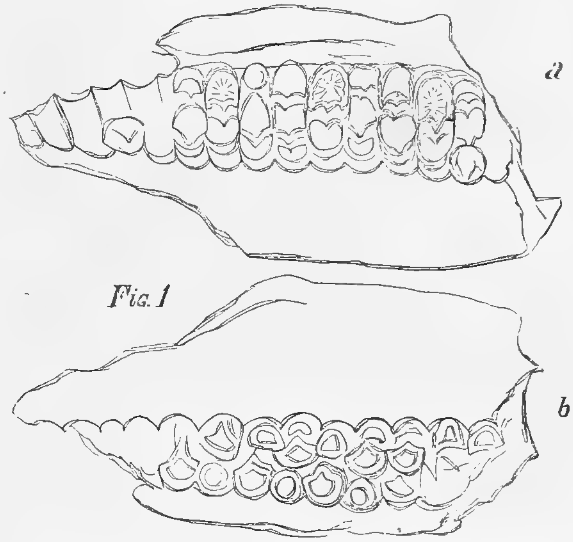


Fig. 1.—Diagram of the maxillary dentition of *Cionodon arctatus*: *a*, grinding-face; *b*, superior or radical view of the maxillary bone, natural size.

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

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

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

CIONODON ARCTATUS, Cope.

Bulletin, *l. c.*, p. 2.

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

Measurements.

	M.
Width of the alveolar groove	0.0120
Length of a triad of teeth on the alveolus	0.0140
Length of an unworn tooth	0.0250
Diameter of the surface of attrition of a tooth of the middle row:	
Longitudinal	0.0063
Transverse	0.0072
Width of the maxillary bone	0.0350
Depth of the maxillary bone at the inner margin	0.0140

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

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

Measurements.

	M.
Anterior dorsal:	
Length of the centrum	0.074
Elevation of the articular face	0.073
Width of the articular face	0.070
Vertical diameter of the neural canal	0.027
Elevation of the anterior zygapophyses	0.122
Middle dorsal:	
Length of the centrum	0.068
Elevation of the articular face	0.085
Width of the articular face	0.080
Middle caudal:	
Length of the centrum	0.062
Elevation of the articular face (at canal)	0.047
Width of the articular face	0.068
Width between the inferior angles	0.024
Width of the neural canal	0.013

The *femur* is only represented by the distal end, with the condyles perfectly preserved. The latter form a single trochlear surface, whose borders form arcs of circles. It is slightly hour-glass-shaped, chiefly by excavation of the posterior face, which is, however, shallow, the deep fossæ seen in

Hadrosaurus and other genera being absent. The area of the articular cartilage is clearly marked out, and the dense surface of the shaft is marked with delicate striæ, which terminate at the edge of the former. One side of the end of the bone is nearly plane, the other is longitudinally excavated; some shallow grooves furrow the angle with the trochlear face. The section of the shaft, three inches from the end, is a wide, transverse parallelogram. This bone looks no little like the distal end of a metapodial bone, but there are various reasons why it is more probably femur or humerus. The presence of the tibia, especially, determines it to be the former element.

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

Measurements.

	M.
Transverse diameter:	
Of the condyles of the femur	0.082
Of the shaft of the femur	0.053
Diameter, fore and aft:	
Of the middle of the condyles	0.054
Of the side of the condyles	0.069
Of the shaft	0.028
Diameter of the head of the tibia:	
Greatest	0.102
Fore and aft	0.096
Transverse	0.060
Diameter of the shaft of tibia (proximally):	
Transverse	0.050
Fore and aft	0.045
Diameter of the distal end of the tibia:	
Transversely	0.115
Fore and aft	0.060

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

Cionodon stenopsis, Cope.

This Dinosaur was discovered by George M. Dawson, of Montreal, geologist of the British North American Boundary Commission, in the Fort Union beds of the Milk River region. It is represented by fragments of maxillary bones, with a few contained pieces of teeth. Probably, several of the numerous bones of reptiles of this order, obtained by Mr. Dawson, pertain to the same genus and species; but there are as yet no means by which to distinguish them from other species of *Hadrosauridæ* in the collection.

The maxillaries exhibit the vertical grooves characteristic of the genus, and the teeth are of the rod-like form of those of the *C. arctatus*, Cope, and the roots are similarly compressed. An important difference in the teeth is seen in their lack of the carina on the enamel-face of the base of the crown at least; the apices being in each case broken away. Accordingly, the root exhibits no corresponding groove on its inner side, as is the case in *C. arctatus*. The form of the maxillary bone is also characteristic. In *C. arctatus*, this piece bears a longitudinal protuberance on its inner side so as to have given the face great proportionate width. In *C. stenopsis*, this protuberance is much less pronounced; the inner face, instead of being nearly horizontal above, is curved abruptly downward, and a shallow horizontal face of no great width replaces the wide oblique cornice which extends from the alveolar border in *C. arctatus*. The remains indicate a species of the size of *C. arctatus*.

Measurements.

	M.
Depth of the maxillary bone on a dental groove	0.0350
Diameter of the maxillary bone external to alveoli	0.0200
Diameter of a tooth	0.0045

POLYONAX, Cope.

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

POLYONAX MORTUARIUS, Cope.

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

Measurements.

	M.
Anterior dorsal:	
Length of the centrum	0.048
Elevation to the neural canal	0.094
Width	0.094
Median dorsal:	
Length of the centrum	0.057
Elevation to the neural canal	0.117
Width	0.083
Posterior dorsal:	
Length of the centrum	0.092
Elevation	0.101
Width	0.083
Diameter of the neural canal	0.016

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

The limb-bones embrace portions of tibia, fibula, and some others not yet determined. The portion of tibia is from the base of the cnemial crest, so that one extremity is trilobate, the other transverse-oval. The former outline indicates two posterior tuberosities. The bone is solid, and the superficial layer for 3^{mm} or less, is so dense and glistening as to resemble cementum. Portions referred to fibulæ have a subcrescentic section, with narrowed width in one direction. Two fragments of shafts of long bones I cannot determine, but they may belong to the pelvis. They belong to opposite sides; each is oval in section, and the diameter regularly contracts to one end. One side is slightly convex in both directions; the other is less convex transversely and gently convex longitudinally. A peculiarity consists of a central cavity present in both at the fractured large end, which is bordered by a layer of dense bone like the outside.

Measurements.

	M.
Transverse diameter of the tibia-fragment below the cnemial crest	0. 125
Antero-posterior diameter of the tibia-fragment at the base of the crest	0. 095
Width of the fragment of the fibula	0. 073
Thickness of the fragment of the fibula	0. 035
Length of the fragment of an unknown pelvic bone	0. 145
Proximal diameterof the fragment of the unknown bone	0. 088
Distal diameter of the fragment of the unknown bone	0. 065

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

ORNITHOSAURIA.

As compared with the European Cretaceous, the corresponding beds in North America have yielded but few species. These are of the largest size to which species of the order are known to attain. To Professor Owen and H. von Meyer, science is indebted for the first explanations of the structure of these remarkable reptiles; while Prof. H. G. Seeley, of Cambridge, England, has added greatly to the work commenced by the elder authors, and also extended our knowledge of the genera and species.

PTERODACTYLUS, Cuv.

Pterodactylus umbrosus, Cope.

Represented by the distal portion (ten inches) of the wing-finger metacarpal; the proximal portion (eight inches) of the first phalange of the same digit, with a lateral carpal, and two phalanges of claw-bearing digits. The distal condyles of the first-named bone are separated by the usual deep groove above and below, and wind spirally to their terminations on the inferior face. The narrow base which supports the inner condyle is bounded posteriorly by an acute edge; directly outside of the base of this ridge is a deep groove or foramen, which is bounded next the external condyle by another ridge, which rises to the base of the inner condyle on the trochlear side. The transverse diameter of the condyles is $0^{m}.043$, or 17 lines.

The proximal end of the first phalange is perfect, but flattened by pressure. It presents the two usual cotyloid cavities well separated by an elevated ridge. Anteriorly, it presents an elevated crest for muscular insertion. This terminates abruptly, and is followed distally by a deep notch. Distal to this is another prominence of the bone, also probably an insertion. Antero-posterior diameter (flattened), 24 lines.

The lateral carpal is short and wide; both its articulations are simple and concave. Both outlines are keeled; one very strongly at one end, and at the other presenting beyond the articular surface for the distal carpal, a wide prolonged process for muscular insertion. Length of carpal without process, 13 lines; process, 4 lines; diameter, widest extremity, 11 lines. This indicates a very stout carpus. The phalange is penultimate, and is remarkable for its small size, perhaps indicating an external rudimental digit. It is only supposed to belong to the anterior limb from its having been found with the preceding bones. It is slender, and has a convex distal articulation, divided by a trochlear groove, and the concave proximal one in like manner divided by a trochlear carina. Length, 9 lines; proximal depth, 3 lines.

This species is the largest Pterodactyle as yet known from our continent; the end of the wing-metacarpal exceeding in diameter that of the species described by Professor Marsh from the same region by more than four millimeters.

From near Butte Creek, Kansas, from the yellow chalk.

PTERODACTYLUS OCCIDENTALIS, Marsh.

Established on wing-metacarpals and phalanges of three individuals. The articular extremities indicate a species from one-half to two-thirds the size of the last-named. Those of the metacarpal are very prominent above as well as below, and there is no distinct ridge in the trochlear groove between them. The inner condyle does not stand on a base with an acute posterior ridge, but overhangs a rather obtusely-edged support. There is no second ridge on the outer (trochlear) side of it. The same condyle terminates abruptly posteriorly on the superior face of the shaft. Width of condyle in No. 1, 11 lines; in No. 2, 13 lines; vertical diameter, inner condyle. No. 1, 11 lines; transverse diameter of the shaft above, 8 lines.

The proximal articular surfaces of the proximal wing-phalanges are deeply concave: the inner protected by an elevated margin behind; that of the outer much lower. They are separated chiefly by a deep emargination but on their short adjacent portions by a low ridge. The process for ligamentous insertion is well developed. The distal extremity is slightly widened, and its articular surface is wedge-shaped with very convex base. Its surface is slightly concave in both directions, and without median ridge. The margin of the shaft terminates in a short tuberosity bearing articular surface. Transverse diameter, 16 lines; length of shaft preserved, but incomplete, 9 inches 1 line.

This is possibly the species originally described by Marsh as *P. owenii*, a name which could not be used on account of its pre-occupation for another species from England. It was described by the writer in 1872 under the name of *P. harpyia;* but, a fire occurring in the establishment printing the paper, its publication was delayed until two days after Professor Marsh had republished his species as *P. occidentalis.*

The type-specimens of the two species described were procured from the bluffs of Butte Creek south of Fort Wallace, Western Kansas.

Order I.—CROCODILIA.

Only two species of this order are known from the Cretaceous formations west of the Missouri River: the one from the lead-colored stratum of the Benton epoch, or No. 2, in Kansas; the other from the Fort Union group, or No. 6, of Colorado. The latter is a short-headed species, allied to, and near the size of, the alligator of Louisiana. The former is a *Hyposaurus,* of eight or ten feet in length, found in digging a well at Brookville, and presented to me by my friend Dr. William E. Webb, of Topeka. The individual discovered was not fully grown, but indicates a smaller and stouter crocodile than the *H. rogersii,* Owen, of the New Jersey greensand. This genus belongs to the group with subbiconcave vertebræ, and had a long, subcylindric snout.

HYPOSAURUS, Owen.

Hyposaurus vebbii, Cope.

An anterior cervical vertebra presents the following characteristics. It is that one in which the parapophysis occupies a position opposite the lower third of the vertical diameter. Its centrum is stout in form; the articular faces but little concave; the posterior a little more so than the anterior. The anterior is almost regularly hexagonal; the posterior subround, a little deeper than wide. The inferior surface possesses a strong, obtuse, median carina, which disappears in front of the posterior margin. Anteriorly, it terminates in a short, obtuse hypapophysis. The suture of the neural arch is very coarse. Surface of the bone smooth.

Measurements.

	M.
Length of the centrum	0.037
Diameter of the centrum anteriorly:	
Vertical	0.032
Horizontal	0.031
Diameter of the centrum posteriorly:	
Vertical	0.032
Horizontal	0.031
Length of the surface of the parapophysis	0.015

As compared with the *H. rogersii* of the New Jersey Cretaceous, this vertebra is shorter and stouter, and the extremities less concave; the suture for the neural spine is much coarser.

This crocodile was discovered in a bluish stratum, encountered in digging a well in Brookville, Kansas.[1] This point is considerably east of the exposure of Cretaceous rocks seen near Forts Hays and Wallace. It was the first of the *Crocodilia* found between the Tertiaries of the Rocky Mountains and the Cretaceous of New Jersey.

It was given me by my friend Dr. William E. Webb, of Topeka, to whom science is also indebted for the *Polycotylus latipinnis*. I have dedicated this species to him.

BOTTOSAURUS, Agass.

Cope, Proceedings of the American Philosophical Society for 1871, 48.

BOTTOSAURUS PERRUGOSUS, Cope.

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

A portion of the left dentary-bone, containing alveoli for ten teeth, shows that this species is not a gavial. The dental series passes in a curve from the inner to the outer sides of the bone; one or two alveoli behind being probably bounded on the inner side by the splenial only, as in *B. macrorhynchus*, when that bone is in place. The dentary is compressed at this point; in front, it is depressed. There is a slight difference in the sizes of the alveoli, but not such as is usual in Tertiary crocodiles. The external face of the bone exhib-

[1] This stratum is similar to that in which Dr. Hayden found the fish *Apsopelix sauriformis* at Bunker Hill.

its deep pits in longitudinal lines. The angle of the mandible is depressed. The cotylus of articulation is partially concealed on the outer side by the elevation of the surangular, whose upper border is parallel with the inferior margin of the ramus for two inches to where it is broken off. The outer face of this region is marked by irregular coarse ridges, more or less inosculating, separated by deep pits. The lower posterior half of the angular bone is smooth.

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

Measurements.

	M.
Length of a fragment of the ramus	0.100
Width in front	0.034
Depth behind	0.032
Length of eight alveoli	0.069
Diameter of the largest alveolus	0.012
Diameter of the smallest	0.007
Width of the base of the angle of the ramus	0.048
Depth at surangular	0.034
Length of the centrum of the vertebra	0.045
Width of the articular cup	0.031
Vertical diameter of the articular cup	0.025
Vertical diameter of the neural arch	0.011
Expanse of the anterior zygapophyses	0.056

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

SAUROPTERYGIA.

As compared with the European and New Zealand Cretaceous beds, those of our country have yielded but few remains of reptiles of this order. Four only are embraced in the present work, three of which are from No. 3, and one from No. 6.

The structure of the scapular arch in *Polycotylus* is yet unknown; in *Elasmosaurus*, it is quite distinct from that of *Plesiosaurus*, so much so as to have induced me to regard it as type of a distinct family, the *Elasmosauridæ*, characterized by the absence of distinct mesosternal bone. Professor Seeley has since more fully defined this group, and has discovered several species of it in the English formations, some of which he refers to three additional genera, under the names of *Cymbosaurus, Eretmosaurus,* and *Murænosaurus.* Allied species, including a *Polycotylus,* have also been described by Mr. Hector, from corresponding strata in New Zealand.

POLYCOTYLUS, Cope.

This genus is established on a series of vertebræ, with portions of pelvic arch and posterior extremity, discovered in the upper Cretaceous of Kansas by W. E. Webb, superintendent of the land-office in Topeka, Kansas. The point at which the remains were found is about five miles west of Fort Wallace, on the plains near Smoky Hill River, Kansas, in a yellow Cretaceous limestone.

There are wholes or portions of twenty-one vertebræ, of which but two retain their neural arches, and six are represented by neural arches only. Four centra may be referred to the caudal series, the remainder to the dorsal; only two indicate the characters of the cervical vertebræ. All of these vertebræ, except the distal caudals, are remarkable for their short antero-posterior diameter, and deeply concave, articular faces. This concavity is not, however, of an open, conic form, as in *Ichthyosaurus,* but is flattened at the fundus, thus exhibiting a small, slightly disciform area. The usual pair of venous foramina appears on the under side of the centrum. The neural arch is continuous with the latter, and exhibits no trace of connecting suture. The diapophyses arise from the neural arch in all the dorsals; they are compressed and vertical in section. The arch is, of course, narrow antero-posteriorly, and presents a pair of moderately prominent zygapophyses in each direction; the posterior, as usual, articulating downward, the anterior upward. On some of the vertebræ they become closely approximated. The neural spines are narrow antero-posteriorly, and much stouter transversely than in *Elasmosaurus;* they are strongly grooved at the base, both anteriorly, and most so posteriorly.

The caudal vertebræ are anteriorly quite as large as the dorsals. Two anterior caudals present, on the latero-inferior part of the posterior margin, a pair of widely-separated articular surfaces for chevron-bones. A portion of one of the latter remains; it is narrow and subcylindric at the base. The diapophyses are situated on the upper part of the centrum, and are continuous with it, and without trace of suture. There are two distal cervicals, which are much smaller than the preceding. They are solidly coössified, and have been broken from one anterior to them, with which they have been also anchylosed. Processes in the position of the diapophyses have disappeared, while a strong infero-lateral process projects from the middle of each, similar in position to the parapophyses (or whatever they may be) of the *Elasmosaurus*. These processes are decurved, and much thickened and rugose; they may be described as more or less elongate-conic. The neural canal of these vertebræ is well-marked, though small. The coössification of cervical vertebræ is a remarkable character, and very unusual. It does not seem probable that these specimens represent a diseased condition, since they are symmetrical, and the inferior surfaces and foramina are unaffected. The rugosity is much that of a ligamentous articulation. Their size indicates a remarkably slender neck, even more so than in *Plesiosaurus*.

That the portions of an extremity alluded to belong to the posterior is rendered probable by the presence of part of an ilium, and by the fact that the portions of the vertebral column secured are chiefly median and posterior. The fragments consist of the extremity of the femur, the tibia, several tarsal bones, and numerous phalanges. The whole limb is of great size compared with the vertebral column, and indicates powerful natatory capacity in its possessor. What the relative length of the femur may be cannot be ascertained, as the proximal portion is wanting; but, if it were like the tibia, it was characterized by stoutness rather than by length. The portion remaining is flattened, and presents distally two distinct articular faces for ulna and radius, instead of the uniformly convex outline characteristic of most of the species of *Plesiosaurus*. The tibia is pentagonal, broader than long, and emarginate externally. The fibula is not preserved. One of the tarsal bones is a flat, unequally hexagonal disk, of less thickness than the tibia and the tarsals, which appear with three faces of broad, plane articulations, and the outer edge rounded in section. Another tarsal or metatarsal is a parallelopipedon, except that one extremity presents two faces meeting at a right angle. Another is similar, but oblique, *i. e.*, rhombic in section; one of the longitudinal angles is also prolonged.

Of the phalanges, there are individuals from three series. Portions of flat bones, perhaps belonging to the pelvic arch, indicate, as do all the other pieces, that the bony structure in *Polycotylus* is more massive than in *Elasmosaurus*, if the only known species has not attained such huge dimensions as some of the latter. These fragments do not throw much light on the structure of the pelvic arch.

The structure of the bones is, like that in the order generally, of the coarsest description. There are no medullary cavities, but the cancellous cells are large, and extend everywhere in the direction of the axis of each bone

The characters which separate this genus from *Plesiosaurus* may be derived from the preceding, as follows:

First. The deeply biconcave and very short vertebral centra.

Second. The tibia broader than long, resembling that of *Ichthyosaurus.*

Third. The coalescence and depression of the cervicals.

Fourth. The continuity of the neural arches.

Fifth. The continuity of the diapophyses of the caudals with the centra.

The only genus with which this one may be here compared is the *Thaumatosaurus* of Meyer. This is known by but a few fragments, and of these but few are present in the Kansas animal. The character on which I rely at present to distinguish them is the much less concavity of the dorsal vertebræ in *Thaumatosaurus.* This is, however, not entirely satisfactory. *T. oölithicus*, Meyer, is from the Lower Oölite of South Germany.

The bones of the specimens of *Polycotylus* are thoroughly mineralized, and the adherent matrix is a light-yellow chalky limestone, similar to that which yielded the fine fragments of the *Liodon proriger.*

Polycotylus latipinnis, Cope.

The anterior dorsal vertebræ have the centra slightly compressed or vertically oval, while the posterior are more rounded. The anterior caudals appear to have been round, or nearly so; they are somewhat distorted by pressure. The sides of the centrum are slightly concave in the longitudinal direction; below, there is no carina, but at least two venous foramina. There is another large foramen on the side of the centrum, usually not far from the neural arch; there are usually other smaller foramina below this. The bases of the diapophyses are longitudinally grooved behind, and separate a concavity of the arch in front of them from one behind. In the most nearly median, the most elevated diapophyses stand about equally on the neurapophysis and the neural spine above it. The diapophyses are vertically compressed, and the costal articulation of the only one preserved is in the same plane. The margins of the external surfaces are not coarsely striate, as in many *Sauropterygia.* The venous foramina of the distal co-ossified cervicals are in pairs, and of large size. In the proximal caudals, the diapophyses are above the middle of the sides of the centra. In one, the basis of a chevron is preserved. It is cylindric and striate. The zygapophysis on the hinder aspect of a dorsal has a disciform articular surface directed outward and downward; the prominence of its upper face is continuous with the lateral ridge of the neural spine. The anterior up-looking surface is equally small and little divergent.

Measurements.

	Inches.
Length of two coössified cervicals	2.5
Width of the anterior in front	1.7
Depth of the anterior in front	0.9
Vertical diameter of the centrum of the dorsal	3.42
Transverse diameter of the centrum of the dorsal	2.7
Antero-posterior diameter of the centrum of the dorsal (below)	1.85
Vertical diameter of the centrum of the dorsal (posterior)	2.98
Transverse diameter of the centrum of the dorsal	2.9
Transverse diameter of the neural canal	0.86
Longitudinal diameter of the base of the neural spine	1.22
Longitudinal diameter of the base of the diapophysis	1.2
Length between the extremities of the zygapophyses (dorsal)	2.26
Depth of the cup of the vertebræ	0.63
Length of the centrum of the anterior caudal	1.73
Distance between the bases of the chevron-bone (caudal)	2.58

It may be observed that the anterior caudals have a nearly round articular extremity; one of them is a little wider than high, but they are too much distorted to furnish reliable measurements.

The portion of the ilium preserved is an extremity. It is flat on one side and convex on the other. The shaft is solid. The articular extremity is oblique in one direction and truncate in the other, which is at right angles to a short, recurved margin, which has been an insertion or articulation; the flat surface is rugose distally. Long diameter of extremity, 2.75 inches; of shaft, 1.9 inches. The articular faces of the extremity of the femur are at an open angle with each other, and are strongly concave in transverse section. The femur is here very flat, with narrow margins; it becomes stouter with diminishing width. Distally, the surface is marked by grooves and small foramina. What may be tibia is the basal frustum of a wedge; the articular faces are broad; the outer margin narrowed; the faces slightly concave. The inner margin is shorter than the outer, and the distal part of it presents a broad articular face. Some of the tarsal bones have been already described. There are thirteen metatarsals and phalanges. They are of stout proportions and are considerably constricted medially. Those of one series are square in section; those of another, transverse; those of a third, transverse, with one edge thinned or acuminate in section. Some of each form are more elongate than others.

Measurements.

	Inches.
Width of the femur at the extremity (restored)	8.
Depth of the femur at the extremity (median)	1.3
Width of the femur four inches from the extremity	6.
Thickness of the femur four inches from the extremity	1.95
Width of the tibia	3.88
Length of the tibia externally	2.6
Width of the tarsi (tibial)	2.48
Thickness of the tarsi (tibial)	1.52
Length of the parallelopiped phalange	1.56
Width of the parallelopiped phalange	1.2
Thickness of the parallelopiped phalange	1.2
Thickness of the depressed phalange	1.
Width of the depressed phalange	1.4
Length of the depressed phalange	1.9

These powerful extremital pieces indicate a body to be propelled of not less than usual proportions. If this be the case, the number of dorsal vertebræ is considerably greater than in the species of this order in general, and approaching more the *Ichthyosauri.* I do not intend to suggest any affinity between the latter and the present genus, as none exists. What the extent of the cervical vertebræ may have been is uncertain. The caudals have probably been numerous, though not probably so extended as in *Elasmosaurus.*

The size of the species may be approximately estimated from the proportions furnished by Owen (Reptiles of the Liassic Formation) in *Plesiosaurus rostratus.* The skeleton of this species measures 11 feet 8 inches in length, and the dorsal vertebræ are of less vertical and equal transverse diameter compared with those of the present saurian. We may, therefore, suppose that the latter exceeded the former in dimensions.

William E. Webb, of Topeka, discovered the specimens from which this species was first described, and liberally forwarded them to me for examination and description Other specimens have been discovered since that time by various other persons. I have received numerous fragments of an individual of about the size of the one above described, which were found by Prof. B. F. Mudge, at a point near the mouth of the north branch of the Smoky Hill River.

These consist of a few vertebræ, portions of pelvic and scapular arches, and three proximal bones of the limbs. Which of these is femur and which humerus, I am unable to determine, owing to their close resemblance. The vertebræ do not differ from those of the specimen just described. The limb-bones are stout and expanded, and thinned distally; this thinning is remarkable, and indicates a much flattened metapodial region. The head is slightly expanded, the articular face being turned obliquely to the inner face of the shaft; the surface is pitted for attachment of the articular cartilage; two-fifths the length from the proximal end is an extensive and exceedingly rugose surface, as wide as the shaft, for the insertion of the adductor-muscles.

Measurements.

	M.
Diameter of the centrum of the lumbar vertebra	0.08
Length of the (?) humerus	0.45
Diameter of the head	0.125
Diameter of the shaft	0.098
Diameter of the distal end (transverse), restored in part	0.18

Should the humerus have been related to the fore-limb, as in *Plesiosaurus dilichodirus*, Conyb., the latter would have had a length of 4 feet 3 inches; as the proportions of the radius and phalanges are shorter, the limb was probably relatively shorter. If related to the total length, as in the same Plesiosaur the humerus would indicate a length of 17½ feet. The cervical vertebræ become attenuated, as compared with the dorsals, to a greater degree in *Polycotylus* than in *Plesiosaurus*.

ELASMOSAURUS, Cope.

This genus has been more completely preserved to us than any other American representative of the order. In the interpretation, however, considerable care is necessary, as the form appears, at first sight, to reverse, to a remarkable degree, the usual proportions of known reptiles. The scapular arch, in the absence of the episternum, presents the same number of elements as the pelvic, and is not without resemblance to the latter, as it exists in some species of the order. The fortunate preservation of the series of cervical vertebræ shows this to have been, in the typical species, three times the length of the body; much exceeding in this disproportion that known to exist in other species of the order.

The neural arches are everywhere continuous with the centra, without sign of suture, and are externally plane. The neural canal is exceedingly small for the size of the vertebræ, especially on the lumbar and caudal vertebræ.

The *dorsal vertebræ* are remarkable from the fact that the diapophyses disappear on the anterior part of the series, and gradually diminish in length from behind forward to the point of disappearance. On the median and posterior parts of the series, they are very elongate, and rise for a short distance from the basis of the neural arch. Anteriorly, they descend and shorten, and finally remain only as the slightly-elevated borders of rib-pits. Throughout the whole of the anterior portion of the column to the cervicals, the neural spines are of great elevation, and of such antero-posterior extent as to be nearly continuous.

The *cervical vertebræ* are not only more numerous, but become anteriorly much smaller and more attenuated than in its allies of the same family. They are remarkably compressed, the centra much longer than deep, and deeper than wide, and with smooth concave sides.

The ribs of the anterior cervico-dorsal region are inserted directly in the vertically-oval pits of the centrum. Immediately at the point where these cease, thin traverse processes appear to arise from the lower edges of the rib-pits. They form a continuous series with the ribs, and soon rise from the plane of the lower face of the centrum, and are directed obliquely downward. At the end of the cervical series, they are directed nearly vertically downward. The number of these vertebræ is very great; the anterior diminishing to a very small size; the whole measuring a little more than half the total length. Most of the cervicals possess two venous foramina below, the dorsals two, and most of the caudals one.

The resemblance of the caudals to the usual type of *Plesiosaurus* is seen in the fact that each bears near its posterior articular aspect, on the inferior face, a pair of articular surfaces for chevron-bones. Similar vertebræ had been described by Leidy as the caudals of a genus he called *Discosaurus.* The study of the present genus shows that they are really of the caudals of the allied genus *Cimoliasaurus*, the support caudals of the latter being the cervicals.

The *ribs* are simple-headed; the abdominal ribs seen in *Plesiosaurus* are possibly wanting, as none were found by the discoverer of the fossil, after a careful search.

The end of the *muzzle*, with symphysis mandibuli, was preserved. This is flat, the symphysis co-osified and rather short, the premaxillary grooved at the intervals between the dental alveoli. The teeth are deeply implanted, with small pulp-cavity, are cylindric, and furnished with nearly straight elongate conic crowns, which are minutely but sharply striate to the tip; the ridges straight, continuous. There are no indications of nostrils, so that these were probably posterior, and near the orbits, as in *Plesiosaurus.*

The *pelvic arch* is more extended than the scapular, and strongly resembles the pelvic arch of the *Plesiosauridæ.* The scapular arch is peculiar; the claviculi are broad, flat bones, resembling the pubes of certain tortoises, while the coracoids are much like the coracoids of *Plesiosaurus.* The clavicles have a greater transverse extent than the latter, and have a very extensive line of union medially, and a narrow posterior prolongation, which meets a similar anterior one of the coracoids, separating the intervening foramina. They appear to form about one-third of the walls of the glenoid cavity, and have a constricted base, as in some *Plesiosauria*, applied to the extremity of the coracoid. The form of the glenoid cavity cannot be readily ascertained from the absence of the scapula. What we have of it would suggest the existence of a fore-limb, of comparatively little power, though no remains of such have been found. The acetabulum is smaller than the glenoid cavity; this point, with the obvious source of propulsive power in the tail, indicates that the hind limbs were smaller than the fore. There is no trace of sacrum, nor of any modified diapophyses for support of an ilium.

The *ischia* are flat, subtriangular bones, with a long median line of junction, and communicating anteriorly with the posterior prolongation of the pubic plate. Their postero-exterior margins project well backward. The pubes are broad plates, whose anterior margins diverge from each other. They are broader than the ischia, and form a broad, shallow basin for the support of the viscera. The suture defining these elements is obliterated; they are continuous, and form a weak, inferior keel on the median line. A simple curved ilium has been preserved, for which there appears to be a smooth articular surface on the pubis, to which it was attached.

The acetabular portions of these elements are flattened and furnished with convex articular surfaces. The supposed ilia are short, curved bones, resembling that of *Plesiosaurus latispinus*, Ow., or of some of the other species of that family. The shank is flattened cylindric; the distal extremity dilated, rounded, and flattened; the proximal extremity subtruncate, or truncate in two or three unequal planes, and with a median pit. It fits well when applied to a concavity on the articular surface of the pubis. The vertebræ above the pelvic arch were furnished with elongate, subcylindric diapophyses.

Dr. Turner, the discoverer of the original specimen, having made a second careful search and renewed excavations at the original locality, failed to find any bones which can be assigned to humerus, ulna, radius, carpus, or phalanges, or similar elements of the hind limbs. The pelvic and scapular arches were further completed, and an additional number of ribs obtained. The glenoid cavities are rather angular, and both were filled with solid argillaceous matrix. The acetabula are not cuplike, but merely exposures of the narrow plane extremities of the pubes and ischia; they were covered with thin layers of gypsum; the pieces of the ilia were found imbedded in the mass of matrix which occupied the pelvic arch.

This genus is well distinguished from *Plesiosaurus* by the peculiarity of the scapular arch. The mesosternum appears to be wanting, and the clavicles and coracoids form a breastplate. If the claviculus was ever united with the scapula, as in *Plesiosaurus*, no evidence of it can be seen in the specimen; it is also broader and more extended anteriorly.

Differences from other Sauropterygia.—The only genus which it is necessary to compare with the present one is *Cimoliasaurus*. The following may be noted as generic distinctions: the series of cervicals rapidly diminishes in *Cimoliasaurus* in absolute size and in relative length of the vertebræ, which are not compressed. In the present genus, they maintain a similar and increased length for a considerable distance, diminish in length very gradually, and are much compressed. The diapophyses of the dorsal vertebræ, as they descend in *Cimoliasaurus*, continue well developed until they attain the inferior planes of the centra, and have there a downward direction. In *Elasmosaurus* they cease while yet on the middle of the centrum, and are replaced by pits throughout the remainder of the length.

The neural canal is everywhere markedly larger in *Cimoliasaurus*.

The American genera of *Elasmosauridæ* may be compared as follows:

Posterior cervical vertebræ without diapophyses:

Cervicals long, compressed; neck very elongate......... *Elasmosaurus.*

Posterior cervical vertebræ with diapophyses:

Cervicals quadrate, short, depressed, transverse, rapidly diminishing in size, hence the neck short............ *Cimoliasaurus.*

Professor Owen figures and describes (Reptiles of the Cretaceous, Paleontographical Society) a vertebra which very closely resembles the cervical of *Elasmosaurus.* He considers it to be the cervical of a peculiar *Plesiosaurus*, which he calls *P. constrictus*, remarking, at the same time, its remarkably inferior pleurapophyses.

ELASMOSAURUS PLATYURUS, Cope.

This, after *Mosasaurus*, the most elongate of the sea-saurians yet discovered, is represented by a more than usually complete skeleton in the museum of the Academy of Natural Sciences of Philadelphia. It was found by Dr. Theophilus H. Turner, the physician of the garrison at Fort Wallace, a point situated near the boundary-line between Kansas and Colorado, and a short distance north from the Smoky Hill Fork of the Kansas River. Portions of two vertebræ, presented by him to Dr. Leconte when on his geological tour in the interest of the United States Pacific Railroad Company, were brought by the latter gentleman to Philadelphia, and indicated to the writer the existence of an unknown plesiosauroid reptile. Subsequent correspondence with Dr. Turner resulted in his employing a number of men, who engaged in excavations, and succeeded in obtaining a large part of the monster. Its vertebræ were found to be almost continuous, except a vacancy of some four feet in the anterior dorsal region. They formed a curved line, a considerable part of whose convexity was visible on the escarpment of a bluff of clay-shale rock, with seams and crystals of gypsum. The bones were all coated with a thin layer of gypsum, and, in some places, their dense layer had been destroyed by conversion into sulphate of lime.

The scapular arch was found in large part adhering to the bodies and neural spines of a series of the anterior dorsal vertebræ, and was detached from it at the academy. The pelvic arch had been slightly crushed, and the lumbo-sacral vertebræ forced into contact with the ischia, where they remain. A broken extremity of the supposed ilium was forced into the matrix which supports the ischia. Many of the dorsal and caudal vertebræ were sent, and remain in continuous masses, so that the succession is readily traced, and the true relations of the extremities preserved.

In removing the matrix from beneath the vertebræ, scales and teeth of some six species of *Physoelyst* and *Physostomus* fishes were found, including an *Enchodus* and a *Phasganodus;* the latter indicating a new species, which I have called *P. carinatus.* These animals had doubtless been the food of the *Elasmosaurus.*

The end of the muzzle was broken from a part or whole of the cranium, which has not been rediscovered, though Dr. Turner has made careful search. It was found in front of the vertebræ, here regarded as cervical, at some distance from them.

The whole skeleton has been under considerable pressure, so that most of the ribs have been pressed flat on the vertebræ; the long parapophyses of the cervicals have most of them been fractured at their bases and compressed, those of opposite sides thus approaching more nearly in the form of chevron-bones than they otherwise would have done. The proximal cervicals are obliquely flattened by the pressure; the other cervicals have the bodies naturally flat, with the articular surfaces much less so than the median portion. Some of the caudals are obliquely distorted.

Description.—Vertebræ.—The neck may be safely assumed as a point of departure, as it consists of above sixty mostly continuous vertebræ, which graduate to an atlas of very slender proportions. Most of them preserve more or less developed parapophyses. At the posterior extremity of this series sixteen are perfectly continuous, and in this portion a great gradation in form is apparent. The anterior are narrow, compressed, and similar to the more distal cervicals in the elevated position of the lateral angle; the anterior are subquadrate, thick, and with lower lateral rib, and stronger (?) pleurapophysis. In these respects, the latter resemble the dorsals which follow toward what I believe to be the tail. Four anterior dorsals are in one mass (figured in Plate 3); in this series, the lateral angle first approaching is finally lost in the margin of the rib-pit, the posterior thus resembling other dorsals.

In a series of four anterior dorsals, which, like the preceding, are in their original continuous mass, those of one extremity have centra rounded in section, with inferior rib-pits; those of the other have quadrate centra and elevated diapophyses; the former have the character of the first dorsals, the latter of the median dorsals. The posterior dorsals and anterior caudals form, in like manner, a continuous series of eleven vertebræ, fractured in four places. In them, the diapophyses steadily descend, reaching the inferior plane in the last; thus, with the reduction of the venous foramina to one at the seventh, indicating the point of transition from dorsal to caudal series. The zygapophyses preserve the usual arrangement, but are much compressed, so that the posterior or down-looking are confluent, and scarcely separated by an emargination.

The neural spines, at their bases, have a slight posterior obliquity; and the superior portions lean strongly in the anterior direction. The inferior limbs of the cervical pleurapophyses appear to be entirely wanting. The articular faces for the chevron-bones are seen at the extremity of the inferior rib of the caudal.

Of the cervicals, there are both axis and atlas. Of the caudal series, probably the distal half, at least, is lost. A single vertebra near the middle does not relate to either of those anterior or posterior to it. There are, therefore, at least four lost from that region also.

There is a considerable interruption immediately anterior to the last dorsal vertebra. Three large vertebræ, with long diapophyses belonging here, were embedded in the hard matrix which protected the pelvic arch. These are far from relating immediately to the vertebræ preserved before and behind them. I estimate the number missing as follows: Seven of the fourteen dorsals preserved have more or less elongate diapophyses. In *Plesiosauri*, vertebræ of this character are much more numerous; in *P. homalospondylus*, Owen gives seventeen. If we add ten to the series in the present species, it will give the abdominal space between the adjacent margins of the *oo. pubis* and *coracoidea* an extent equal to the length of the pelvic arch. This is relatively shorter than in the *Plesiosauri*. Dr. Turner found that a space of "three or four" feet intervened between the two portions of the skeleton, which was otherwise continuous. I think ten an average number to represent safely the missing dorsals.

From the cervical proximal regions, probably three vertebræ are missing from two interruptions. The remainder of the cervical series exhibits three interruptions. Most of the proximals have been broken medially, leaving the articulations solid, an advantage in determining their continuity. Three vertebræ and one-half are thus found missing in this region.

The whole number of vertebræ preserved and lost, with the relative lengths of each, may be stated as follows:

	Present.		Lost.		Total lengths.
	No.	Length.	No.	Length.	
		Inches.		*Inches.*	*Inches.*
Cranium	......	....	......	24.	24.
Cervicals	68½	257.5	3½	22.3	279.8
Dorso-lumbars	14	55.10	10	37.6	92.16
Caudals	21	60.4	30	60.	120.4
Total	103½	....	43½	....	516.36

This gives the total length to the animal of 43 feet 2 inches, which, increased by the amount taken up by intervertebral cartilages, will give roundly about forty-five feet. Of this, twenty-two must be reckoned to the neck.

The *cervical vertebræ* are assumed to commence where the rib-pits cease and the continuous lateral processes commence. This point is ascertained with difficulty on the specimen. It is, however, perhaps the same point where the longitudinal lateral ridge leaves the upper margin of the rib-pit; and it was to the series of vertebræ which pass this point that the scapular bones, the clavicle, and the coracoid were found attached. On the anterior dorsals, the inferior margin of the rib-pit is most prominent, and is finally produced into the flat, thin process which is directed obliquely downward on the cervicals. Both these and the posterior ribs are crushed on the centra, and project obliquely below them; their mode of attachment is thus rendered rather obscure. A similar structure exists in the posterior cervicals of *Cimoliasaurus*, while, on the anterior dorsals, short, thick diapophyses support the ribs. The proximal cervicals are remarkable for their compressed and elongate form. They are, for a considerable distance, longer than any dorsals. The lateral longitudinal ridge rises successively nearer to the neural arch and disappears. The articular surfaces are vertically oval, flattened above and below. The inferior faces are slightly grooved in line with the venous foramina. These vertebræ diminish in length, and, in front of the posterior third of the series, materially in depth. They diminish to terminal ones of very small size. In most, the decurved (?)parapophyses are broken near the base; but the basal portion of various lengths generally adheres. They are as wide as a rib and scarcely half as thick. They have much greater antero-posterior extent on the terminal than the proximal cervical centra, having a base five-sixths the length of the latter. The zygapophyses have relatively a larger size on these than any other vertebræ. In such, the centrum is less compressed, though with concave sides, and with a section rather quadrate.

The cervical vertebræ, from the sixty-sixth to the thirty-ninth, are all longer than the dorsals; they commence four inches in length, increase to five, and diminish to four again.

Measurements.

	Inches.	Line.
Length of sixty-third cervical	4	9.2
Depth of the articular face of the centrum	3	8.
Width of the articular face of the centrum	3	10.2
Total elevation of the ninth cervical	2	9.
Anterior posterior diameter of the third cervical	2	2.
Transverse diameter of the third cervical	2	11.
Length of the head of rib	1	9.7
Width of the head of rib	1	3.
Width of the shaft of rib	1	10.5

Many of the *ribs* preserved have been pressed upon the vertebræ and crushed.

The first *dorsal* is that vertebra which first presents a distinct articulation for a rib. The diapophyses are never much elevated above the centrum, and are longest on the thirteenth (inserting seven supposed to be lost). Their form is stout and much depressed, and distally expanded. They diminish gradually, and, on the third, are represented by a longitudinal angulation; the superior angle is first distinct on the first, and bounds the articular surface last on the third. They give the transverse section of the posterior cervicals a pentagonal form; that of the anterior dorsals is nearly circular. The latter are strongly constricted medially, and the articular faces are slightly concave. The external surface near the included angle is coarsely ridged, in conformity with coarse cellular texture of the spongy bone. The venous foramina gradually become more widely separated, approaching each other again on the posterior cervicals. On the dorsals, they occupy the bottom of a more or less pronounced concavity. These concavities, on the posterior dorsals, are bounded externally by a strong obtuse longitudinal angulation, giving a quadrate outline to the section of the centrum in this part of the series.

The posterior cervicals are not readily distinguished from the anterior dorsals. In the latter, the ribs appear to be present, of reduced length, judging from the smaller size of the remaining heads. The articular pits continue to descend till their lower marginal ridge is the inferior lateral angle of the vertebra. On such vertebræ, the inferior surface is flat.

Measurements.

	Inches.	Lines.
Antero-posterior diameter of the (?) twelfth dorsal	3	7.2
Transverse diameter of the articular surface	4	10.
Vertical diameter of the articular surface	4	2.5
Neural canal and spine (the latter broken)	5	3.5
Length of the diapophysis of the twelfth dorsal	4	
Width of the diapophysis at the middle	1	10.
Antero-posterior diameter of the (?) eleventh dorsal	3	4.5
Transverse posterior diameter of the articular face	5	3.
Vertical posterior diameter of the articular face	3	10.
Transverse posterior diameter of the neural canal		10.2
Transverse posterior diameter of the articular face of the third dorsal	5	2.5
Elevation of the centrum, arch and spine of the second dorsal	1	19.
Elevation of the upper edge of the zygapophysis of the second dorsal	6	
Length of the zygapophysis at the upper edge of the second dorsal	1	10.2
Length of the centrum of the last cervical	4	
Width of the centrum of the articular face of the cervical	5	3.
Elevation of the neural arch and spine of the cervical	7	9.
Antero-posterior width of the neural spine of the cervical at the zygapophysis	3	7.

The *caudal vertebræ* have slightly concave articular surfaces, which are not bounded by groove or ridge. The neural arches have flat sides; and there is no longitudinal ridge above the diapophyses. The neural spines are elevated; the margins of those of the adjacent vertebræ close together. The diapophysis is very short and wide, terminating in a large oval concavity for the pleurapophyses. Each limb of the chevron-bone is attached to an articular surface on the lower posterior face of the vertebra at the extremity of a strong inferior ridge. These inferior ridges are rather close together, and distinguish the vertebræ from those of *Cimoliasaurus magnus*, where they are wanting. They are absent on the anterior seven of the caudal series. The diapophysis is nearer the anterior than the posterior face of the vertebra. The venous foramen is single and median on all but the last six caudals.

Measurements.

	Inches.	Lines.
Antero-posterior diameter of the fourth caudal	2	4.
Transverse posterior diameter of the fourth caudal	3	10.5
Total elevation of the fourth caudal	8	
Vertical diameter of the centrum of the fourth caudal	3	1.5
Antero-posterior diameter of the diapophysial pit	1	9.2
Length of the ninth caudal	1	7.5
Transverse diameter of the articular face	1	6.
Vertical diameter of the articular face	1	2.7

Heads of fourteen *ribs* are preserved, and a great number of shafts. The heads are simple, with elongate-oval articular face. They are oblique in the narrow direction, and frequently in their length also; the margins are somewhat everted. The extremities of the diapophyses of the larger dorsal vertebræ are transverse, some flattened, the others more oval; the more anterior are subtriangular; and the rib-pits on the first dorsals are subround or vertically oval. Thus, the heads of the ribs also vary. The shafts are all flat, probably partly from pressure. They are frequently curved in the direction of the compression, which suggests a vertical head. They, however, are probably more or less distorted, and the plane of compression changed. No well-defined distal extremity of a rib can be made out; nor have anything like abdominal ribs been preserved.

The *scapular arch* is remarkable for its large clavicles (or procoracoids). As preserved, the latter are quite convex downward, both antero-posteriorly and transversely; while the coracoids are equally concave in both directions. The clavicles have a remarkable external flat projection, which is separated from the glenoid cavity by a deep sinus. The glenoid cavity is bounded by an elevated ridge, which sends a branch along the claviculo-coracoid suture to the precoracoid foramen. This foramen is relatively of small size, and is longitudinally oval; the two are separated by an isthmus composed equally of processes of clavicle and coracoid. The coracoids are very thin, except in a transverse portion, which extends across behind the precoracoid foramina; a strong elevated rib extends across the posterior face at this point. The outer margin of the coracoid is thickened, rounded, and slightly concave.

Measurements.

	Inches.	Lines.
Greatest antero-posterior length of the scapular arch	33	6
Greatest antero-posterior length of the clavicle	14	9
Greatest antero-posterior length of the glenoid cavity	6	9
Greatest antero-posterior length of the precoracoid cavity	7	3
Transverse extent of the claviculi	27	
Transverse extent of the coracoidea	16	
From the acetabulum to the foramen	7	6

The form of the posterior margin of the coracoidea is unknown, and they are much broken on the inner margin.

The greater part of the *pelvic arch* appears to be preserved. From the obliquity of the median suture, and from the form of the pubes, as they are preserved on a large nodule of indurated clay, it is evident that they have formed a boat-shaped support to the abdominal viscera, with an obtuse keel on the median line below.

Measurements.

	Inches.	Lines.
Greatest antero-posterior length of the pubis and ischium	25	
Greatest antero-posterior length of the pubis	13	6
Antero-posterior median length to the notch of the ischia	7	
Length of the coracoids behind the notch	4	6
Greatest width of the pubes	27	6
Greatest width of the ischia	21	

The anterior and lateral portions of the pubes are very thin, as are also the median posterior portions of the ischiadic plates. The pubic bones are thickest on the posterior margin; they present a downward-projecting median convexity near the anterior end. Depth of the articular face, 2 inches 8 lines.

The superior surface of this arch was brought to light by the exertions of my friends B. Waterhouse Hawkins and William M. Gabb, who removed a large mass of matrix, which fortunately protected and accompanied it. This presents a transverse thickening extending across it, and continuous with the posterior margin of the clavicles. A median longitudinal thickening extends from this to the anterior emargination, embracing in its angle with the transverse a shallow concavity. The posterior projection, which is continuous with the median part of the ischia, is strongly deflexed behind the transverse rib, and is continuous with the basinlike concavity formed by the united pubes. The glenoid surface of the pubes is a sigmoid, while that of the ischia is regularly convex. The articulation of the ilium has been exclusively with the former.

Of the pleurapophysial portion of the two arches nothing appears to be preserved except two lateral symmetrical long bones. One was found embedded in the mass carrying the pelvic arch, and they articulate well with the pubes; but the articular extremity is too short to articulate with ischia at the same time. Though they resemble the inferior view of the procoracoids, they represent the ilia of *Plesiosaurus*. The head is subdiscoid, rather flat, slightly projecting eccentrically with a ligamentous pit. The articular surface is very oblique to the axis of the shaft, and is separated from the surface by a marked angle all round. Nothing like a trochanteric ridge is apparent in this bone.

Measurements.

	Inches.	Lines.
Length in the middle of the curve	9	9
Diameter at the head	3	3
Diameter, distally, on the curve	6	
Diameter, distally, straight	1	

The shaft is flattened cylindric; much flattened nearest the proximal extremity. The latter is very oblique to the shaft, and slightly convex near the proximal margin.

The end of the *muzzle* preserved includes also the symphysis and parts of the rami of the mandible. The parts have been crushed together, and the ends of the teeth broken off. The alveoli of the two jaws incline at a narrow angle to each other; hence the teeth, which alternate, cross each other near the middles of the crowns. The parts preserved appear to belong to the premaxillary bone, though no suture can be found, and the bony walls are so thin as to render their obliteration a probability. There is a keeled ridge along the middle line above, which is not continued to the margin of the bone. The form of the muzzle is narrow; the sides subparallel near the tip, which is elongate rounded. The mandibular symphysis, however, is not very elongate, as the rami are given off at three inches from the tip. The latter appear to have been quite slender from the various small sections or pieces sent with the muzzle. The premaxillary border of 4 inches 7 lines exhibits eight teeth, or their alveoli, of which the median two are close together, and not separated by any mandibulars. The sections of the teeth are round or oval, and their sizes are irregular, probably on account of differing age and degree of protrusion. The diameters at alveolar margin vary from 6 lines to 3. Their form is slender conic, or, with the root, slender fusiform, and the pulp-cavity is small and median, sometimes cylindric, and sometimes narrowed. The surface, from a short distance above the alveolar margin to the tip, is marked with acute, threadlike ridges, which are sometimes interrupted, and sometimes furnished with short branchlets. They are more or less undulate, and do not unite, but simply cease as the tip of the tooth is approached. The latter is smooth without lateral cutting-edges. The width of the mandible at the commencement of the rami is 3 inches 0.05 line; of the muzzle of the seventh tooth, 3 inches 7.5 lines; at the third tooth, 2 inches 4.2 lines.

General Remarks.—The tail is a powerful swimming-organ, more or less compressed in life; hence the specific name, which means flat-tailed.

The danger of injury to which such an excessively elongate neck has been exposed would render the recovery of a perfect specimen like the present an unusual accident. The neural spines of the dorsal region are so elevated and closely placed as to allow of little or no vertical motion of the column downward; while, those of the cervical and caudal region being narrower, the elevation of the head is quite possible, and an upward flexure easy.

The habits of this species, like that of its known allies, were rapacious, as evinced by the numerous caninelike teeth, and the fish-remains taken from beneath its vertebræ. The general form of this reptile was that of a serpent, with a relatively shorter, more robust, and more posteriorly-placed body than is characteristic of true serpents, and with two pairs of limbs, or paddles. It progressed by the strokes of its paddles, assisted by its powerful and oarlike tail. The body was steadied by the elevated keel of the median dorsal line, formed by the broad, high, neural spines. The snakelike neck was raised high in the air, or depressed at the will of the animal, now arched swanlike, preparatory to a plunge after a fish, now stretched in repose on the water or deflexed in exploring the depths below.

Comparisons.—In *Cimoliasaurus magnus*, the dorsals with elevated diapophyses have considerably larger centra than those in which they are situated lower down. In *E. platyurus*, these vertebræ are of relatively equal length. The cervical pleurapophyses in *C. magnus* are anteriorly considerably stouter and less flattened.

In comparing this species with the *Cimoliasaurus grandis*, Leidy, from Arkansas, we observe, first, the generic character of the strong inferior diapophyses in the latter. That species marks itself also as a pre-eminently short-necked form, as these anterior dorsals are even shorter than in *C. magnus*, being nearly twice as wide as long. The depth of the articular faces is also relatively greater than in the *E. platyurus*.

Localities.—This species has been found in various parts of Kansas, besides that from which the specimen above described was procured. Prof. B. F. Mudge obtained vertebræ from a point thirty miles east of Fort Wallace, which probably belong to this animal.

PLESIOSAURUS, Conybeare.

Two American species have been provisionally referred to this genus: the *P. lockwoodii*, Cope, from No. 3 of New Jersey; and the *P. gulo*, Cope, from Kansas. This determination is only temporary, since the structure of the sternum, in which the type-characters of the sauropterygian families are to be observed, are unknown. The two species agree with *Plesiosaurus*, and differ from *Elasmosaurus* and *Cimoliasaurus* in the non-coössification of the arches and centra of the vertebræ.

PLESIOSAURUS GULO, Cope.

The typical specimen consists of eleven cervical, thirteen dorsal, and seven or eight other vertebræ, with portions of scapular and pelvic arch and ribs.

The cervicals are longer than wide, and considerably compressed in form anteriorly, but depressed posteriorly. This is partly due to pressure, but not wholly; and it is likely that the posterior centra are about as transverse as in *Cimoliasaurus magnus*, Leidy; while the anterior are relatively several times as long. In the length, the latter resemble the English *Plesiosauri*, in which the centra are also compressed. The compressed anterior centra exhibit a ridge on the side above the middle. A more massive ridge extends between the articular extremities at the lower part of the side, and presents a pit for the parapophysis. The pit for the neural spine is of nearly similar size. Where the cervicals begin to be depressed, two foramina appear near together on the inferior face, and the articular extremities display an open obtuse emargination below. They are also emarginate for the neural canal above, so as to have a form approaching a transverse figure 8. In the large posterior cervicals, the sides are contracted both below and at the sides. In all the cervicals, the articular faces are a little concave; in the larger, with some median convexities.

In none of the dorsals preserved are the diapophyses seen to issue from the centra; hence the former are probably not posterior in position. The centra soon become smaller than those of the posterior cervicals, and are subround in section, with a well-marked emargination for the neural canal. The sides are gently concave, and are without angulation, but are marked near the articular extremity with short, sharp, and regular undivided ridges, eight in a half-inch. The articular faces are slightly concave and without ridges. There are the two inferior foramina, and one on the lower part of each side. The articular face for the neural arch is an oval pit extending the length of the centrum, and interrupted by some transverse ridges near the middle. The vertebræ diminish in size posteriorly. Two centra, probably sacral, resemble the dorsals, but present an extensive vertical articular surface on each side. This facet has raised edges, and terminates above in the longitudinal surface for the neural arch, having thus a T-shape; it narrows below to an obtuse point, and, no doubt, supported a free diapophysis.

The fragments of the pelvic and scapular arches indicate that they are capacious. The clavicle incloses a large foramen, and is thickened on the inner edge. The glenoid surface of the coracoid was wide and subrhombic. Some of the other bones are quite thin. The median suture of the ischium is relatively about as long as in the English *Plesiosauri*, and the adjacent part of the bone has a similar form.

Measurements.

	M.
Length of the anterior cervical	0.062
Depth of the articular face of the anterior cervical	0.050
Width of the articular face of the anterior cervical	0.050
Length of the posterior cervical	0.070
Depth of the articular face of the posterior cervical	0.052
Width of the articular face of the posterior cervical	0.090
Distance between parapophysial pits	0.048
Length of the anterior dorsal vertebra	0.059
Depth of the articular face of the anterior dorsal	0.062
Width of the articular face of the anterior dorsal	0.072
Width of the neural canal on the centrum	0.017
Long diameter of the proximal end of the clavicle	0.114

This saurian is readily distinguished from the *Elasmosaurus platyurus*, Cope, by the relatively shorter cervical vertebræ and the regular acute ridges on the exterior surfaces near the margin of the articular faces, as well as the less contracted form of all the vertebral centra. As the neural arches and the cervical parapophyses are not coössified with the centra, the species is referred to the genus *Plesiosaurus*.

The bones of this reptile and those of a smaller species, probably a *Clidastes*, were found in close proximity, near Sheridan, Kansas, by Joseph Savage, of Leavenworth. According to this gentleman, the vertebral column of the *Clidastes* was found immediately below that of the plesiosauroid, and in a reversed position, as though it had been swallowed by the latter, and larger reptile. The largest vertebræ of the *Clidastes* were about three-quarters the length and one-fourth the diameter of those of the plesiosauroid, and the animal must have furnished a large, or at least a long, mouthful for its captor. The bones of the *Clidastes* were not in good condition, and resembled those of *C. cineriarum*, Cope, though smaller.

TESTUDINATA.

This order is but sparingly represented in the marine formation of No. 3, and more abundantly in the fresh-water beds of No. 6. Of the former, there are three species, two of them with natatory limbs of the character now known among sea-turtles. Of the latter, all are *Trionychidæ* and *Emydidæ;* the land-tortoises not appearing among them, according to present information.

COMPSEMYS, Leidy.

This genus presents the characters of *Emys* in its well-developed marginal bones, united to the costals by suture. The surfaces of the carapace possess a dense layer, which is sculptured in two of the known species. One of these, the *C. victus*, Leidy, has been found to have had a wide range in the West during the Fort Union epoch; while a second has been found in corresponding strata near the northern boundary of Dakota.

Compsemys ogmius, Cope.

Represented in the collections of the British American Boundary Commission by portions of the carapace and plastron. These are massive, and indicate a species of large size. As in other species of the genus, the external surface is a dense layer of cement or allied substance, which is sculptured with shallow pits.

A portion of the costal bone is concave, and increases rapidly in thickness in one direction. The suture is coarse, but neither gomphosial nor squamosal. A portion of the plastron is thinner, not curved, and displays a very coarse median suture, in part squamosal in character. The sculpture consists of shallow pits, not wider than the low, smooth ridges which separate them. There are deep superficial grooves, marking the boundaries of dermal areas; a feature in which this tortoise differs much from the *P. coalescens*, and resembles the species of *Compsemys*. Should marginal bones be found to exist in the *P. ogmius*, its reference to that genus will be further established.

From six miles west of first branch of Milk River, near latitude 49°.

ADOCUS, Cope.

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

This genus possesses a large intergular plate. This I have verified on *A. beatus* and *A. syntheticus*. Having also perfect xiphisternal bones of these two species, I can show that there is no sutural attachment for the pelvic bones. The co-existence of these two characters has been hitherto found to be universal, and the present deviation from it is a point of much interest. Instead of sutural surfaces, there is an obtuse ridge corresponding to the pubis, and a knob answering to the extremity of the ischium, both more prominent than is usual in genera of *Emydidæ*.

This exceptional combination of characters points to the propriety of separating *Adocus* as the type of a family equally distinct from the *Emydidæ* and the *Hydraspididæ*, to be called the *Adocidæ*.

Further characters of the genus have been already pointed out in the later essays above quoted. They are: the free lobes of the plastron narrowed and shortened, furnishing extensive posterior and anterior entrances to the carapace; a series of intermarginal scuta on the bridge; costal capitula reduced or wanting.

No recent or even Tertiary form of the *Testudinata* has yet been discovered which possesses the remarkable combination found in this genus; and I think it must be regarded as a generalized group, and as such of much interest to the student of paleontology.

ADOCUS (?) LINEOLATUS, *sp. nov.*

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

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

Measurements.

	M.
Width of the vertebral bone in front	0.0135
Width of the vertebral bone (greatest)	0.0280
Thickness of the vertebral bone	0.0070
Thickness of the sternal bone	0.0080

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

PLASTOMENUS, Cope.

This genus has been discovered to embrace tortoises having characters of both *Trionyx* and *Emys*. The carapace is like that of the former, in the absence of articulated marginal bones, and the presence of a superficial cement layer, which is sculptured in various patterns. The plastron resembles that of some emydoid genera, but presents certain fontanelles indicating an incomplete grade of ossification. The species known to possess the typical structure are found in the Eocenes of Wyoming and New Mexico; and those here referred to it are all from the Fort Union or Transition beds of the Cretaceous. In none of them is the sternum so well-preserved as to exhibit the characters which should finally refer them to the genus *Plastomenus.* This is due to the fact that they, as well as other vertebrate remains from this horizon, are always much broken or dislocated.

Plastomenus coalescens, Cope.

This species is represented by large fragments of carapace and plastron of a single individual. These indicate a large animal of adult age. The fragments are thick, and the sutures separating the component elements have disappeared. Dermal sutural grooves are also wanting. The portions of the plastron preserved are emydoid in character, being most thickened in the lateral portions, especially in the inguinal region. The borders of the carapace are free and obtuse; at some points, somewhat thinned out. The ribs proper, in the portions preserved, terminate in a short, free extremity, shorter than in most species of *Trionyx.* There is no indication of the existence of marginal bones.

The surface of plastron and carapace is covered with a dense layer, which is thrown into rather coarse, inosculating folds These form an open, reticulate pattern towards the middle portion of the carapace, and become obscure near the borders. They are well-marked on the plastron, and are more or less longitudinal. The appearance is that of a *Trionyx.*

The costal axis scarcely projects on the inner face of the carapace. The anterior border of the carapace is a free, thickened margin, divided by a horizontal groove. The presence of nuchal bone cannot be ascertained.

Measurements.

	M.
Thickness of the carapace at the middle of the length of a costal bone	0.014
Thickness of the carapace at the anterior margin	0.008
Thickness of the carapace at the lateral margin	0.008
Thickness of the plastron near the bridge	0.015
Thickness of the plastron more centrally	0.009

Four areolæ in $0^{m}.10$.

This species is found in a greenish-brown arenaceous clay deposit near the Milk River in British America, belonging to the Transition series, probably the Fort Union or Lignite epoch. Collected by George M. Dawson, of Montreal, geologist of the British North American Boundary Commission, near Woody Mount.

Plastomenus costatus, Cope.

Represented, in the collections made by Mr. Dawson, by small portions of plastron and carapace, which display distinct osseous, but no dermal scutal sutures. These specimens were discovered together, and are believed to belong to the same individual. The bones are thinner than corresponding ones of the two other species of tortoises described, from the same locality, excepting at the costal enlargement, which is remarkably prominent and well-defined on the under side of the carapace. The dense or cement layer of the carapace is thrown into very delicate, but prominent ridges, which run parallel to the axis of the carapace, and occasionally inosculate, or are crossed by a similar ridge running at right angles to them. The sculpture of the plastron is similar, but more obtuse and obscure. The superior edge of the free border of one of the lobes of the plastron projects beyond the inferior, and is not, as is usual, less prominent than the inferior.

Measurements.

	M.
Thickness of a costal at the margin	0.005
Thickness of a costal at the rib	0.009
Thickness of the free edge of the plastron	0.009

The costal bone of this species is much like that of a *Trionyx*, but the character of the plastron refers it to *Plastomenus*.

Collected in the bad lands of the Fort Union Cretaceous, south of Woody Mount, near latitude 49°, British America. Associated with this species were the *P. coalescens*, *Compsemys ogmius*, fragments of perhaps *Compsemys victus* and *Trionyx vagans*, with *Dinosauria*, *Cionodon stenopsis*, etc. (See chapter I.)

? Plastomenus punctulatus, Cope.

Established on a costal bone found in association with the preceding species, and referred to the genus *Plastomenus* provisionally, and with a possibility that it will be found not to pertain to it when fully known.

That genus has so far only been found in the Eocene formation. The bone is rather thin, and sufficiently curved to indicate a convex carapace of moderate thickness. The surface is marked with closely-packed shallow pits without material variation of form on the proximal half of the bone. The result is an obsolete sculpture quite similar to that seen in some species of the genus to which it is at present referred.

Measurements.

	M.
Width of the costal bone	0.0230
Thickness of the costal bone	0.0033
Number of pits in $0^m.010$, 6.	

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

? PLASTOMENUS INSIGNIS, *sp. nov.*

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

Measurements.

	M.
Length of the hyposternal fore and aft	0.025
Thickness of the hyposternal at front	0.004
Pits in $0^m.010$, six.	

Lignite Cretaceous of Colorado.

TRIONYX, Geoffr

Although species of this genus occur in the greensand of Cretaceous No. 4, in New Jersey, none have been discovered in the West below the horizon of No. 6, or the Fort Union fresh-water beds. Dr. Leidy has described a *T. foveatus* from the bad lands of the Judith River, Montana: and I have added the following:

TRIONYX VAGANS Cope.

Bulletin of the United States Geological Survey of the Territories, No. 2, 1874.—*Trionyx ? foveatus*, Leidy, Proceedings of the Academy of Natural Sciences, Philadelphia, 1856, p. 312.

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

Measurements.

	M.
Width of the costal bone	0.0370
Thickness of the costal bone	0.0045
Number of areæ in 0m.019, 4 and 5.	

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

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

CYNOCERCUS, Cope.

Established on a metapodial bone and caudal vertebræ of a tortoise of uncertain, but in any case peculiar, affinities. The caudal vertebræ are not anterior ones, almost lacking diapophyses, but are long and slender, and the articular faces singularly incised. The form had a tail more elongate than the snapping-tortoise, and different from it in details of composition, especially in being of the procœlian type.

Associated with the remains of *Clidastes*, and other saurians, and at a distance of two or three hundred yards from the locality of the fossil *Protostega gigas*, were found some vertebræ of a Testudinate reptile, which approaches the type of *Trionyx*.

CYNOCERCUS INCISUS Cope.

The vertebræ have elongate centra concave below, and have well-developed diapophyses. One vertebra has transversely oval articular extremities; in another, they are much less depressed. The former is the more anterior, being known as such by its larger diapophyses and much smaller articular surfaces for chevron-bones; it appears probable, indeed, that this one has been without these appendages. It is, therefore, from no great distance behind the sacrum. Its position being thus determined, it may be described in detail as follows:

As observed, the centrum is elongate and depressed. The inferior surface at the cup is flat; it is then arched upward, descending again to the rim of the ball. The posterior two-thirds has a median groove, which terminates in a deep notch of the ball, which involves one-third of its vertical diameter, and widens backward. The ball is transverse oval, and only moderately convex; near its upper margin, a small deep pit interrupts its surface, having the appearance of an unusually large ligamentous insertion; its border slightly excavates the margin of the ball. The cup is a transverse oval, wider below. Its inferior and superior margins are so deeply (but openly) emarginate as to reduce the concavity in the vertical direction very much. From the superior emargination, a deep groove descends to below the middle, probably for ligamentous insertion. The neural canal is subtrilateral. The neural arch is, as usual in this group, deeply emarginate in front, and much prolonged behind. The zygapophyses project beyond the ball, and the arch is contracted in front of them. Its upper surface has neither process nor keel, but is rugose for ligamentous and muscular insertion. The diapophyses have a wide base, and are subcylindric.

The surface is delicately reticulate rugose; coarsely rugose on the external faces of the zygapophyses. There are several small nutritious foramina, the largest being in the bottom of the groove of the lower face.

Another vertebra differs in being rather more slender, and in having an obtuse keel of the neural arch. The pit of the ball is wanting, and the inferior emargination. The chevron-articulations are larger; and the groove of the cup occupies its middle, instead of its upper half.

Measurements.

	M.
Length of the centrum (greatest)	0.027
Diameter of the cup, vertical	0.01
Diameter of the cup, horizontal	0.017
Elevation of the top of the neural arch above the floor of the neural canal	0.013
Length of the arch on the median line above	0.02
Width of the arch in front of the posterior zygapophyses	0.012

A metacarpal or metatarsal bone was found near, though not with, the vertebræ, and probably belongs to the same animal. If metatarsal, it is much stouter than in *Trionyx*, but is more likely to be a metacarpal. It is about as long as the vertebræ, centrum and arch together. The proximal end is transversely truncate, compressed L-shaped; the shaft compressed-subquadrate; the articular extremity hour-glass-shaped, with an inferior projection for the insertion of a flexor-tendon. This bone is not that of a marine turtle, but of a species of riparian or terrestrial habits. Length, $0^m.034$; proximal diameter, $0^m.013$.

These vertebræ indicate a genus with elongate tail like that of *Chelydra*, or probably longer; but they differ from those in that genus by their procœlian character. An approach to their incised margins is to be found in *Trionyx;* but in those of that genus, where this character appears, the diapophyses are largely developed. The genus is evidently quite distinct from anything known, and we await further remains with interest. The species is much smaller than the *Protostega gigas*, and about equal to the Mississippi *Macrochelys.*

TOXOCHELYS, Cope.

This genus is represented by a single species as yet, which reposes on a number of specimens. These indicate a structure in many respects similar to the genus *Chelone*, but sufficiently different to belong to another genus

The mandibular ramus is slender, and has a narrow, flat, alveolar surface. The coronoid process is moderately elevated, and is excavated behind by the anterior extremity of the elongate and deep dental foramen. The cotylus is depressed, and the articular bone ossified; the angle is not produced. The coracoid bone is long and spatuliform, like that of the marine turtles. A fragment of the same skeleton supports a condyle with slender, subcylindric, slightly-curved bone attached to one side of it. Were it not a turtle, I should say that these are the extremity of the quadrate, with a slender jugal or malar bone adhering.

The slenderness of the mandibular rami resembles the form in *Chelydra*, but it differs in the absence of the alveolar cutting-edge of the latter. The phalanges are broad and flat, and not unlike those of *Protostega.*

TOXOCHELYS LATIREMIS, Cope.

The symphysis mandibuli is very short, and the upper face horizontal. The angle is truncate behind, flat, and not produced beyond the cotylus.

Measurements.

	M.
Length of the coracoid	0.250
Width of the coracoid distally	0.080
Length of the ramus of the mandible	0.157
Length of the symphysis of the mandible	0.031
Elevation of the coronoid of the mandible	0.043
Width of the angle of the coronoid	0.023

The axes of the mandibular rami produced unite at an angle of 65°, indicating a muzzle of intermediate length.

The size is about that of the existing loggerhead (*Caretta caouana*).

Found by Professor Mudge near the forks of the Smoky Hill River.

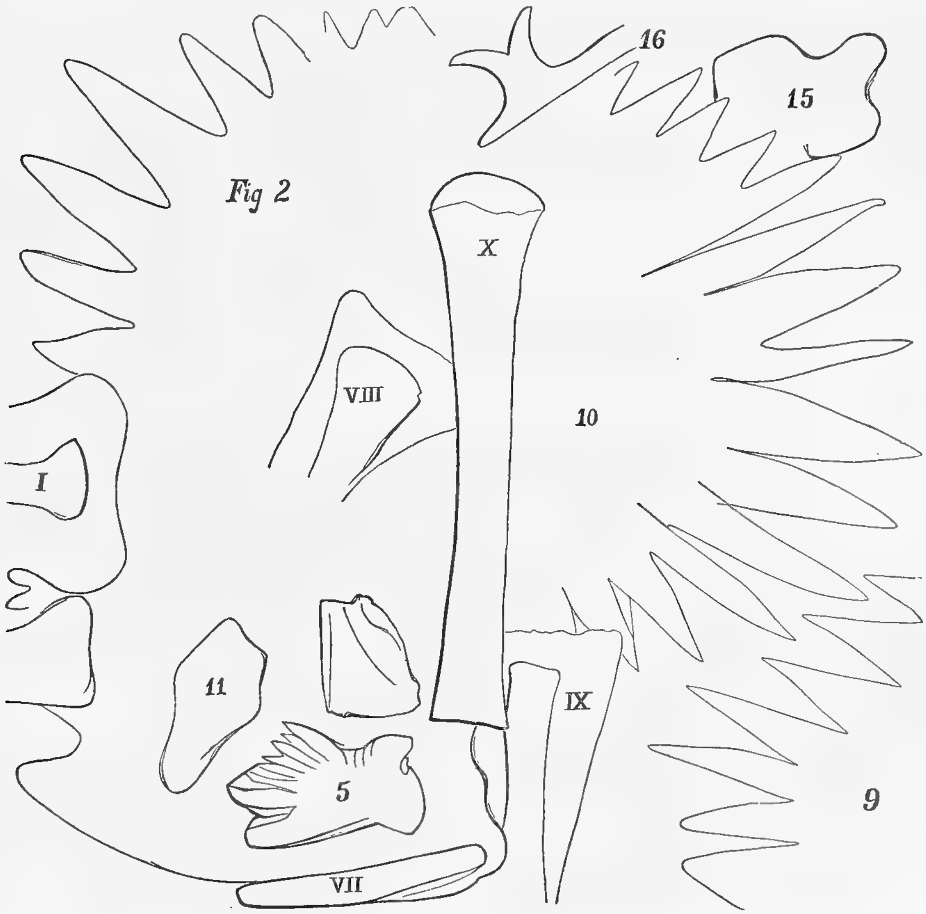


FIG. 2.—Sketch of the large radiated bone of *Protostega gigas*, with other elements, as they were uncovered by excavation; size much reduced, drawn on the spot. Nos. I, VII, VIII, and IX, costal bones, with the rib-heads looking upward; X, the coracoid bone; 5, a marginal bone; 9 and 10, the lateral a radiate bones; 16, vertebra, with other bone adherent.

PROTOSTEGA, Cope.

This genus is the type of a new family of tortoises of the suborder *Athecæ*, characterized by the lack of expansion of the ribs into a bony roof, or carapace, and the development of independent superficial dermal bones. The dermal bones consist of large plates lying above the ribs, which have no sutural union with each other; of some small vertebral shields on the dorsal line; and of thin, marginal bones, which have no sutural union with each other or with the other bones. The vertebræ preserved possess ball-and-socket joints, and have flat neural arches, with widely-spreading articular processes. The humeri are flat, and furnished with an enormous deltoid crest. The fore limbs were very long, and formed flippers like those of the marine turtles of the present seas. The bones of the head are very light and thin, and mostly united by squamosal or overlapping sutures. The mandible presents the elements usual in the marine turtles, and has no angle. It exhibits a deep pterygoid fossa, and is very light. The constitution of the bones is rather dense, and there are no medullary cavities whatever. The superficial layer is very thin and striate. The bones are all very fragile.

The affinities of this genus appear to be largely to the *Sphargididæ*. This family is represented, in our present knowledge, by but one genus and one species of the recent seas. It is one of the most generalized, or, in special characters, the most aberrant, of the order of tortoises, and the discovery of an extinct ally, even as far down in the series as the Cretaceous period, is not surprising.

The remains preserved belong to a single individual, and include many portions of the cranium, five vertebræ more or less incomplete, the scapular arches of both sides, with the coracoid bones; both humeri perfect, with nine phalanges, ten ribs, one vertebral(?), and ten marginal bones; parts or wholes of four large lateral (?) dermal bones, with five distinct bones of unknown reference. There are also some slender curved bones, which probably pertain to the plastron.

As the bones were exposed by excavations in the yellow Cretaceous chalk, sketches of their positions and relations were made, which aid materially in the restoration of the animal. The upper layer of bones were those of most irregular form, as cranial and limb bones. Mingled with these, but often beneath them, were the ribs; while underlying all were the large flat pieces here described as dermal. Adhering to the inferior surface of these was a layer of thin oyster-shells, with parallel striate surface, perhaps *Inocerami*. The ribs presented their heads upward, so that, taking all points into consideration, there is little doubt that the reptile was entombed lying on its back.

The texture of the bones is peculiar. There are nowhere to be seen medullary cavities, and the bone is spongy, but very finely so; the tubules at the largest being equal in diameter to an ordinary pin, and generally considerably smaller. They are arranged in concentric series. There is no thick dense layer of the bone as in other tortoises, but an extremely thin one, which is hard, and sculptured on the surface with minute grooves or pits. The tissue of the bone is very fragile, and has a fracture like the mineral inclosing it. Many of the bones, especially those of the dermal skeleton, are extremely attenuated on the margins, being no thicker than writing-paper.

In discussing the affinities of this genus, one doubtful point must be considered. The large flat elements described as lateral dermal bones, are they ossifications of the dorsal or ventral integument? They were found below all the other bones, and nearly all the ribs laid on them with their heads turned upward. This rendered it probable that the shields were dorsal, and that the animal was entombed on its back; and a coracoid, which was afterward found lying immediately on the largest bone (No. 10), crossed in its course parts of two ribs. This could not have been the case had the shields been ventral. An examination of the shields does not reveal any conformity to any known type of Testudinate plastron. The bones radiate in all directions, leaving no margins for fore and hind limbs, or for a median fontanelle, still less for suture with each other.

Should these bones then be regarded as dorsal, they constitute a character not previously noticed in the order, but one whose homologue is seen probably in the dermal shield of bony tesselated plates seen in *Sphargis*. The other points of affinity to *Sphargis* are the distinct ribs; the thin laminiform jaws with cutting-edges; the quadrate bone with such a strong anterior concavity; the elevated position of the zygomatic bone; the form of the humerus. Points of special resemblance to *Chelone* are: the short posterior superior portion of the quadrate; the entire edge of the maxillary bone; the deep dentary. The points in which it differs from both are numerous. They are: the dorsal shields; the marginals; the notched symphysis, etc.; the shortened articular end of scapula; the elongate form of the carapace, etc.

The constant separation of the ribs and the short vertebræ are characters which are more like those possessed by other reptiles than those characteristic of *Testudinata*. The presence of dermal dorsal bones is of the same kind. The genus *Protostega* then belongs near the *Sphargididæ* in the suborder *Athecæ*, and is in some points to be approximated to the *Cheloniidæ*.

PROTOSTEGA GIGAS, Cope.

There are twelve *marginal bones*. They are all characterized by their laminar form. The thinnest are those farthest removed from the middle of the sides. They consist of a single lamina, slightly thickened within the margin, producing a slight convexity of the lower side. The proximal part of the bone is an extremely thin plate, with radiating ossification, and consequently more or less serrate margin. It extends some distance over the extremity of the rib, whose apex is received into a half-pit or acuminate groove with abrupt termination, about one-sixth the width of the bone from the margin.

In following the marginals to the middle of the side, the edge, as usual, increases in thickness. The lower side becomes more convex, and the upper slightly concave. The edge is acute, with a very open interior entering angle at the middle. The lateral extremities of the marginals are irregular, terminating in a double series of closely-packed digitations, which terminate freely, and enter into no suture. The pit receiving the extremity of the rib approaches the margin, which now develops an inferior lamina of bone. This incloses the end of the rib, and thins out laterally in contact with the superior plate. In some, the inner lamina is short; in others, it is almost as extensive as the outer part of the marginal plate, causing the double appearance when fractured. As the marginals thicken, a distinct inferior plane becomes distinguished, separated from the interior face by an obtuse angle. The upper face near the margin is more concave. In the thickest, the inferior face is also somewhat concave, and the edge quite acute. The lateral extremities consist, as before, of packages of digitations, which easily break out.

A single nearly bilateral bone of this series appears to be either nuchal or caudal; but, as it has no sutural connection with any other, it is not easy to determine which it is. Its marginal length is much less than its transverse extent, which consists chiefly of a flat lamina. The marginal part is a little thickened, and bilaterally concave below, and correspondingly convex above. The margin is thin and acute. A few grooves radiate at a distance from the middle toward the margin. The lack of concave excavation of the margin would incline the balance in favor of the view that this bone is the caudal.

A very long, gently-curved bone is probably the marginal extending on one side of the nuchal. It is nearly twice as long as the others, and has an extensive and thin superior lamina. Its ?anterior part is in one plane; but the margin soon thickens, and displays a rather wide infero-external face. It appears to have had an inferior lamina on its posterior half, which made an angle with the face just described. An oval cavity included looks as though designed for the apex of a rib.

The variation in the lengths of these marginal bones is noteworthy. I give measurements, premising that a few lines may be added to the extremities of some for lost digitations.

Measurements.

	M.
Length of the long anterior (11 inches)	0.28
Width of the long anterior (some lost)	0.135
Length of the lateral with the inferior face	0.195
Width of the lateral (much lost)	0.110
Length of the lateral with narrower inferior face	0.206
Width of the lateral (much lost)	0.115
Length of one with the interior lamina	0.14
Width of one (some lost)	0.086
Length of a thinner, no inferior plate	0.193
Length of a still thinner, no inferior plate	0.182
Width of a still thinner (broken)	0.137
Length of the thinnest	0.162
Width of the thinnest (nearly complete)	0.160
? Caudal length	0.117
? Caudal width	0.150

The shortness of the marginal with large interior lamina is noticeable, as also the same peculiarity in the caudal. As compared with marine turtles, difference is to be observed in every particular. Such are the lack of sutural union; the laminar character; the great extent of the superior and distinctness of lower laminæ. There is no trace of epidermal sutures visible anywhere.

A single symmetrical plate appears to have belonged to the middle line of the back or nape. It was subtriangular in outline, all the margins very thin, and with an obtuse keel extending on the middle line, on the posterior (or anterior) two-thirds to the apex. This ridge disappears in ?front by a gradual expansion The surface is marked by lines of minute pits and grooves, which radiate from the base at the (?) front of the ridge. Length, $0^m.135$; width, $0^m.21$.

The *lateral dermal bones* preserved, are two entire, and large parts of one or two others. They have an irregular oval outline, and are slightly dished on the inferior surface or that next the ribs. The upper surface is more convex longitudinally, from the thickening of the bone. The margins are irregular, from the projection of many digitations. Some of these are broad and flat; others are narrow. They are frequently two deep, and the fissures separating them occasionally extend far toward the middle of the bone. The convexity assumes the form of a low ridge toward one end of the bone. At the point where this reaches the margin, the latter is in all the four plates, thickened, and composed of several layers of packed osseous radii. When found, the ribs laid across these shields, one of them occupying the position of a radius to one of them. These shields are much larger than the marginal bones.

Measurements.

	M.
Length of "No. 10" (21 inches)	0.535
Width of "No. 10" (broken)	0.400
Thickness at the middle	0.014
Length of "No. 9"	0.530
Width of "No. 9" (much broken)	0.350
Thickness at the middle	0.013

The lengths and breadths given are a little below the truth, owing to the loss of the exceedingly thin margins.

Turning to the endo-skeleton, the *vertebræ* deserve mention. There are more or less complete examples of five of these; in two, both centrum and neural arch, in two neural arch, and in one centrum, are preserved. These have been recognized chiefly by their neural arches, which are separate. They are in form something like an X, the extremities of the limbs carrying the zygapophysial surfaces. The only point of contact with the centrum is a wide process, which stands beneath the anterior zygapophysis, and spreads out footlike obliquely forward and outward, to beyond the line of its anterior margin. Its surface extends nowhere posterior to the surface of the zygapophysis above it, but a little farther inward. Its outer margin rises ridgelike to the under side of the neural arch, and each one, forming a semicircle, forms the boundary of the neural canal, and, turning outward, forms the *inner* boundary of the posterior or down-looking zygapophyses. The space between these apophyses is roofed over, so as to produce a shallow zygantrum, which, however, only seems to roof over the deep emargination of the neural arch of the vertebra immediately following. The anterior zygapophyses are often broken away, so that the neurapophysial supports look like the missing pair, when the difficulty ensues that both pairs look downward. The top of the neural arch is, in two cases, broad and flat; in two others, there is an obtuse keel.

The centra, apart from their arches, are puzzling bodies, especially since in the present case, they are somewhat flattened by pressure. They differ materially in size; one of them being twice the size of the others. The smaller ones are of the ball-and-socket type, and have a deep longitudinal groove on each side. The thicker portion of the centrum forms the inferior boundary of this pit-groove, while a thinner portion, possibly a diapophysis, limits it above. It is, however, thin, and had no great length. There is no sign of chevron bones and articulations, so that these vertebræ may have been cervical. Their bodies are, however, shorter and wider than in those vertebræ of any known tortoise. A groove on the upper surface represents the neural canal; while a flat area on each side, in front, supports the neurapophyses. The large centrum exhibits the superior groove and antero-lateral platform for support of the neural arch. One end is cupped obliquely, while the other is nearly plane, with the same obliquity and a slightly-raised margin. Its outline is subtriangular. The lower side of this centrum possesses a short keel posteriorly. The sides exhibit no pit, but have a thin edge, which is concave behind the middle, and then turned outward. I can see no articulation for a rib.

The forms and characters of these vertebræ resemble *Sphargis* more than anything yet described.[1] Either the large or the small, or both, must be referred to the dorsal region; in this case, the concavity of one extremity is a new feature among tortoises, so far as known. The great freedom of the arch from the centrum is very peculiar; while it is probable that the articulations of the ribs were to the middle of the side of the body, and not to the adjacent parts of two bodies, and may have been (see below) to processes or diapophyses.

Measurements.

	M.
Length of the medium centrum	0.037
Width of the medium centrum	0.060
Length between the margins of the zygapophyses of the medium centrum	0.060
Width between the anterior margins of the zygapophyses of the medium centrum	0.070
Width between the posterior margins of the zygapophyses of the medium centrum	0.047
Width between the anterior bases of the arch	0.070
Width of the arch at the middle	0.028
Length of the arch at the middle	0.040
Width of the posterior zygapophyses of No. 2	0.048
Width of the arch	0.025

[1] See Temminck and Schlegel Fauna Japonica, Reptiles, Tab. 1–4.

	M.
Length of the arch	0. 025
Length of the anterior foot (oblique)	0. 020
Length of the centrum of the large one	0. 060
Width of the centrum of the large one	0. 094
Width of the neural canal of the large one	0. 017

Ten *ribs* were recovered. These are slender and rather flatter than in most reptiles, but without the peculiar form characteristic of tortoises and turtles. They are most expanded proximally; the bone spreading into a lamina from the tubercular region, extending laterally and proximally some distance beyond the head. The superior plane of this expansion is continuous with that of the rib, and is flat; the head of the rib therefore turns downward and inward from it, to join the vertebra. Now, the extent of the inner part of the lamina is such that, were the head articulated to any of the centra discovered, the laminæ would interfere or overlap. They may, therefore, have been articulated to diapophyses. The expansions are serrato-digitate on the margins, and exhibit radiating grooves and ridges in some places on the superior aspect. The lengths of these ribs are not so great as the proportions of some of the other bones would indicate.

Measurements.

	M.
Length of "No. VI" (16 inches)	0. 510
Width at the head	0. 140
Width of the head	0. 040
Width at the middle	0. 055
Width at the extremity	0. 040
Length of "No. II"	0. 390
Width of "No. II" just below the head	0. 100
Width at the middle	0. 037
Length of "No. IX"	0. 380
Length proximal to the head	0. 060
Width at the middle	0. 080

In the rib "No. II," the head is turned obliquely to one side, indicating that the rib diverged at a strong angle from the vertebral column; in fact, not more than one of 45°. This is, then, an anterior or posterior rib; probably the latter, since the shell is usually expanded chiefly in that direction. All the ribs are flat above, and convex inferiorly.

Both sides of the *scapular arch* are complete, except the sutural portions of the coracoid and scapula of one side. The scapula and procoracoid make a very open angle with each other, both being stout; the scapula the longer, with grooved sculpture at its proximal end. The procoracoid is a little the shorter. The glenoid cavity and coracoid suture are almost sessile at the union of the scapula and procoracoid. The coracoids are very elongate, almost equal to the ribs, and not stouter except at the extremity. It is expanded into an oblique head proximally. The shaft is flat; one edge thickened or truncated; the other thin. The distal portion is scarcely expanded; being more slender than in any recent Testudinate known to me.

Measurements.

	M.
Length of the scapula to the glenoid cavity	0.213
Width of the scapula proximally	0.045
Length of the procoracoid to the articular surface	0.106
Width of the procoracoid distally	0.060
Length of the coracoid	0.400
Width of proximally	0.086
Width of medially	0.047
Width of distally	0.080

The elongate coracoid resembles most, among recent Chelonians, the marine genus *Chelone;* while the sessile glenoid cavity and short procoracoid with open angle are entirely different. In these points, this genus is more like terrestrial forms, as *Testudo*, or less like *Emys.*

Both *humeri* are entirely preserved. They appear to have been somewhat flattened by pressure; but, when unaltered, they were, no doubt, flat, with stout proportions. They have a globular head, with an immense trochanter, which projects much beyond it proximally. The shaft is then much contracted, and expands again distally to the broad and very convex articular extremity. Opposite the narrow part of the shaft, the small trochanter appears on the inner side, forming an elongate ala. The long axis of the humerus is not straight; the proximal and distal portions making an angle of 110° with each other.

Measurements.

	M.
Total length of the humerus (1 foot) straight	0.300
Length of the humerus from the head	0.296
Width at the head	0.156
Width of the head	0.073
Least width of the shaft	0.076
Greatest distal width	0.132
Length of the basis of the little trochanter	0.080
Thickness at the shaft	0.031

The flatness of this element, and situation of the large trochanter in the general plane, are characters of the *Sphargididæ*. The great constriction medially and expansion of both extremities remind one of the mosasauroid humerus.

Of bones of the fore-arm, there may be one; but the bones next in size to the humerus look more like metacarpals or metatarsals. Two of them were found together in position; and their relations were not like those seen in the fore-arm of sea-turtles. They measure over seven inches in length, and are strongly concave on their adjacent sides. One of them is slightly concave on the outer side; the other convex, the convexity being at two-fifths the length from one end. The ends of both are a little expanded; and one end of one displays a double or trochlear extremity. The same end of the other is injured by pressure. A still larger metacarpallike bone is relatively more expanded at the ends. The articular surface of one of these is wide at one end, and much narrowed at the other. The smaller bones, undoubtedly phalanges, are six in number. They are quite slender, a little expanded at the ends, and flat.

Measurements.

	M.
Length of the largest	0.165
Width of the largest at the extremity	0.065
Width of the largest at the middle	0.032
Length of the longest of the pair	0.180
Width at the extremity	0.650
Width of the shaft	0.027
Length of the phalange	0.132
Width at the extremity	0.032
Width of the shaft	0.018
Thickness of the shaft	0.011

These measurements indicate, for the fore-limb, a total length of 4.52 feet ($1^{m}.347$) if proportioned as in *Chelone;* this would give an expanse of 11.3 feet. If, however, it was constructed on the plan of *Sphargis*, the expanse would be nearer seventeen feet.

Several instructive *cranial bones* were preserved. These are the maxillary and distal part of the dentary of the left side; the posterior part of the left mandibular ramus; quadrate bones and adjacent pterygoids and squamosal, one side with the columellar plate; right postorbital bone and part of the left; also, some probably hyoid elements.

The *maxillary bone* and the dentary present a considerable extent of the alveolar margin. This is remarkable in being thin, sharp, and elevated; without horizontal portion. The former bone is but little incurved to the premaxillary suture; its anterior outline is elevated and vertical, the nostrils entering opposite the probable middle of the orbit. The palatal plate of the maxillary has no great antero-posterior extent, so that the inner nares are opposite the anterior part of the orbit. The latter presents only the anterior and inferior outlines in the specimen. The part of the maxillary below it is very narrow, and weaker than either *Sphargis* or *Chelone*. The cutting-edge has a very open sigmoid flexure, the suborbital part being turned inward, the anterior part a little outward. The osseous rim of the orbit projected outwards considerably beyond the plane of the maxillary anteriorly.

The *dentary bone* is very deep anteriorly, and, like the maxillary, is a thin, vertical lamina. The lower anterior angle is truncated by an acute, concave margin. This is the anterior extremity of the symphysis. This suture occupies the inner face of a triangular area, which extends but a short distance on the lower margin of the ramus, and then passes upward and backward for a short distance on the inner face of the ramus. That portion above the symphysis diverges outward; thus producing a deep notch at the symphysis, as though designed to receive a beaklike projection of the premaxillaries. The cutting-edge has a slight sigmoid flexure, corresponding with that of the maxillary; it rises into a projecting angle.

The posterior part of the ramus displays the cotylus, and, in front of it, a deep, long fossa behind the articular bone. There is no angle nor coronoid bone, as in all marine turtles. The superior margin of the *dentary* is thicker posteriorly than in front; and its outer wall is produced backward as a thin lamina, covering the surangular almost to the posterior edge of the ramus. The *angular* is, as in recent forms, a narrow, wedge-shaped piece below the dentary and surangular. The posterior edge of the surangular projects behind the dentary, and exhibits an acute, convex edge rising forward. It supports a small part of the articular cotylus on its inner face. Most of this portion occupies the extremity of the *articular*. The latter sends a stout lamina obliquely upward and forward to the lower posterior part of the dentary.

The *quadrate bones* are of peculiar form. They exhibit the usual posterior curvature above, with a shallow funnellike fossa for the tympanic cavity. It presents two strong ridges anteriorly, an inner and an outer, which inclose a deep, vertical concavity. The inner exhibits the suture with the pterygoid bone; the outer, with the zygomatic. The superior border of the quadrate within the squamosal is massive, and not inflated. Its surface is thickest where the usual articulation with the opisthotic exists. The posterior horizontal is short and deep. The transverse part of the bone which supports inferiorly the exterior part of the condyle is thin, and disappears above to the antero-posterior portion. From its middle upward, it supports the *zygomatic*. The latter has no great extent anteriorly to its malar suture; and its inferior margin arches high above the line of the condyles of the quadrate.

The *pterygoid bones* are subtriangular in outline, with concave sides, an emarginate base, and a very obliquely truncate apex, which articulates low down on the quadrate bone. Both margins are thickened and rounded; the superior as a boundary of the foramen ovale. The posterior margin of the platelike columella overlaps it on the inner side, deeply notching it; on the outer side, the suture is zigzag and transverse. The superior part of the bone is produced like a flat rod, and, at its end, exhibits a squamosal suture for union with what is, in the snapper, a postero-inferior rod-like prolongation of the columella. No such process of the columella appears to exist in this species. The *columellar plate* is half as large as the pterygoid, and exhibits the oblique suture in front for the descending lamina of the parietal.

The *postfrontal bone* of the left side is preserved entire, and the inferior portion of that of the right. The inferior margin for the malar is the longest, and is straight. The orbit is excavated in part from its anterior margin; while the supero-posterior is a continuous curve. The inferior suture is a groove, whose inner bounding wall is convex, but rises past the straight outer to an inner ridge, which probably approaches the ectopterygoid region. A large sutural face for the zygomatic exists at the lower posterior angle, and an elongate one above for the parietal. The inner face is concave, indicating a large temporal fossa, as in *Sphargis* and *Chelone*.

Two bones, of opposite sides of the cranium, are either those portions of the pterygoids which bound the temporal fossa below in front, or those portions of the maxillary bounding the palatine foramen. As the free margin is much thickened, they are probably the former. Their inner, or thinner, lamina is marked for squamosal suture with other bones, perhaps columella and palatine.

Measurements of the cranium.

	M.
Depth of the premaxillary suture of the maxillary	0.060
Length from the premaxillary suture to the inner nares	0.068
Depth of the maxillary below the orbit	0.035
Depth of the dentary at the symphysis	0.078
Depth of the notch of the dentary at the symphysis	0.044
Depth of the dentary behind the symphysis	0.095
Depth of the dentary at the coronoid region	0.085
Depth of the ramus at the front of the cotylus	0.061
Length of the pterygoid fossa of the cotylus	0.060

	M.
Length of the cotyloid fossa	0.070
Length of the postfrontal on the inferior suture	0.195
Depth of the postfrontal at the boundary of the orbit	0.136
Thickness of the postfrontal of the lower suture	0.019
Length of the postfrontal from the orbit (oblique)	0.115
Length of the right quadrate	0.140
Width (antero-posterior)	0.110
Width of the condyle	0.064
Length of the right pterygoid superiorly	0.155
Depth of the right pterygoid at the inner columellar angle	0.100
Length (oblique) of the columella	0.085

Restoration.—Better materials exist for the restoration of this species than is usual in the case of most extinct *Testudinata.* The cranium was $0^{m}.50$, or $24\frac{5}{8}$ inches, in length. If the neck and carapace were related to it as in the genus *Chelone*, the total would be as follows:

	Inches.
Cranium	$24\frac{5}{8}$
Neck and carapace	$138\frac{2}{8}$
Total, 12.83 feet	$162\frac{7}{8}$

an extent not far from the expanse of the flippers above given, viz, 11.30 feet. The shortness of the cervical vertebræ indicates that the proportions of the neck were not dissimilar to those of the existing marine genera. The flippers were probably similar to the same; of the hind limbs, nothing can now be stated. The shortness of most of the ribs, considered in connection with the length of the marginals, is remarkable. Thus, the longest rib measures $0^{m}.51$, or 16 inches; width of lateral marginal beyond apex of rib, 2.25 inches; width of vertebra, 3 inches, which is, however, covered by the expansion of the rib, included in this case in the length, 16 inches; total width of carapace at middle, $36\frac{1}{2}$ inches; length of carapace, estimated from cranium, 118 inches; or, width, 3 feet $\frac{1}{2}$ inch; length, 9 feet 10 inches. An outline, twice as long as wide, is justified in measure by the size, especially the lengths, of the marginals, which, if placed end to end, would measure on one side of eleven pieces, if each were as long as the median, 8.5 inches $\times$ 11 = 7.8 feet. Some of the posterior marginals are shorter than 8.5 inches, while some of the anterior appear to be longer. The length, 8.5, may then be taken as an average. But they formed the circumference of an open arc, so the axial length of the carapace should be placed at a lower figure than the above. This proposition may be offsetted by the fact that the marginals were not united to each other, and exhibit no indications of contact. The length of seven feet for the carapace is not, then, too much, and, estimating from the size of the head, is too little. We can then safely conclude that the carapace of this turtle is more elongate and narrowed than existing forms. Thus, in *Chelone mydas*, the carapace is six-eighths as wide as long.

It remains to discuss the question of the age of the specimen. It might be objected that the absence of carapace, and the radiate character of the margins of many of the bones, indicate that our type-specimen is young. To this it may be replied, first, that it is in the (?) sternal bones unlike the young of any known type, when certain of their bodies do at all times exhibit smooth margins as boundaries of the points of exit of the limbs; moreover, it is possible that these plates were dorsal; secondly, the superior or inner extension of the marginals exceeds that of any known tortoise in the adult condition; thirdly, the articular bone is ossified; fourthly, separate ribs should be discovered among extinct tortoises as an adult character, on theoretical grounds, the more as it exists in one recent genus (*Sphargis*, fide Wagler).

FIG. 3.—Costal bones of a young *Testudo polyphemus* from below; natural size.

Distribution.—This fossil was found near Fort Wallace, Western Kansas. It was entirely recovered by excavating. The edges of one of the large bony shields were seen projecting from a bluff near Butte Creek, and was followed into the chalk-rock with pickax and shovel with the result already indicated. The large bones were exposed in an entire condition, but were much fractured in the attempt to lift them from their bed. Though carefully packed, the transport of fifteen hundred miles still further injured them, and the portions described were reconstructed of over eight hundred pieces by myself. One of the bony plates was broken into 108 pieces, the ribs into 183, the marginals into 146, &c. A second species of *Protostega*[1] appears to have existed during the Cretaceous period, as indicated by a humerus from near Columbus, Miss., sent by Dr. Spillman to the Academy of Natural Sciences. With it were received bones of the mosasauroid *Platecarpus tympaniticus*, Cope; and Dr. Leidy, who described them,[2] regarded all as belonging to one animal. On this basis, he

[1] Proceedings of the American Philosophical Society for 1871, p. 173.
[2] Cretaceous Reptiles of North America, p. 42: Smithsonian Contributions, 1864.

expressed the opinion that the fore-limbs of the *Pythonomorpha* were natatory. That this view was correct I proved by study of the skeleton of *Clidastes propython;* and it now appears that the fore-limbs of the latter were the first ever described.

The humerus of the Mississippi *Protostega* (see Leidy, *l. c.*, Pl. viii, Figs. 1–2) is more elongate than that of the *P. gigas*, is less contracted medially, and the (great trochanter or) deltoid crest is longer and stouter. This I called *Protostega tuberosa.*[1] (Proceedings of the American Philosophical Society for 1872, p. 433.) I also pointed out the existence of a third species, as distinguished by the form of the humerus, in the greensand of New Jersey, which had been referred by Leidy to the "great *Mosasaurus*." From this specimen, Leidy inferred the natatory character of the limbs of Mosasaurus. The New Jersey species I called *Protostega neptunia.* A name had been already proposed for it; but, as it was unaccompanied with specific or generic description, I did not adopt it. This was done in accordance with the well-known rule that such names without description are useless in nomenclature; and I conceive it to be not only a privilege but a duty to ignore names put forward in this manner.

The custom of giving generic and specific names without corresponding diagnosis has only recently been introduced, and has no claims to respect. It will, if continued, render the science of paleontology accessible only to a privileged class, who may have control of museums, or who can adopt a nomadic life in traveling from one musem to another. In the case of the *Protostega neptunia*, had Professor Leidy, who figured and described the specimen for the first time, adopted the name already given, I should have felt bound to employ the latter, ascribing it to Leidy as the author; but, as he left it among the synonymy of the Mosasauroids, I have thought it advisable to follow him.

PYTHONOMORPHA.

The characters which distinguish this order are the following:

1. The quadrate bone is attached to the cranium by a ginglymoid articulation, admitting of free movement.

2. The ribs are attached by simple articulations to single articular facets or diapophyses springing from the bodies of the vertebræ.

[1] I inadvertently wrote *Platecarpus tuberosus* in the above essay.

3. There are two pairs of limbs, which form paddles, having the elements arranged in one plane, and incapable of rotation or flexure on each other.

4. There is no sternum.

5. The scapular arch consists of scapula and coracoid only.

6. There is no sacrum.

7. The pelvis consists of slender elements, of which the inferior are nearly transverse, and meet without uniting on the middle line below.

8. The opisthotic bone projects free from the cranium as the suspensorium of the quadrate bone, and is supported and embraced by a pedestal projecting from the cranial walls, composed of the proötic in front and the exoccipital behind.

9. The stapes lies in a groove on the posterior side of this suspensorium, and is produced to the os quadratum.

10. There is no quadrato-jugal arch.

11. The parietal bone is decurved posteriorly, forming the cranial wall in front of the proötic.

12. The brain-chamber is not ossified in front.

13. The squamosal bone is present, merely forming the posterior part of the zygomatic arch.

14. The mandible is composed of all the elements characteristic of reptiles: the articular and surangular distinct; the angular represented by its anterior portion only; and the coronoid present.

15. The atlas consists of a basal and two lateral pieces only; the odontoid is distinct, and is bounded by a free hypapophysis, besides the hypapophysis of the axis.

16. The caudal vertebræ support chevron-bones.

17. The teeth possess no true roots.

The free quadrate bone and simple costal articulations at once refer this order to the *Streptostylicate* division of the *Reptilia*, which embraces only the three orders of *Lacertilia*, *Pythonomorpha*, and *Ophidia*. There are several characters, however, in which it resembles some orders of one other primary group, viz, the *Synaptosauria*, which embraces the *Sauropterygia*, *Testudinata*, and *Rhynchocephalia*.[1] In the absence of sternum, it resembles tortoises and Plesiosaurs, and differs from lizards. It resembles the tortoises in the

[1] See Proceedings of the American Association for the Advancement of Science, vol. XIX, p. 233. 1870.

posterior decurvature of the upper portion of the quadrate bone, which thus partially incloses the auricular meatus in a manner not seen in lizards and serpents. To the orders of the other primary divisions *Ichthyopterygia* and *Archosauria*, as the *Ichthyosauridæ* and *Crocodilia*, there is not the least affinity.

The remaining characters above enumerated ally the *Pythonomorpha* to both serpents and lizards. As there are many *Lacertilia* without limbs, and some serpents with them, their presence in this order is irrelevant in this connection, especially as the arches supporting them are most like those of tortoises and Plesiosaurs. In the absence of sacrum, it resembles both the associated orders, though the same character is universal in serpents, as the presence of limbs is general in the lizards. The manner in which the opisthotic bone projects from the embracing bones is a decidedly ophidian feature, while the production of the exoccipital and proötic is lacertilian. The position of the stapes and absence of quadrato-jugal arch are characters common to both orders. The lateral decurvature of the parietal is a character of the *Ophidia*, and not of the *Lacertilia;* while the failure of this bone and the frontal to complete the cranial-chamber in front is a lacertilian feature. The composition of the posterior part of the lower jaw is like that in the lizards in the distinctness of the articular and surangular bones; in the presence of chevron-bones, it differs from snakes;* the atlas and axis are those of both snakes and lizards, and entirely different from those of *Crocodilia*. In the absence of true roots of the teeth, these animals differ from all *Lacertilia*, and more nearly resemble, without being identical with, the *Ophidia*. Thus it is evident that the Mosasauroids and their allies represent an order of reptiles distinct from any other, and I have called it *Pythonomorpha*, from those points in which it resembles the *Ophidia*.

There are many other characters common to all the known species of this division, which are not probably of ordinal character, and which I proceed to enumerate. Among them will be found some known elsewhere in the *Ophidia*, and others which relate them to lacertilian groups.

Cranium.

The skull, in the known species of this order, is wedge-shaped, and generally elongate. Posteriorly, it presents postfronto-squamosal and parieto-quadrate arches; in some species, also, a malar arch is thought to exist.

Teeth.—These exist in a single row on the dentary, palatine, and maxillary bones, and in two rows on the premaxillary. The crowns are simple, and offer various modifications of the cone. Their dentinal substance is confined to the crown, and is attached, at the base, to a pedestal of ostein, which occupies the alveolus of the jaw, and projects above it. This is stated, by Cuvier, to be an ossification of the tissue surrounding the circulatory vessels and nerves which penetrate to the crown, and which remain unossified in serpents and most fishes, but are surrounded by true dentinal roots in most vertebrates of the land. Hence, the teeth, in this order, do not possess true roots. The crowns are covered with enamel, and their forms indicate the carnivorous habits of these reptiles.

The *premaxillary* is a narrow, simple element, one-half of a cone anteriorly, and much attenuated posteriorly, separating the maxillaries above by the width of its spine only. Its extremity projects considerably beyond the latter. The anterior extremity bears two teeth on each side in the known species.

The *maxillary* bones are widely separated on the palatal surface, in front, by the vomers; behind, by the nares and palatine bones. They terminate in a narrow process behind, whose extremity is broken in the specimens at my disposal, but which may have supported a malar arch, probably slender, as in the dolphins. The nostrils are linear and superior, and separated by a septum composed of coössified nasal and frontal bones. The nares extend to a point in advance of the anterior margin of the orbit. The *prefrontals* are largely developed, and margin the posterior part of the nares. In many species, their posterior exterior margin projects strongly in the plane of the muzzle, and has caused the orbit to be horizontal, and the range of vision vertical, as in some aquatic serpents; while, in others, it is decurved, as in land-vertebrates.

The *frontal* is a wedge-shaped, flat bone, and presents lateral descending alæ medially. The post-frontals are large, flat, and prominent, and project beyond the process they send, posteriorly, to join the squamosal. Posteriorly, they embrace between them a broad, rectangular process of the parietal, which, in *Clidastes*, contains, near its front suture, the parietal fontanelle. In *Platecarpus*, the foramen is, usually, in or nearer to the suture.

The *parietal* has two broad lateral wings, which advance on the frontal, and form posteriorly the broad anterior margin of the temporal fossa. The parietal crests are separated by a plane which is narrowed, or they unite into a median crest posteriorly. Two antero-superior projections of the supraoccipital embrace the parietal on each side below the crest; while it is overlapped, just below, by the anterior extremity of the proötic. This does not extend so far forward as the supraoccipital. In front of, and below, this point, the parietal is decurved, and forms a considerable part of the lateral wall of the cranium, though with but moderate antero-posterior extent. The lateral wall extends to the body of the sphenoid, where extensive sutural surface has received it. I can find no suture crossing it; and it is apparently all alisphenoid or all parietal. A part of the pārietal is, however, undoubtedly decurved in front of the alisphenoid. The structure is quite as crocodilian as ophidian in this point.

The postero-lateral angles of the parietal send the parieto-quadrate arches to the opisthotic, which sends an ascending process to meet the parietal, as in lizards. It differs from most of these in the presence of an intermediate bone, which has been observed by Marsh, and which would appear to be a dismemberment of one of those with which it is in contact.

The anterior ala of the *proötic* overlaps the alisphenoid largely. Its posterior lamina may, or may not, meet the expansion of the exoccipital on the upper face of the suspensorium. Inferiorly, it is in contact with the outer and posterior base of the sphenoid.

The *supraoccipital* is roof-shaped. The posterior extremity of the parietal rests upon it, sending lateral arches to the opisthotic, as in most *Lacertilia.*

The *exoccipital* is distinct, and bears a very small segment of the occipital condyle.

The *opisthotic* stands obliquely upward and forward, and furnishes a glenoid cavity for the articulation of the quadratum. It has a process, directed upward and forward, which occupies a concavity on the inner face of the squamosal, which has the same direction.

The *squamosal* is a subrhombic bone in a vertical plane, and is flat below, and proximally presents a longitudinal external angle; distally, it is slender and prolonged, and receives the posterior process of the post-frontal.

The *basioccipital* presents a strong transverse condyle. It is a massive bone, and presents infero-laterally two powerful processes, which diverge posteriorly, and present broad, rugose, ovate faces of insertion. There is an obtuse keel on the middle line below, which bifurcates posteriorly to each of the lateral processes. The distal portions of these processes are overlapped by corresponding cuplike processes of the basisphenoid.

The *basisphenoid* is distinct from the basioccipital, and underlaps the latter almost to its middle. It is longer than broad, and sends two processes latero-anteriorly to support the pterygoids. These are not so long as in most lacertilians. Latero-superiorly, it presents a broad surface, on each side of the brain-case, for support of the upper side-walls. Postero-externally, it supports the proötic. It thins out anteriorly, and overlaps the alisphenoid. The suture for this bone widens anteriorly; inwardly, it is elevated into a low crest of the sphenoid.

The *presphenoid* appears to have been distinct; its base was small; it is readily lost, and I have not seen it.

The floor of the cranial cavity indicates that the medulla oblongata possessed the downward flexure characteristic of reptiles; but it does not take place till the middle of the length of the basioccipital is reached. The posterior margin of the sphenoid is marked by a deep pit; its median floor is a transverse elevation; it then descends again, and terminates in a deep longitudinal groove.

The roof of the brain-case is marked on the parietal bone by two obtuse divergent ridges, which leave its posterior margin and embrace the fontanelle. The grooves for the olfactory pedicels are narrow and well separated, but they unite and are entirely inclosed by inferior processes of the frontal bone, as in serpents and *Varani.* These ridges then separate, and leave the bulbi exposed below. Behind and between the nares, the median ridge again appears, separating two strong grooves.

The *vomer* is divided, and is composed of two slender compressed bones in contact.

The *palatine bones* have a short lateral union at their anterior end with the maxillaries, and possess a great extension posteriorly, being separated from the quadrates by the short pterygoids only. They are free on both sides behind the maxillaries, and are flattened either transversely or vertically, or both, and support a series of strong teeth, generally similar to those of the jaws. Near their posterior extremity, they send outward and forward a strong and generally long process, the distal connection of which is uncertain. These bones are the pterygoids of Cuvier. The true *pterygoids* are rather short, compressed bones, which are united by suture to the borders of a concavity of the palatine. They are toothless, and have no sutural connection with the *ossa quadrata*. They present no sutural facet for a columella; but Goldfuss and Marsh believe that the latter element exists. I have not seen it.

The *os quadratum* is a stout bone, and one of the most uniformly preserved among the bones of fossilized individuals. In general, it forms a half-disk; the convex border thin, one side concave, and the posterior border thickened. The proximal end is produced backward beyond the line of this border, forming a hooklike process, which is decurved, nearly inclosing the auricular meatus. Just anterior to the latter, on the inner face of the thickened portion, is a pit, which received the end of the stapes or stapedial cartilage. The vertical plane of the inferior or mandibular condyle is oblique to that of the superior.

The superior extremity of the *os quadratum* appears to have had considerable motion on the opisthotic. Its extent is so much greater than that of the cotyloid or glenoid cavity, applied to it, as to indicate a gliding motion, especially as it constitutes an extensive arc, possessing grooves of attachment for articular cartilage throughout its length. This arc is bent or curved in the horizontal plane, which would result in a twisting of the *os quadratum* round its long axis, should the motion I suggest have taken place. Such a twist would throw the proximal portion of the ramus of the jaw outward, a motion quite necessary to the horizontal flexure of the ramus at the splenial articulation, which no doubt took place in swallowing any large object. The extent of this outward deflexion of the articular, coronoid, &c., portions of the jaw, was measured by the outward concavity of the proximal end of the *quadratum*. Thus, this is least in *M. depressus*, and greater in *M. dekayi* and *M. maximus* (see cuts, Fig. 48); the great projection of the external angle in *Liodon* gave that species an excessive power of dislocation, and the same peculiarity in *Clidastes* was followed by the same effect.

As the development of processes and ridges on the *ossa quadrata* differ in the different species, they may be named as follows: The proximal articular surface extends over the *internal angle* and over the upper edge of the ala, forming the *alar process* (see plates). Below the meatus and knob, on the postero-external margin, there is a ridge, which terminates in a process in some species, to be called the *median posterior ridge*. In some, a ridge rises from the outer angle of the distal articular face, extending outside the ridge just mentioned, toward the pit, called the *distal internal longitudinal.* In front of this, on the inner face of the quadrate, behind or near the origin of the ala, may be a ridge called the *internal ridge.* (See Plate xxxvii.)

The cotylus of the *mandible* is also obliquely transverse; the inner portion deeper, in order to receive the large condyle of the quadratum

The mandible, of course, partakes of the elongate form of the cranium.

The fossa for the temporal muscle is large and deep, but without inner wall. The coronoid process is elevated, convex, and rugose interiorly, and with a deep longitudinal groove exteriorly. The superior margin of the coronoid bone is longitudinally concave and obtuse. The dentary terminates in a peculiar striate plug, posterior to the last tooth. The distal third, or less, is strongly grooved for Meckel's cartilage; proximally, this is concealed by the very long laminiform splenial.

The *splenial* is largely developed on the inner face of the ramus, where it articulates by ball-and-socket joint with the angular.

The *angular* has a narrow and inferior exposure on the external face of the ramus, and overlaps the articular by extensive squamosal suture. Interiorly, it is a little more elevated, but only opposite to the coronoid bone; behind and above this it is restricted by the long anterior process of the surangular. Anteriorly, it is terminated by the squamosal suture of the splenial, just below the beginning of the coronoid bone.

The *articular* furnishes the floor of the cotylus for the quadratum and the large angular termination of the jaw. Inwardly, it is largely exposed; exteriorly, it is extensively concealed.

The *surangular* is the largest bone behind the dentary. It is convex externally, and sends a longitudinal ridge from the cotyloid cavity to that of the coronoid, thus inclosing a large shallow fossa. It supports the outer or vertical half of the articular cotylus of the mandible.

The *coronoid* is a longitudinal bone attached by squamosal suture only to the surangular. It is easily separated, and its form differs in the genera. It is always more obtuse anteriorly, and more projecting and aliform posteriorly, where its superior margin is rolled over to the outer side.

In the *splenial articulation,* the angular bone presents the condyloid; the splenial, the cotyloid face. The former narrows and retreats upward and backward. The articulation allows of a rotary motion inward and upward; the alveolar margin of the dentary bone being thrown upward and outward.

This motion is permitted by the laminar character of the overlapping margins of the splenial, etc., as follows:

The principal body of the dentary comes to an obtuse but grooved posterior termination. Its external wall is prolonged more posteriorly, the inferior margin fitting a rabbet of the outside of the splenial. The superior margin of this thin plate is much lower than the truncate extremity; and its margin gradually rises to meet the outer margin of the latter. The section of the *splenial* is U-shaped, much thickened at the turn. The inner lamina is more elevated than the outer, and is concave, turning outward above to conform to the dentary. A narrow laminar prolongation of the articular is observed between the folds of the U. An outwardly convex, wedge-shaped terminus of the surangular is included between the inner lamina of the coronoid and the outer lamina of the dentary, moving freely on the latter. There is, then, nothing that prevents this from being a complete articulation, except the lamina of the articular, which is about half a line in thickness, and probably flexible in life.

The superior margin of the coronoid is convex outwardly, and is not continuous with that of the dentary, when the elements forming the splenial articulation are in line. When, however, the process of the articular is properly applied to the dentary, and the coronoid and splenial are in line, as they no doubt were under ordinary circumstances in life, the curvature of the upper margin of the ramus is continuous and normal. At the same time, the splenial articulation is strongly flexed, and the inferior outline of the ramus angulate at that point.

We have in this feature one of the most extraordinary peculiarities of this remarkable order. The mandibular arch, in its usual relations, inclosed a diamond-shaped area, open behind, the portion anterior to the lateral angles the longer, and only closed by ligament in front. The structure is an element of weakness, though, indeed, without such an articulation, such a light and slender jaw would be particularly liable to fracture. There was, no doubt, a strong ligamentous union of the parts, as the grooved adjacent margins testify; but for any supernumerary muscles to flex the dentary bones I can find no provision.

This structure was no doubt designed to effect the deglutition of large bodies, which would readily pass between the expanded mandibular rami. This lateral extension is necessary to reptiles, which, like the snakes, swallow large animals whole, but are not furnished at the same time with the arrangement of the suspensorium, the quadrate, and mandible, by which they unfold downward, thus increasing the vertical diameter of the pharyngeal cavity. The palatine and maxillary arches not having the mobility seen in snakes, the mandibles possess increased adaptation to the necessities of doubtless similar habits.

The accompanying cut shows the appearance of the normal flexure of the ramus: *c* is the splenial articulation; *d*, the coronoid process; and *e*, the quadrate cotylus.

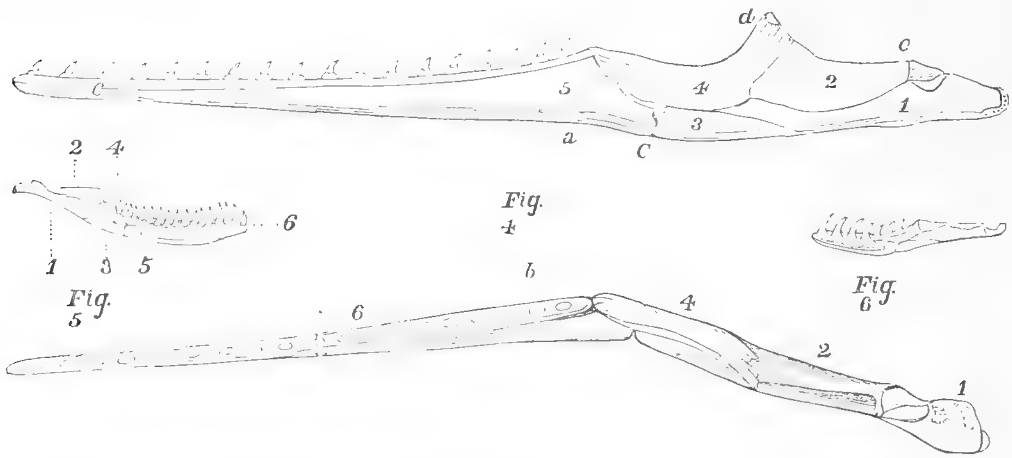


Fig. 4.—Right mandibular ramus of *Clidastes propython*, Cope, one-third natural size: *a*, from the inner side; *b*, from above. Fig. 5.—Left ramus of *Loxocemus bicolor*, a pythonid from Central America, inner side, natural size. Fig. 6.—Right ramus of *Eryx johnii*, Russ., from India, inner side, natural size: 1, articular; 2, surangular; 3, angular; 4, coronoid; 5, splenial; 6, dentary.

Vertebræ and ribs.

Vertebræ.—As has been already pointed out by Cuvier, the vertebræ in *Mosasaurus* fall into cervical, dorsal, sacro-lumbar, and caudal series. The cervicals are either round or depressed; they are arbitrarily characterized by the presence of an obtuse hypapophysis, which has an articular surface for a separate continuation of the same. The latter may be compared to short, compressed, ungueal phalanges. The articular extremity of some is nearly plane; of others, conic, with antero-posterior enlargement. They are directed posteriorly, and have a broad, obliquely ovate outline on the lateral view. Their extremities are rugose.

The atlas consists of the three pieces, the basal and two lateral. The axis supports a large odontoid process, which is bounded below by a three-sided piece, which is provisionally called its hypapophysis. Besides these, he axis has its own proper fixed and corresponding free hypapophyses.

The dorsals have no hypapophysis, and the diapophyses decrease in vertical extent toward the posterior part of the series. The greatest variation is presented by the different species in the long series preceding the caudals, which do not present zygapophyses. The posterior of this series are much shorter than the anterior; the former having the form of the dorsals, the latter of the caudals. In the *Mosasaurus dekayi*, *M. gracilis*, and *M. giganteus*, none of these are depressed; the shorter are subpentagonal in section. In *M. depressus* and *M. missuriensis*, the longer are depressed, while the depression of the shorter diminishes regularly to the distal caudal series. In *M. brumbyi*, the long vertebræ are flattened to a still greater degree. (See Gibbes' Monograph on *Mosasaurus* and its allies.)

The caudals are divided into three series by Cuvier, viz: those with separate chevron-bones; those where the latter are united to the centrum; and those without them. Passing posteriorly, these vertebræ become gradually shorter and more vertically ovate in form. The more posterior are less narrowed in the *M. maximus*, *M. oarthrus*, and *M. missuriensis* (*vide* Leidy's work); while, in *M. dekayi* and the Liodons, they are rather more narrowed vertically.

The characters of the diapophyses are marked in different parts of the column. In all the species of the family, they descend from an elevated position on the cervicals and anterior dorsals to an inferior one on the lumbars. They never spring from the neural arch, as in the *Archosauria*, but always from the base of it. On the median dorsals, they originate from the middle of the side of the centrum, and, on the lumbo-sacrals, from the plane of the inferior surface. They diminish in size, and, as soon as the articulations of the chevron-bones appear, begin to ascend again. On the anterior caudals, they rise to near the middle of the centrum, and gradually disappear at different points in the different species.

The chevron-bones are free throughout the anterior part of the caudal series in the *M. giganteus*, and confluent with the centrum in the posterior portions. This is probably the case with many species of the genus. During immaturity, they may be all distinct in *Mosasaurus*, while in the genus *Liodon* (*vel Macrosaurus*) this condition is permanent throughout life, and thus characteristic. They have two short hæmapophysial limbs, and a very long, tapering spine, which is grooved in front. On the middle caudal of certain species it is much longer than the centrum and neural spine, and as long as 4.5 centra adjacent. All the hæmal arches are directed obliquely posteriorly.

Although I do not possess any specimen with complete vertebral column, an approximate idea of its length may be gained by comparison of parts which are more or less complete in different species. The cervicals are all preserved in a specimen of *Clidastes propython* from Alabama, and number eight,[1] including atlas and axis. In the type-individual of *C. stenops*, seven may be counted; in a *Platecarpus ictericus*, seven; in a *Liodon dyspelor*, seven; of which the last two are without free hypapophyses, while in the two species preceding, but one without the free hypapophysis is preserved. In Cuvier's *Mosasaurus giganteus*, the dorsals number forty-three; in an undetermined *Liodon*, from Kansas (alluded to in a former article as *L. latispinus*), there are preserved the seven terminal dorsals and thirty-two caudals, with diapophyses, which exhibit little diminution in size; the last with stout but reduced diapophysis. Caudals without diapophyses, in a supposed species of *Platecarpus*, number twenty-seven; and there were at least as many, judging from the rate of diminution, beyond these. A specimen of *Clidastes vymanii* has, according to Marsh, eighty-one with chevron-bones.

The *ribs* commence at the axis, which bears a small one. There is no distinct parapophysis; hence each rib-head is undivided, but is flattened vertically. The anterior may be known by the greater compression of both head and shaft. The rib of the third vertebra has a narrow, convex, articular surface, and is concave on the anterior face. Those of the dorsals are much wider, and with more truncate head.

The limbs and limb-girdles.

The limbs in all the members of this order are very small in proportion to the size of the body and tail, and the bones of the scapular and pelvic arches of proportionate small development.

The *scapula* is a broad segment of a disk, differing in form from that seen in any other order of the *Reptilia.* It only presents facets for the coracoid and humerus. The coracoid is a similar bone, but embraces a larger

[1] Professor Marsh (American Journal of Science and Arts, 1872, p. 454) quotes me as assigning ten cervical vertebræ with articulated hypapophyses to this species. This I have not done, but state (Synopsis of the Extinct Batrachia and Reptiles of North America, p. 221) that it possesses six such vertebræ. Professor Marsh's statement and consequent supposition that he first determined the number of cervical vertebræ in the genus *Clidastes* are the result of a misapprehension.

portion of a disk. In some genera, it is deeply emarginate, as in *Lacertilia;* but it is usually entire, as in *Sauropterygia.*

The *humerus* is a small bone, exceedingly wide in *Clidastes* and *Platecarpus,* and narrower in *Liodon.* It is wider distally than proximally, has a flat shaft, and presents no condyles, but elongate articular surfaces only. The radius is also a wide bone, especially dilated at its distal and exterior border. The ulna is much less expanded; the extremities being subequal, and the shaft contracted, but flat. The carpals are small, flat, and few in number; they are subround or hexagonal in outline. The phalanges, metacarpals, and metatarsals are flattened near the carpus, but soon become less expanded and more cylindric at the extremities and at the shaft. The terminal ones are flat.

The *pelvic* elements are slender, and the inferior but loosely-united on the middle line below. The ilium is the longest, and is quite attenuated above, and without immediate contact with a vertebra. The pubis is clavate and flat; the wider portion next the ilium, and pierced with the foramen observed in *Lacertilia.* The ischium is broader, and has an angulate posterior outline. The femur is equally or more slender than the humerus (see the plate of *Platecarpus crassartus*), and, in *Liodon,* resembles it in form. It is flat, without condyles, wider distally, and with a trochanteric tuberosity at the proximal end. The fibula is a very wide bone, sometimes constituting three-quarters of a disk. The tibia is, like the ulna, a more slender bone than its companion, with contracted shaft, and subequally-expanded extremities.

The phalanges much resemble those of marine turtles, and the pes and manus are of a less robust type than in any other order of marine reptiles.

Affinities.

The significance of the ordinal characters has been already pointed out. There remain a number of peculiarities, not certainly of ordinal value, which are, nevertheless, necessary to consider in estimating the relations of these reptiles to others:

1. The form and position of the coronoid bone are those seen in eryciform serpents.

2. The articulation of the splenial with the angular is only paralleled in the pythonoid and allied serpents.

3. The extensive freedom of the palatine is less complete than that of the same element in the *Ophidia*, and much more so than in most *Lacertilia*, resembling, in this respect, the *Varanidæ*.

4. The close articulation of the parietal with the supraoccipital is seen in the serpents and the amphisbænian section of the lizards, but not in true lizards; while the supraoccipital crest is a character of serpents, not of lizards or saurians.

5. The presence of fronto-parietal fontanelle is very general in *Lacertilia* and various extinct saurians, while it is unknown in serpents, crocodiles, and other groups.

6. The parieto-quadrate arch belongs to several groups of saurians and the *Lacertilia*, but not to serpents.

7. The squamosal bone has a similar distribution among reptilian orders.

8. The firm attachment of the maxillary to the other bones has the same significance.

9. The want of sutural symphysis is seen in snakes, the varanian lizards, *Ichthyosaurus*, &c.; but not in *Lacertilia* generally, *Testudinata*, *Sauropterygia*, or *Crocodilia*.

10. The simple premaxillary is general in the streptostylicate orders, and uncommon in the others.

11. The underarching of the olfactory lobes by frontal laminæ is characteristic of some lizards (the *Varani*) and of all snakes.

The above characters are of very unequal value, and may, in many cases, be departed from by forms hereafter discovered without invalidating their ordinal relations with the *Mosasauridæ*.

As a conclusion, it may be derived that these reptiles are not nearly related to the *Varanidæ* as has been supposed, but constitute a distinct order of the streptostylicate group; that they are primarily related to the *Lacertilia*, secondarily to the *Ophidia*, and thirdly to the *Sauropterygia;* that they present more points of affinity to the serpents than does any other order; and their nearest point of relationship in the *Lacertilia* is the *Varanidæ* or *Thecaglossa*.

Experience in paleontology has shown that generalized orders have been the predecessors of the special groups of the existing fauna. The structure of the *Pythonomorpha*, which has so much in common with orders well distinguished from each other, offers a hint of the character of the primary group from which the latter have sprung. That this order is not that unknown type is clear; but the indication of affinity to it is equally unmistakable.

Restoration.

The proportions and appearance of the *Pythonomorpha* can be determined from the remains which have been procured. The body-cavity is more elongate than in any group of lizards and saurians, excepting the *Amphisbænia*, but not so long as in serpents. The tail is excessively long and flattened. The head is also long—in some genera, as *Clidastes*, very slender, and always flat, with the eyes nearly vertical. There is no distinction between neck and body, but a contraction behind the head. The limbs are very small for the size of the animal, forming broad paddles, with but little peduncle; the hinder limbs well behind the ribs, and often smaller than the anterior. The general effect of the more slender of these animals was that of gigantic eels, or some of the snakelike lizards of the present time, so that they are veritable sea-serpents of the Cretaceous ocean, and would doubtless be described as such were any perchance to be found to be still in existence in the depths of modern oceans.

Several peculiarities affecting the appearance of these animals may be derived from the peculiar articulation of the lower jaws. The position of these articulations in advance of the pharynx indicates a baggy extension of the gular walls, to permit the passage of large bodies between the jaws to the œsophagus. This had, perhaps, the appearance of the posterior part of the pouch of the pelican. This arrangement necessarily requires that the larynx should be, as in the serpents, in the middle or anterior part of the mouth; for, as in those animals, the delay involved in deglutition would cause suffocation were the glottis immediately below the descending mass. This structure requires another, namely, the anterior position of the tongue; and this organ, unless very small, would have to be received into a sheath beneath the larynx and opening anterior to it. Ensheathed tongues, among reptiles, tend to become cylindric in proportion to the completeness of the sheathing, for obvious mechanical reasons. It is almost certain that the *Pythonomorpha* had tongues of this kind; for their nearest living allies on both sides have them, viz, the serpents and the varanian or thecagloss lizards. These have the tongue cylindric, ensheathed, and forked at the end, and project it as a delicate tactile organ.

It is stated by Professor Marsh that these reptiles possessed scales; that, in *Clidastes*, a complex pattern was produced by alternate rows of scutes of different shape and size. They are osseous, but thin, and generally united by beveled edges. Such structures would produce a distinct effect in the living animal. I had already inferred the existence of dermal scales, and figured them in a restoration of *Mosasaurus*, published in the American Naturalist,[1] but had not suspected osseous scuta. It is a little singular that I have never detected them among the numerous skeletons of these reptiles which I have exhumed in Kansas and elsewhere; nor have any been sent me by Professor Mudge.

The proportions varied somewhat in the known genera. Thus, in *Clidastes*, we see the greatest attenuation of form; while, according to Marsh, the caudal series is less elongate in *Liodon*. In *Clidastes* and *Platecarpus*, the humerus is very short and wide, broader than the femur. In *iodon*, the humerus is more slender, and not very different in proportions from the femur; hence, the flippers were more distinctly pedunculate.

Classification and distribution.

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

I. Cervical hypapophyses separate, articulating:

- *α*. A zygosphenal articulation:
  - Chevron-bones coössified with centra . . . . *Clidastes.*
  - Chevron-bones free . . . . *Sironectes.*
- *αα*. No zygosphenal articulation:
  - Teeth subcylindric conic; humerus short, platelike; chevron-bones free . . . . *Platecarpus.*
  - Teeth mostly compressed, cutting; humerus with narrowed extremities; chevron-bones free . . . . *Liodon.*
  - Teeth subcylindric faceted; chevron-bones in part coössified . . . . *Mosasaurus.*

II. Cervical hypapophyses continuous and entire:

- No zygosphene . . . . *Baptosaurus.*

The material obtained in Kansas, during the autumn of 1871, by the writer, proved conclusively that this order of reptiles attained a predominant

[1] 1869, p. 84.

importance during the Niobrara epoch of the Cretaceous period. This is indicated by the great profusion of individual remains and specific forms. Although occurring in America, wherever the Cretaceous formation appears, they are, so far, more numerously represented in Kansas than elsewhere. Though not rare in New Jersey, crocodiles and tortoises outnumber them; but, in Kansas, all other orders are subordinate to the *Pythonomorpha.* As is now well known, since 1868,[1] the seas of the American continent were the home of this order; while they were comparatively rare in those of Europe. In the latter country, we have four species only determined by paleontologists, viz:

Mosasaurus	2
Liodon	1
(?) Saurospondylus	1

In North America, the species have been exactly determined from three regions, as follows:

Greensand of New Jersey.

Mosasaurus	6
Baptosaurus	2
Clidastes	2
Liodon	4
(?) Diplotomodon	1
	15

Rotten limestone, Alabama.

Mosasaurus	1
Holcodus	1
Liodon	3
Clidastes	2
	7

Chalk of Kansas.

Clidastes	10
Sironectes	1
Platecarpus	11
Liodon	4
	26

[1] See Transactions of the American Philosophical Society, vol. XIV.

We have additional species from—

North Carolina (Mosasaurus)	1
Mississippi (Platecarpus)	1
Nebraska (Mosasaurus)	1

Making, with the others from—

New Jersey	15
Alabama	7
Kansas	26
A total of	51

Of these, I am not acquainted with any species which extends its range into two of the areas above named; while some of these districts possess peculiar genera. It is, nevertheless, premature to draw any conclusions as to geographical range, as most of the species are known as yet from but few specimens.

History.

The knowledge of the structure of the animals of this order has been due, almost exclusively, to the labors of three paleontologists, viz, Georges Cuvier, Prof. O. C. Marsh, and the writer. Cuvier determined the characters of the dentition, and of the anterior regions of the skull, and of the vertebral column. Professor Goldfuss added little to this beyond the description of the parieto-quadrate and postorbito-malar arches. The writer ascertained the structure of the posterior part of the skull, including the walls of the brain-case, the suspensorial apparatus, the pterygoid and palatine bones, and the median hinge of the lower jaw; also, of the scapular arch and fore and hind limbs, except the phalanges. On this basis, the determination of the affinities of the order was made. Professor Marsh determined, for the first time, the presence of hind limbs, and described the pelvic arch; he also determined the relations of the phalanges of the fore limb, the presence of two small supernumerary cranial bones, and the probable existence of dermal scuta.

CLIDASTES, Cope.

Vertebral column exceedingly elongate, the vertebræ united by the zygosphenal as well as the usual articulation; the zygosphene elevated but little above the plane of the zygapophyses. Chevron-bones coössified; cervical hypapophyses free. Humerus short and very wide. Parietal fontanelle pierced in the parietal bone.

The species of this genus are, so far as known, the most elongate in the order. The quadrate bone, in the most typical species, exhibits a very prominent internal longitudinal ridge, indicating a great degree of rotation of that bone, and hence external flexure of the mandibular rami.

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

A. Centra of dorsal vertebræ depressed:

α. Frontal bones with median keel:

Clidastes tortor, Cope.

A slender species of some thirty feet in length, with a narrow, pointed head of two and a half feet. Its teeth are compressed, and with a cutting-edge fore and aft, and were eighteen in number on the under jaw; the palate was armed with eleven teeth.

The *frontal bone* is light, and with thin margins; it is keeled above for the anterior three-fourths of its length. On its inferior face, the olfactory groove is closed by the apposition of its lateral bounding ridges. Posterior to this point, the latter diverge and disappear; and a median ridge, with an acute edge on each side, carries the deep median olfactory groove, but disappears with the lateral ridges. There is no grooved triangular area in front of the foramen parietale. The *parietal bone* below presents a V-shaped, rounded ridge; the limbs embracing the narrow and small parietal fontanelle in front. The bone, in general, is broad and expanded laterally. Its antero-lateral ala is largely underlaid by the postfrontal, and presents a transverse ridge for its boundary. The superior surface of the bone presents a flat, longitudinal surface; the angles bordering the temporal fossæ being obtuse, well separated, and low. Bases of slender parieto-squamosal arches project from it behind.

The *postfrontal* is large and prominent, and terminates in the usual posterior process, connecting with the squamosal.

The *prefrontal* is a slender, flat, triangular bone. Its orbital portion projects at right angles to the orbital margin of the frontals, and is, in its direction, at right angles to the exterior margin. The latter is in the horizontal plane, and is transversely plicate. A strong process projects inwardly from the lower side, and is continued across the latter as a curved, flat-topped ridge, to which the maxillary bone is articulated. It soon reaches the outer margin of the prefrontal.

The *suspensorium* is flat (perhaps on account of pressure). The opisthotic sends a flat process to the parietal. The squamosal is, as usual, a sickle-shaped bone, with a flat extremity for articulation with the opisthotic. Unlike what is observed in *Platecarpus* and *Mosasaurus*, it presents no concave articular face below for the articulation (by ginglymus) of the quadrate. The *exoccipital* extends to near the end of the suspensorium, and terminates in a flat extremity with truncate border. The *proötic*, on the other hand, terminates near the middle of the length of the suspensorium by a transverse suture. The *basis cranii* I have not yet found among the *débris* of this skeleton.

Quadrate bone with long internal angle, and rather thick anterior ala, with broad, rugose margin. A prominent, obtuse ridge is continued from the internal angle to the inferior articular extremity; the distal portion being more acute. A rugose process projects at the point where the posterior hook approaches the body, and is continued, as an elevated, narrow ridge, parallel to the one previously mentioned, to the distal articular surface. A button-like knob appears on the posterior margin of the hook opposite the meatal pit. A strong ridge extends, on the outer face of the bone, from opposite the end of the hook to the base of the great ala. The distal articular surface presents two planes: the narrower at the end of the posterior pair of ridges above described; the larger considerably less distal, like a broad step.

The *maxillary bone* descends regularly in front, uniting with the premaxillary by minute suture. Its posterior extremity is slender and acute. The *premaxillary* is short conic; not particularly prominent. The *palatine bone* has a slight expansion on the inner side; on the outer, the margin is very narrow.

The *teeth* number seventeen on the maxillary bones. They are compressed, least so anteriorly, and with a cutting-edge from base to crown as far as the fifth from the front; in those anterior to that point, the posterior edge is discontinued. There are sixteen palatine teeth, which are smooth, and without anterior cutting-edge. The *frontal bone* has a low carina along the median line of its anterior portion.

Vertebræ of the cervical and anterior dorsal regions with round articular faces, not emarginate for the spinal cord. The bodies are elongate and somewhat contracted, and marked everywhere with finer and coarser striæ. Hypapophyses prolonged on the cervicals; the free one of the atlas with a prolonged keellike process.

Measurements.

	M.
Length of the axis with the odontoid process	0.078
Diameter of the ball of a cervical, vertical	0.026
Diameter of the ball of the same, transverse	0.026
Expanse of the diapophyses of the same	0.084
Length of the centrum of the same	0.052
Length of the maxillary bone	0.363
Length of the ramus mandibuli behind the dentary	0.310
Length of the premaxillary	0.040
Total length of the cranium (2.33 feet)	0.713
Length of the pterygoid and palatine	0.315
Length of the centrum of the posterior dorsal vertebra	0.066
Diameter of the ball, vertical	0.033
Diameter of the ball, transverse	0.038

The bones of this species are all light and slender. The elongation of the vertebræ indicates that, if their number was of the usual amount, the animal was of more than usually slender proportions. The position in which it was found was a partial coil; the head occupying the inside of a turn of the dorsal vertebræ. As compared with *E. dispar* and *E. velox* of Marsh, the present differs in the lack of depression of the centra of the vertebræ, especially the anterior, and in some details of structure of the quadrate bones, as well as the larger number of teeth.

Discovered in Fossil Spring Cañon, in the gray limestone, by Martin Hartwell and Sergeant William Gardner. But one specimen was found, which includes the greater part of the cranium, with the vertebræ as far as the lumbar region.

CLIDASTES STENOPS, Cope.

Indicated by a large part of the skeleton of one individual, and fragments of two others. The first includes a large part of the cranium, with both quadrates, and fifty vertebræ, including the axis. The characters are similar to those of the preceding species; but all the bones are more massive, though of the same dimensions.

The *teeth* are strongly compressed with cutting-edge fore and aft, and with the surfaces distinctly faceted; there are seventeen on the mandible. The palatine bones are stouter than in *C. tortor*, but the teeth are not larger, and are probably as numerous, as they are similarly spaced.

The *parietal* is thicker than in *C. tortor*, and flat above. The decurved lateral portions are short antero-posteriorly; behind these, there is a prominence on the inferior face, which is broken, but probably ends in the acute median termination of the bone. The apex of an inferior V-shaped ridge is preserved. The parts of the *frontal* preserved show the olfactory groove nearly closed, and its division in front into two contiguous lateral grooves. The middle of the upper surface is plane; its anterior part, with a low keel.

The *prefrontal* is of peculiar form, and displays the greatest difference from that of *C. tortor*. Instead of being a horizontal bone, it is so oblique as to be nearly vertical. From this follows an alteration of the relation of all the parts. The squamosal suture with the frontal, which is marked by peculiar concentric rugosities in both species of this genus, instead of being on the upper, is nearly on the under surface, though oblique to both. The lateral margin is subinferior and plicate; the crest of the inner side bounding the maxillary projects far below it in front. In consequence of the form of the bone, there is less expansion of the face in front of the orbits than in other species of the order; whence the face is much narrower, and the name *stenops* is appropriate. The portions of the prefrontal of the other side which are preserved are similar to those described. The characters of the suspensorium are in the main as in *C. tortor*.

The *quadrates*, like those of the last species, have a very prominent internal angle. They present various differences, which may be regarded as only individual: for example, the edge of the great ala is not expanded inward, but only outward; the distal articular extremity is wider; the posteriorly decurved hook is more contracted, forming a deeper internal concavity behind the internal angle. The button on the posterior aspect of the hook is wanting; its place being taken by a recurvature of the smooth articular face along the margin. Characters of more importance are, the lack of the two ridges which bound the posterior face of the distal end of the bone, that face being thus convex instead of concave; and the process below the meatus is isolated, and not continued into a ridge, except externally, where it gives rise to the heavy ridge which extends to the base of the great ala.

The *vertebræ* exhibit round articular surfaces; those of the dorsal region being rather stouter than the cervical, though the difference does not appear to be so marked as in the preceding species. The anterior caudals possess wide diapophyses. The articular faces are a vertical oval, a little contracted above, sometimes by a straight outline. They preserve a peculiarly elongate form.

Measurements.

	M.
Length of the axis (alone)	0.060
Diameter of the ball, vertical	0.027
Diameter of the ball, horizontal	0.027
Length of a posterior dorsal	0.060
Diameter of the ball, vertical	0.033
Diameter of the ball, transverse	0.038
Length of the caudal with the flat diapophysis	0.033
Depth of the cup of the caudal	0.031
Width of the cup of the caudal	0.030
Length of the mandible (28 inches)	0.720
Depth at the coronoid process	0.150
Depth at the proximal end of the dentary	0.074
Depth at the distal end of the dentary	0.020

A fine specimen of this species was found by Martin V. Hartwell near Fossil Spring; and portions of a second were found by Lieut. James H. Whitten, on a bluff on Butte Creek, during my expedition of 1871.

αα. The frontal bone without median keel:

Clidastes planifrons, Cope.

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

The *frontal bone* is especially massive, and is plane on the superior surface. The superciliary borders are strongly concave, a feature either little or not at all marked in other species known to me. It is thickened; but the fossa for the postfrontal bone extends far toward the front and middle on the inferior surface. In front of the prefrontal angle, the frontal contracts, narrowing regularly to the line of the nares. The prefrontal has the remarkable form characteristic of *Clidastes stenops;* that is, with the exposed face subvertical or steeply roof-shaped, instead of horizontal. A groove descends on each side to each nareal orifice, and the intervening longitudinal ridge is deeply fissured by a parallel groove. The parietal fontanelle is entirely in the parietal bone. The postfrontal is massive.

The *quadrate bone* presents a very prominent internal angle, as in other *Clidastes*, and has the posterior hook much prolonged downward and inward, with a button and surrounding groove on the inner side of one, but none on the other. The stapedial pit is a narrow oval, as in *Liodon proriger*. The median posterior ridge is prominent, and united with the distal internal longitudinal, extending to the narrow posterior angle of the distal articular face. The internal ridge is prominent, dividing the internal face of the bone into two planes, the posterior of which is but little concave along its upper posterior border (*i. e.*, on the inner side of the hook); this region is very concave in some species of the genus. There is a strong transverse obtuse ridge, which extends along the outer side, turning backward into a rough process opposite the origin of the base of the ala. Between this and the distal articular face is a subtriangular rugose area. The palatine bone has its anterior and posterior extremities broken away, the fragment supporting six teeth. The bone is flat, much as in the species of *Platecarpus*, the tooth-line passing from the inner margin behind to the outer before, the roots being more exposed on the external side; the external process is stout. The crowns of the palatine teeth are curved, with lenticular section, one face being much more convex than the other; the enamel is shallowly striate-grooved.

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

Measurements.

	M.
Length of the frontal bone to the nares	0.150
Width of the frontal bone posteriorly	0.140
Width of the frontal bone at the orbits	0.104
Width of the frontal bone at the nares	0.040
Width of the palatine at the third tooth in front of the transverse process	0.037
Width of the palatine just behind the transverse process	0.035
Depth of the mandible at the cotylus	0.040
Depth of the splenial condyle	0.032
Width of the proximal articular surface of the quadrate (transverse)	0.023
Width of the distal articular surface	0.043
Length of the third cervical centrum	0.062
Depth of the ball of the third cervical centrum	0.030
Width of the ball of the third cervical centrum	0.037
Length of the articular end of the fixed hypapophysis	0.025
Length of the free hypapophysis	0.029
Length of a median dorsal centrum	0.072
Width of the ball of a median dorsal centrum	0.048
Depth of the ball of a median dorsal centrum	0.040

This species need only be compared with the *Clidastes stenops*, Cope, which exhibits the same peculiarity of roof-shaped prefrontal bones. That species has the cervical articular faces entirely round; the frontal bone is keeled in the middle, and the palatine much more vertically compressed. The quadrate bone differs in various respects; among others, in the round form of the stapedial pit. As compared with the species described by Professor Marsh as *Edestosaurus dispar* and *E. velox*, it differs in the form of the quadrate, which, in these species, is much as in *C. tortor* and *C. stenops; i. e.*, with short proximal hook, oblique inferior articular surface, round pit, &c. In this species, the quadrate is truncate distally, &c. This fine species was discovered by the veteran geologist, Prof. B. F. Mudge, during his annual expedition of 1873.

AA. Centra of anterior dorsals compressed.

Clidastes cineriarum, Cope.

The largest species of this genus, as indicated by the zygosphen articulation of the vertebræ.

The region where it was found is the same as the last, but the specimens were taken from the gray bed, perhaps the same that produced the *Elasmosaurus platyurus*, Cope. They consist of vertebræ and pterygoid teeth. There are two anterior dorsals, three lumbars, and one caudal. The articular faces of the caudals are broad vertical ovals. They increase in width on the lumbars till, on the last of these, they assume the subpentagonal form characteristic of many species, and which is still more marked on the caudal. The centrum of the anterior dorsal is much compressed; inferiorly, slightly concave longitudinally, regularly and prominently convex transversely. Conversely, the rims of the cup and ball are strongly expanded; the latter with surrounding groove. The diapophyses of the lumbars are of considerable length, exceeding, in this respect, those of *Mosasaurus* we possess where these parts are preserved. On the median of the lumbars, the inferior surface of the centrum first becomes truncate or plane, and separated from that below the diapophyses, which become slightly concave. The expansion of the ball becomes more abrupt and striking on these vertebræ. The caudal is a little more compressed than the lumbars, and presents the character of coössified chevron-bones. These are slender and longitudinally grooved.

A single pterygoid tooth was found in the matrix on one of the dorsals The basis is short and much swollen; the crown curved, acute, a little compressed, and with an obtuse cutting-edge posteriorly.

Measurements.

	M.
Anterior dorsal, length of the centrum	0.0608
Anterior dorsal, depth of the articular ball	0.0[illegible]8
Anterior dorsal, width of the articular ball	0.038
Anterior dorsal, diameter behind the diapophyses	0.029
Anterior dorsal, depth of the articular face for the rib	0.022
Lumbar, length of the centrum	0.060
Lumbar, depth of the ball	0.037
Lumbar, width	0.039
Lumbar, length of the remnant of the diapophysis	0.046
Lumbar No. 2, length of the centrum	0.055
Lumbar No. 2, width of the zygosphen	0.0182
Caudal, length of the centrum	0.041
Caudal, depth of the cup	0.040
Caudal, width of the cup	0.040
Caudal, width of the basis of the diapophysis	0.0245
Caudal, width between the chevron rami	0.0115
Pterygoid tooth, height of the crown	0.0125
Pterygoid tooth, diameter of the pedestal	0.013

This species was found by Professor Mudge near the locality of the *Platecarpus mudgei*, six miles south of Sheridan, Kansas.

It is only necessary to compare this species with *C. intermedius*, Leidy, as the *C. iguanavus* and *C. propython* have depressed vertebral centra. Those of the first are rounded; of the present one, compressed. The *C. intermedius* also agrees with the two others in the obliquity of the articular faces to the vertical transverse plane of the centrum; in the present species, these planes are *parallel.* This species is also larger than the *C. iguanavus*, Cope; the *C. intermedius* is smaller.

A smaller specimen, apparently of this species, was obtained by Professor Mudge during his expedition of 1872. The small distal caudals exhibit the coössified chevron-bones, and the articular faces broader than long; the anterior caudals do not exhibit the two angular ridges of the lower side, seen in so many species. The lumbars are short, and the dorsals rather elongate, with the slightly vertically-oval articular faces and contracted sides of the centrum.

Measurements (No. 2).

	M.
Length of the centrum (with ball) of the posterior dorsal	0.060
Depth of the cup	0.042
Width of the cup	0.040
Length of a lumbar	0.040
Depth of the cup	0.038
Width of the cup	0.037
Length of the caudal without the diapophyses	0.021
Depth of the cup	0.024
Width of the cup	0.028
Length of a more distal caudal	0.019
Depth of the cup	0.021
Width of the cup	0.022

This is the specimen mentioned under the head of *Plesiosaurus gulo* as having been probably swallowed by the latter. Found near Sheridan, Kans., in the gray shale.

SIRONECTES, Cope.

The characters of this genus are such as to unite closely that which precedes it with that which follows it in the present enumeration. It is more nearly allied to *Platecarpus* in the only species known, where the zygosphen is weak, but articulates with special facets on the lateral walls of the zygantrum, which are not known in that genus. The form of the bones of the limbs is unknown.

SIRONECTES ANGULIFERUS, Cope.

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

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

Measurements.

	M.
Depth of the mandible at the posterior margin of the cotylus	0.058
Length of the centrum of the anterior cervical	0.070
Diameter of the ball, vertical	0.028
Diameter of the ball, transverse	0.040
Expanse of the diapophyses of the anterior cervical	0.095
Expanse of the anterior zygapophyses	0.064
Expanse of the diapophyses of the anterior dorsal	0.115
Length of the centrum of the anterior dorsal	0.071
Length of the centrum of the anterior caudal	0.053
Depth of the cup of the anterior caudal	0.044
Width of the cup of the anterior caudal	0.041
Width of the neural spine	0.033
Elevation of the neural spine (apex lost)	0.070
Diameter of the centrum of the twenty-fourth caudal, vertical	0.039
Diameter of the centrum of the twenty-fourth caudal, transverse	0.040
Length of the centrum of the twenty-fourth caudal	0.042

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

PLATECARPUS, Cope.

Vertebræ very numerous; caudal series very elongate; zygapophyses strong; zygosphen wanting, or very rudimental. Chevron-bones free. Teeth subround in section, acute, and curved. Humerus short and wide.

While the form of the humerus in this genus is that of *Clidastes*, the vertebral articulations are those of *Liodon*, the zygapophyses being, however, stronger. The teeth are different from either.

Besides the characters assigned to this genus in the analytic table already given, *Platecarpus* is characterized by the position of the fronto-parietal fontanelle on, or very close to, the coronal suture, instead of in the broad plate of the parietal bone posterior to the suture, as in *Clidastes.* The genus is also characterized by the form of its teeth, which are neither compressed, as in *Liodon*, nor broadly, angularly faceted, as in *Mosasaurus* (and *Holcodus, fide* Marsh), but are curved and subcircular in section. The exposure of the roots of the palatine teeth is largely less, or scarcely greater, on the outer than on the inner side. The form of the cranium is, in this genus, less elongate than in *Clidastes*, and the muzzle is often quite short and obtuse. The caudal vertebræ of the type-species *P. tympaniticus* are unknown; but its quadrate bone and the forms of its cervical vertebræ and palatine teeth are quite similar to those of the other species here referred to *Platecarpus.* Professor Marsh has referred the same species to a genus, *Lestosaurus*, Marsh, of which the species *L. simus*, Marsh, is regarded as type, and which he regards as nearly coëxtensive with the genus I previously defined under Dr. Gibbes's name *Holcodus.* He finds the coracoid of *L. simus* to be deeply incised, as is often the case in *Lacertilia.*

The name which I formerly used for this genus was originally applied by Dr. Gibbes,[1] of Charleston, to a species represented by teeth from the Cretaceous of Alabama, but of which no other portions were known. The teeth of the Kansas species referred to it are somewhat similar in character to those described by Gibbes; but it is evident that the latter belonged to an

[1] On *Mosasaurus* and allies, in Smithsonian Contributions to Knowledge, 1851, 9; plates.

animal more nearly allied tothe true *Mosasaurus*. The place of *Platecarpus* is evidently between *Clidastes* and *Mosasaurus;* the palatine bones being those of the former, and the vertebral articulations being identical with that characteristic of *Mosasaurus*. In all of the species, traces of the zygosphen appear; but in the *H. coryphæus*, Cope, the rudiment amounts to a short process directed forward at the base of each anterior zygapophysis.

The species known, as yet, are of medium size in the order.

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

It is probable that this genus had a considerable geographical distribution. *P. tympaniticus* has been found in Alabama; and I suspect that other species from other localities belong to it.

PLATECARPUS CORYPHÆUS, Cope.

Characters.—Cervical and dorsal vertebræ with the articular surfaces depressed transverse, slightly excavated above for the neural canal. The diapophyses not continued inferiorly to the rim of the cup on the cervical vertebræ, and not receiving from it a cap of articular cartilage. Occipital crest much elevated. Quadrate bone small, the meatal pit depressed between bounding ridges above and below. Rudimental zygosphen not uniting into a keel above. Teeth slender, less curved than in *P. ictericus.*

Description.—This species is chiefly based on one specimen, which includes the greater part of the cranium, and seventeen vertebræ, with ribs. Isolated portions of other individuals were also found in the same region of country.

The disproportion between the diameters of the cervical and dorsal vertebræ is more marked here than in the species of *Clidastes*. The centra are also less elongate, though with larger diameter. The cranium is relatively much smaller; the teeth absolutely smaller, though the quadrate bones are of equal size. The general character of the species is stouter, but less strongly armed, and less elegantly built.

The hypapophysis of the *atlas* has a short small keel below. The neural spine of the *axis* is elongate, but less so than in the two *Clidastes*, truncate behind, with a median groove, into which the anterior keel of the neural spine of the third cervical vertebra is applied. The diapophysis of this vertebra has a short vertical articulating surface, and is continued into a longitudinal keel, which disappears before reaching the edge of the cup. The same process of the axis has a longitudinal parallelogrammic articular surface.

The *supraoccipital* is very thick, and is roof-shaped, the keel rising nearly perpendicularly from the foramen magnum. The *suspensoria* are directed both upward and backward, at about an angle of 45° in each direction, and support, on their extremities, the squamosal bones. These are prolonged, each forming a part of its appropriate arch. The occipital condyle is transversely oval. The *sphenoid* bone embraces, as usual, the basi-occipital protuberances; it is not carinate on the median line below. It sends out, on each side near the anterior extremity, a subhorizontal, laminar process.

The *quadrate bone* is much like that of *P. ictericus*, but is relatively smaller. While the teeth in that species are smaller, the quadrate is larger; hence, the difference in the species is, in this point, quite striking. The internal angle is prominent, but very obtuse, and is the summit of a very thick, obtuse ridge, which extends to near the distal articular face. The posterior hook is much prolonged downward, and has no buttonlike process or extension of the articular surface on its posterior face. This face presents a strong rib along the meatus, and, disappearing above the pit, throws the latter into a depression. This is increased by the swelling of the internal angular rib. A prominent knob, very rugose at the extremity, rises beneath the end of the hook, and bounds a concavity between it and the internal rib. The latter closes the concavity by curving round toward the knob above mentioned. A keel rises interior to the rib, and below it, and continues into the internal angle of the articular extremity. Another very prominent keel extends from the knob beneath the hook to the base of the great ala. The articular extremity is transverse, and in one plane.

The *maxillary bone* is marked with shallow longitudinal grooves. It supports eleven teeth, and has a rather steeply-descending premaxillary suture in front. The nareal expansion in front occurs opposite the fourth tooth.

The *teeth* are rather long, slender, and incurved and recurved. There is a distinct cutting-edge anteriorly, and on a greater or less part of the length of the posterior face. The crowns are four or five faceted on the outer face:

the inner face is more numerously faceted, and striate-grooved. The section at the base is subcircular; higher, the outer face is flatter, the inner more convex. The apex is acute, and the cutting-edges strong.

The *frontal* is narrow, and differs from the other *Platecarpi* here described in having the olfactory groove closed by contraction behind. Both palatines are preserved. They support twelve cylindric conic teeth, which have recurved apices and striate enamel. The section of the bone is a flat, transverse oval, where the external transverse process is given off. The shaft of the bone is much expanded inwardly, with a thickened margin; exteriorly, the margin is thin, and is nearly followed by the series of teeth whose bases are exposed externally, and are therefore pleurodont. The emargination for the pterygoid is very deep.

Measurements.

	M.
Length of the axis with the odontoid	0.074
Length of the third cervical	0.048
Diameter of the ball of the third cervical, vertical	0.021
Diameter of the ball of the third cervical, transverse	0.033
Elevation of the spine of the third cervical from the centrum	0.046
Length of the posterior dorsal	0.068
Diameter of the centrum, vertical	0.033
Diameter of the centrum, transverse	0.048
Length of the basioccipital and basisphenoid	0.084
Elevation of the occipital crest above the floor of the foramen magnum	0.030
Length of the suspensorium from the foramen ovale	0.090
Length of the os quadratum	0.073
Width of the distal extremity	0.036
Length of the os maxillare	0.210
Depth of the os maxillare at the third tooth	0.036
Length of the fourth tooth	0.032
Length of the crown of the fourth tooth	0.021
Length of the pterygoid bone	0.155

This fossil was found by the writer projecting from the side of a bluff in a branch of the Fossil Spring Cañon, near the mouth of Fox Cañon. The bluff was from eighty to one hundred feet in height; and the *Platecarpus* was taken from a position forty feet below the summit, from the yellow chalk.

PLATECARPUS ICTERICUS, Cope.

Characters.—Internal angle of the os quadratum close by the meatus, and continued as a rounded ridge separating the anterior and posterior internal faces of the bone. Median posterior ridge not prominent. Centra of dorsal vertebræ depressed. Humerus broad, short.

Description.—This species is represented by portions of a cranium, as postfrontal, suspensorial, pterygoid, articular, and quadrate bones; by parts or wholes of several vertebræ, which are all dorsals; and by scapula and coracoid, with many elements of the fore limb. The latter include humerus, radius, a carpal, and numerous metacarpals and phalanges.

The species is first well characterized by the form of the *quadrate bone.* The specimen lacks a portion of the ala, and the postero-superior decurved process, but is otherwise perfect. Its form is intermediate between that in *Liodon validus*, Cope, and *Mosasaurus depressus*, Cope. Its internal angle of the proximal extremity is posterior to its usual position, as in the former species, but is less prominent than in it. It extends to near the distal end, disappearing between the extremities of the median posterior and the distal longitudinal angles. The former of these is short, and it disappears by a gradual descent distally in a very rugose margin. The distal longitudinal is short and acute, not prominent at the distal extremity. From the posterior position of the proximal internal angle, the alar articular surface is somewhat elongate. The postero-internal face above the meatus is proportionately short. The meatal pit is scarcely one-fifth the usual size, so far as determinable from the present surface; but it is possible that the greater part is filled by an impacted mass of bone derived from the adjacent ridge. The margins of the articular extremities and of the ala are striate and papillose rugose. No meatal knob.

The suspensorium is slender. It is peculiar in the great extent of the exoccipital element, which covers the whole superior surface, and extends externally over the opisthotic to the squamosal, concealing the former, except its anterior margin. The proötic sends a small proximal portion only to the superior face.

The palatine has been free from its fellow medially. A distal and median portions have been lost; the remaining fragments presents bases and alveolæ for eleven teeth. The fangs are rugulose and but little swollen; probably five to seven stood on the lost portions. The bases of the crowns are circular. The external process of the bone is slender and flat.

The portion of the mandible preserved includes much of the articular, and adherent parts of the angular. The latter forms a narrow band on the lower edge of the external face, and one twice as wide on the inner face. The only characteristic feature is the lowness of the ridge which descends and extends anteriorly from the anterior margin of the cotylus for the quadratum.

Of the vertebræ, several are so distorted by pressure as to be uncharacteristic. Two well-preserved anterior dorsals have transversely oval articular surfaces excavated openly above for the neural canal. One is from a position anterior to the other; and these surfaces are less oval, though still transverse. The centra of both are very concave in profile below, and expand both inferiorly and laterally to the edge of the cup. A deep groove surrounds the base of the posterior face. In the anterior dorsal, the neural arch is preserved. It exhibits an approach to a zygosphen articulation, more marked than in any other *Platecarpus,* and is hence nearer *Sironectes* in this respect, as well as in the slender pterygoid. A zygosphen is not separated from the zygapophyses, owing to their connection by a lamina of bone. The notches at the posterior end of the arch for this prominence are marked. The neural spine had a long anterior ala, the base of which extends to the summit of the neural arch. It presents a fine striation vertical to the centrum and oblique to the edge of the bone, as is seen in *C. propython*, Cope. The diapophysis on this vertebra looks obliquely upward, and carries a vertical articular surface, which is concave behind. The line of its lower extremity falls the depth of the neural arch below the latter, and of its upper reaches the apex of the canal in front. The more posterior vertebra has, as usual, a broader articular rib-surface, the diapophysis being flattened above and below. The marginal and angular surfaces are striate-rugose on these and the other vertebræ. One of the free hypapophyses of a cervical is preserved. It has a subtrigonal section, and is longer than wide, and obtuse. Its posterior faces are exceedingly rugose.

A cervical rib is compressed and short. Head narrow, large, simple; the adjacent sides striate-rugose. Sides with a shallow groove.

The scapular arch is represented by an entire right scapula and proximal part of right coracoid. The former is broader than in any of the species in which I have seen it, and is flat and thin above. Its anterior extension is greatest below; its posterior above, at the superior angle. The lower posterior margin is strongly concave and thickened. The antero-superior margin is a regularly convex arc of more than 180°. The lower portion in front is on a different plane, and is the rudimental acromion. The articular surface is rugose, and the glenoid cavity not less so.

The proximal portion of the coracoid is flat. It presents the usual foramen near the anterior margin; and the shorter concavity of the anterior margin leads to the belief that the anterior extremity of the bone is the more prolonged, as in *Clidastes propython*.

The glenoid cavity is not concave, but merely two adjacent flattened rugose surfaces.

Consequently, the *humerus* has no head, but merely an elongate articular surface, which exhibits a median keel and a short angular expansion near the middle. This bone is of remarkable form, more resembling that I have described in *C propython*[1] than any other, and very different from that described in *Liodon dyspelor*. It is a broad flat bone, expanded at the extremities, and in one plane distally, so as to be as wide as long. In the present individual, it is crushed by pressure, so that its thickness is not readily determinable. Its external surface rises into a crest medially at the narrowest portion, which continues to the lateral angle of the proximal end, following parallel to one of the borders. A moderate thickening exists on the opposite side, a little beyond the extremity of the crest. Strongly rugose striæ extend to the edges of the articular faces. An oval rugose muscular insertion exists on the least prominent of the distal angles, and not on a process, as in *C. propython*.

A bone, which, from its analogy to the *radius* of the last-named species I suppose to be that bone, accompanies the others. It is flat, truncate proximally, and with nearly parallel borders on the proximal half. Distally, it is obliquely expanded; the outline forming a segment of an ellipse, whose axis is oblique to that of the bone. Its extremities are rugose-striate.

One *carpal* remains; it is a quinquelateral bone, one side being marginal and concave. Perhaps it is the intermedial. There are several elements, which are probably metacarpals. The general structure of the whole limb may be determined from these and from the numerous *phalanges*. The former are flattened and with oblique extremities; the latter more cylindric, with a transverse truncation. Both have a median contraction, which becomes less marked in the distal ones; these are also more cylindric, entirely so at the distal extremities, which are concave. All of these elements are rod-like, much more slender than any of those figured by Cuvier or Leidy. Those immediately following the metacarpals are flattened, but thickened distally.

The number of *digits* cannot be readily determined, but four may be

[1] See Transactions of the American Philosophical Society, 1869, p 219, Table XII, fig. 17.

certainly distinguished. The general similarity in construction of the manus to that of a cetacean mammal is noteworthy.

Measurements.

	M.
Length of the suspensorium anteriorly	0.111
Width of the suspensorium, medially	0.031
Quadrate, greatest length	0.099
Quadrate, width of the ala	0.066
Quadrate, thickness behind	0.030
Quadrate, length of the distal extremity	0.043
Palatine, length of six alveoli	0.055
Anterior dorsal, length of the centrum	0.059
Anterior dorsal, width of the cup	0.0515
Anterior dorsal, depth of the cup	0.038
Anterior dorsal, expanse of the posterior zygapophyses	0.0395
Anterior dorsal, expanse of the diapophyses	0.091
Anterior dorsal, width of the neural canal	0.0135
Anterior dorsal, depth of the neural canal	0.011
Posterior dorsal, depth of the ball	0.049
Posterior dorsal, width of the ball	0.0425
Posterior dorsal, length of the centrum	0.0555
Posterior dorsal, expanse of the diapophyses	0.088
Scapula, length	0.145
Scapula, width, proximal	0.070
Scapula, width, median	0.112
Coracoid, width, proximal	0.066
Humerus, length	0.154
Humerus, width, proximal	0.119
Humerus, width, median	0.075
Humerus, width, distal (restored from *C. propython*)	0.158
Radius, length	0.115
Radius, width, proximal	0.061
Radius, width, distal (oblique)	0.105
Carpal, length	0.040
Carpal, width	0.037
Metacarpal, length	0.095
Metacarpal, width proximally	0.045
Metacarpal, width medially	0.018
Metacarpal, width distally	0.034
Phalange (medial), length	0.085
Phalange (medial), width proximally	0.027
Phalange (distal), length	0.059
Phalange (distal), width distally	0.00[illegible]2
Ramus mandibuli, depth in front of the cotylus	0.056
Cervical rib, length	0.074

The total length of the anterior limb could not have been less than $0^{m}.90$, which allows of five phalanges in the longest digit. There may have been more. That the digits were of unequal length is indicated by portions of two in matrix accompanying the specimens, where the articulation of two phalanges falls opposite the shaft of one of the adjoining digits. The phalanges were separated by a short interval of cartilage.

The size of this reptile was near that of *Liodon validus*, perhaps thirty-five to forty feet in length.

The specimens on which this species rests were discovered by Prof. B. F. Mudge, formerly State geologist of Kansas, now professor of geology in the State Agricultural College of Kansas, on the north bank of the Smoky Hill River, thirty miles east of Fort Wallace, Kansas.

Numerous fragments of another larger individual were found by Professor Mudge near the same locality, which belong probably to the same species. Among them is a portion of the maxillary bone, with bases of two teeth; the bases of the crowns where broken off are not compressed, but slightly oval. A radius is a flat bone, more dilated at one extremity than that of *Clidastes propython*.

Measurements.

	M.
Length of the radius	0.108
Width of the radius at the narrow extremity	0.064
Width of the radius at the wider extremity	0.080
Width of the radius medially	0.042

In addition to the two individuals procured by Prof. B. F. Mudge, the writer obtained a considerable part of a third from a low bluff on Fox Cañon, south of Fort Wallace. This includes seventeen lumbar, dorsal, and cervical vertebræ, including axis, with ribs, and a large part of the cranium, with both quadrates, occipital and periotic regions, etc. Its characters may be briefly pointed out as follows:

Articular surfaces of dorsal and cervical vertebræ transverse oval, excavated above for neural canal; diapophyses not extending below to the edge of the cup, hence not receiving an area of articular cartilage continuous with the rim. Occipital crest low, oblique; quadrate bone larger; the meatus depressed between ridges. A button of articular surface on posterior face of hook. Scarcely any rudiment of zygosphen. Teeth small, much incurved, faceted, and striate-ridged.

Some characters, additional to those already derived from the first-known examples, may be added. The *mandible* supports only twelve teeth. The *palatine bone* is shorter anterior to the external process, and longer behind it than in *H. coryphæus*. In our specimen, the posterior extremity is broken off, yet shows no indication of the emargination for the pterygoid bone an inch behind the position of its anterior extremity in *H. coryphæus*. There are ten teeth on the part preserved, four in front of transverse process (six in *H. coryphæus*), and six (probably seven) behind (six in *H. coryphæus*).

The plate is more expanded than in the last-named species, especially the thickened inner margin, which only approaches the basis of the last tooth (reaches the tooth-line at the fifth in *H. coryphæus*).

The *occipital crest* is low, and directed obliquely forward from the foramen magnum. The suspensoria are stout, and directed at an angle of 45° in both the superior and posterior directions. The *basisphenoid* is strongly keeled below. The *quadratum* is like that of *H. coryphæus* in its massive external angle and ridge, but differs in the shorter hook and the non-interruption of the groove between the internal angular ridge and the knob below the meatus. The *cervical* and *dorsal vertebræ* display the same disproportion in size observed in *H. coryphæus*.

Measurements.

	M.
Length of the os quadratum	0.081
Width of the articular extremity of the os quadratum	0.038
Length of the dentary bone	0.280
Length of the tooth of the dentary bone, third from behind	0.022
Length of the tooth, crown only	0.016
Length of the suspensorium from the foramen ovale	0.108
Total length of the cranium (23 inches)	0.580

This species cannot be confounded with the *Liodon proriger*, Cope, and *L. congrops*, Cope, owing to its depressed vertebral centra; from *L. mitchillii*, DeKay, the equal and numerous pterygoid teeth separate it at once.

Platecarpus curtirostris, Cope.

The specimen below described was found by the writer on the denuded foot of a bluff on the lower part of Fossil Spring Cañon. The posterior part of the cranium, with several vertebræ, was found exposed, and many other bones, including the cranial, were found only covered by the superficial washed material. Other portions were exposed on excavating the blue-gray bed of the side of the spur adjoining. The name has reference to the abbreviation of the head and jaws. These are relatively shorter than in any other species here described where these parts are known. The end of the muzzle does not overhang, but descends gradually to the tooth-line. There are but ten maxillary teeth and two premaxillaries on each side. Size about that of *P. coryphæus*.

Characters.—Cervical and dorsal vertebræ with transversely oval articular faces, which are little depressed, and, though not continued to the base of the neural arch, are scarcely excavated above for the neural canal. The diapophysis with stout inferior horizontal branch, which is capped by an extension of the articular cartilage from the rim of the cup. Occipital crest elevated, subvertical. Quadrate broad below; pit sunk between bounding ridges.

Description.—There is a great disproportion in the sizes of the cervical and posterior dorsal vertebræ; the centra of the latter are rather more depressed than those of the former. They are similar in proportions to those of the other *Platecarpi*, and shorter than those of the *Clidastes.* The short axes of the articular faces are subvertical. The rudiment of zygosphen is seen in the slight anterior prolongation of the roof of the neural canal. The keel of the hypapophysis of the atlas is short and obtuse.

The greater part of the *cranium* is preserved. The supraoccipital keel is vertical, and furnished at the summit with a plicate knob for the insertion of a *ligamentum nuchæ.* The thickness of the walls of the bone is not equal to that in *H. coryphæus*, and the suture for the parietal is a double squamosal; *i. e.*, with a groove along the middle of the edge. The basisphenoid is but slightly keeled below, and is distally expanded into a horizontal plate on each side. The parietals are, as usual, confluent, and send off two light arches postero-laterally for union with the squamosal bone. Between their origins are two subparallel ridges, which disappear, the transverse section of the narrow part of the parietals being rounded. The lateral ridges within the temporal fossæ are obsolete, while the convergent angles which bound the parietal table posteriorly are strongly marked. This table is nearly plane, and the *foramen parietale* is large. The *frontal* is narrowed in front, and has an elevated keel along its anterior half. The olfactory groove is not much contracted behind, but is closed by the apex of the rugose area in front of the foramen parietale.

The *palatine bone* is narrow, and the external margin is very slight, the bases of the teeth being exposed in that direction. The inner margin is much thickened downward, but not so as to be a vertical plate. The hinder part of the bone is flat and horizontal, with a long maxillary process. The pterygoid notch falls opposite the second tooth from behind. The whole number of teeth is eleven.

The *jaws* are represented by the greater part of all of the tooth-bearing portions. The maxillary bone is shallowly sulcate on the exterior face. Its proportions are quite similar to those of the *H. coryphæus*, but the teeth it supports are larger and fewer. There are none missing from the extremities of the specimen, the whole number being ten; in the *H. coryphæus*, there are eleven. The crowns are incurved, faceted externally, and striate grooved internally; there are cutting-edges in front and rear, both strongest near the apex; the anterior continued to the base, the posterior wanting on the basal third on the median maxillaries. The anterior nareal excavation marks the fourth tooth from the premaxillary suture. The *premaxillary bone* is remarkable for its shortness and flatness at the extremity; this part being depressed and scarcely projecting at the lower margin in front of the anterior teeth. These, as usual, number four.

Both *quadrate bones* are preserved nearly entire. They have the same general character as those of *Pl. ictericus* and *Pl. coryphæus;* resembling rather the latter in the great length of the posterior hook, which is without posterior marginal button. The proximal internal angle is large and obtuse, and is continued into a prominent thick ridge. The latter divides below, the thick extremity turning outward and ceasing; an acute ridge continuing inward, and joining the interior acute extremity of the distal articular surface. The sub-meatal knob is broad and thick, and not prominent; and its extremity turns at an acute angle forward on the outer face, and forms the commencement of the great ala. The articular surface is straight crescentic, with an expansion on a tuberosity on the inner face (concave of crescent). The meatal pit is sunk between the ridges surrounding, one of which is on the outer margin of the posterior hook.

The *mandible* is nearly perfect. The dentary bone bears thirteen teeth, and, at the extremity, is contracted in both directions, and not prolonged beyond the base of the last tooth. The ridge, which descends from the cotylus along the inner face of the articular bone, is not nearly so strong as in the *P. mudgei*.

Measurements.

	M.
Length of the axis with the odontoid	0.062
Elevation of the neural spine of the odontoid at the middle	0.046
Length of the third cervical (body)	0.050
Diameter of the ball, vertical	0.025
Diameter of the ball, horizontal	0.032
Length of a posterior dorsal	0.065
Diameter of the ball, vertical	0.038
Diameter of the ball, horizontal	0.050
Length of the basis cranii	0.090
Length of the suspensorium	0.105
Elevation of the occipital crest above the floor of the foramen magnum	0.045
Length of the tooth-line of the palatine	0.115
Length of the maxillary bone	0.210
Length of the premaxillary laterally	0.035

	M.
Width of the premaxillary at the second tooth	0.041
Length of the dentary	0.245
Length of a maxillary tooth	0.030
Length of the maxillary tooth, crown only	0.023
Length of the os quadratum	0.077
Width of the os quadratum distally	0.045
Length of the parietal	0.085
Length of the frontal to the nares (median)	0.110
Width of the frontal between the orbits	0.077
Total length of the cranium (18.75 inches)	0.473

PLATECARPUS CRASSARTUS, Cope.

This saurian, which is of larger size than the last, is represented by a series of dorsal, lumbar, and caudal vertebræ, with some bones of the limbs.

The vertebræ are as much distinguished for their shortness as those of *P. latispinis* are for their elongation. The articular faces are but little broader than deep, and their planes are slightly oblique. They are very slightly truncate above by the neural canal. The inferior face is somewhat concave in the longitudinal direction. The zygapophyses are stout, and there are no distinct rudiments of zygosphen.

The dorsal vertebræ best preserved are those in which the diapophyses reach the middle of the sides of the centra, and have no horizontal limb. The latter are narrow, and have not extensive articular extremital surfaces.

The lumbars and anterior caudals have round articular surfaces. One of the latter, with strong diapophyses, but posterior, is subpentagonal in outline of cup.

This species furnished the materials for the first description of the posterior extremities in this order of reptiles. The humerus is a remarkable bone, having the outline of that of *Clidastes propython*, Cope, but is very much stouter, the antero-posterior dimensions of the proximal extremity being greatly enlarged. The long diameters of the two extremities are, in fact, nearly at right angles, instead of in the same plane; and the outline of the proximal is subtriangular, one of the angles being prolonged into a strong deltoid crest on the outer face of the bone, which extends half its length. The inner or posterior distal angle is much produced; while the distal extremity is a flat, slightly-curved, diamond-shaped surface. The fibula is as broad as long and three-quarters of a disk. The phalanges are stout, thick, and depressed, thus differing much from those of *Platecarpus ictericus*. A bone which I cannot assign to any other position than that of femur has a peculiar form. It is a stout bone, but more slender than the humerus. The shaft is contracted and subtrilateral in section. The extremities are flattened, expanded in directions transverse to each other; the proximal having, however, a lesser expansion in the plane of the distal end. The former has, therefore, the form of an equilateral spherical triangle; the apex inclosing a lateral fossa, and representing probably the great trochanter. The distal extremity is a transverse and convex oval. This bone is either ulna, femur, or tibia, judging by form alone. Its greater length, as compared with the fibula, forbids its reference to the last; the trochanter-like process of the head is exceedingly unlike any examples of the second bone I have seen. Its reference to femur is confirmed by its presence with the caudal vertebræ of a similar species from near the Missouri River, Nebraska, and its resemblance to the femur of *Liodon dyspelor*.

Measurements.

	M.
Length of the humerus	0.100
Proximal diameter of the humerus	0.095
Distal diameter of the humerus	0.102
Length of the femur	0.080
Proximal diameter of the femur	0.065
Median diameter of the femur	0.035
Length of the centrum of a dorsal vertebra without the ball	0.061
Transverse diameter of the cup	0.060
Vertical diameter of the cup	0.053
Length of a lumbar (total)	0.055
Diameter of the ball of a lumbar (transverse)	0.060
Length of a caudal	0.041
Depth of the ball of a caudal	0.052
Width of the ball of a caudal	0.052

The form of the humerus is something like that of *Ichthyosaurus*. Both this element and the femur are remarkable for their small size. They are scarcely half the dimensions of the elements of the anterior limb of *Platecarpus ictericus;* and are even less than those of *L. dyspelor* in proportion to the animal's size

Some of the ribs preserved exhibit cylindric shafts.

The form of humerus nearly resembles that of *P. simus* as figured by Professor Marsh, and it is probable that these species are very nearly allied. The vertebræ indicate the largest of species of this genus.

The remains above described were obtained by Prof. B. F. Mudge, near Eagle Tail, in Colorado, a few miles west of the line separating that Territory from the State of Kansas.

A series of twenty-nine caudal vertebræ, with and without diapophyses, from a bluff on Butte Creek, belongs perhaps to this species. The proximal specimens, at least, cannot be distinguished from those of Professor Mudge's collection. The distal ones cannot readily be distinguished from those of *L. proriger*.

PLATECARPUS LATISPINIS, Cope.

The remains representing this species consist of seven cervical and dorsal vertebræ; five of them being continuous and inclosed in a clay concretion. It is a large species, nearly equaling the *L. mitchillii* in its dimensions, that is, forty or fifty feet in length, and is intermediate between such gigantic forms as *Liodon dyspelor* and the lesser *Platecarpi*. The type-specimens were found by Prof. B. F. Mudge, one mile southwest of Sheridan, near the "Gypsum Buttes." These display the elongate character seen in *Liodon lævis*, &c.; but the articular surfaces are transversely oval, thus resembling the *P. ictericus*. They are less depressed than in *L. perlatus* and *L. dyspelor*. The cup and ball of the penultimate cervical are a little more transverse than those of the fourth dorsal, and none of them are excavated above by the neural canal. The last cervical is strongly keeled on the middle line below, and with a short, obtuse hypapophysis marking the beginning of the posterior third of the length; the median line of the first dorsal has an obtuse ridge. There is no keel on the fourth dorsal, but the lower surface is concave in the antero-posterior direction. The diapophyses on the last two cervical and first three dorsal vertebræ have great vertical extent; the articular surface for the rib is not bent at right angles on the first dorsal. Neural arches and spines are well preserved in most of the specimens. There is no trace of zygantrum. The neural spines are flat, and have considerable antero-posterior extent on cervical as well as dorsal vertebræ, and are truncate above. The first dorsal bears a long, strong rib.

Measurements.

	M.
Transverse diameter of the cup of the penultimate cervical vertebra	0.051
Vertical diameter of the cup of the penultimate cervical vertebra	0.041
Length of the centrum of the fourth dorsal, without ball	0.072
Vertical diameter of the ball	0.0455
Transverse diameter of the ball	0.0555
Elevation of the front margin of the neural spine of the penultimate cervical	0.088
Antero-posterior diameter of the neural spine of the penultimate cervical	0.050

There are smooth bands around the balls, and the surfaces of the centra are striate to these.

The depressed cups of the cervicals and anterior dorsals distinguish this species from the *Liodon validus*, *L. proriger*, and *P. mudgei*. The same elements are much larger and more elongate than in *P. ictericus*. It differs especially from these species of *Platecarpus* in the elongate form of the anterior dorsals. In four of the latter, at least, the inferior limb of the diapophysis is turned forward to meet the rim of the cup; while this feature ceases with the last cervical in *L. latispinis*. The articular surfaces have planes at right angles to the axis of the centrum, and are not prolonged above, as in *P. glandiferus*. The last hypapophysis is very short, with the anterior margin transverse and elevated, as in the last-named species.

Platecarpus glandiferus, Cope.

A smaller species than the last, with apparently a greater flexibility of body, as indicated by the forms of the vertebral centra. It is represented by portions of two individuals from localities twenty-five miles apart. There is, unfortunately, in each case, only a cervical vertebra; but they agree in possessing such peculiarities as distinguish them widely from anything yet known to the writer.

One is an anterior, the other a posterior cervical. The articular surfaces are transversely elliptic, and completely rounded above; that is, neither truncated nor excavated for the neural canal. Their shorter axes are oblique, *i. e.*, make less than a right angle with the long axis of the centrum; and the articular surface of the ball is thus carried forward on the upper face to much nearer the base of the neurapophyses than usual, in the anterior vertebra nearly touching them. The ball is, likewise, more convex than in any other species, having a slight central prominence in the posterior vertebra. There is no annular groove round the ball. In both, the articular surface of the hypapophysis is truncate and bounded by an elevation in front, a peculiarity not observed in any of the species already described There is no trace of zygosphen in either. In the anterior vertebra, the diapophyses are nearly horizontal; the posterior portion slightly thickened and oblique. The anterior portion is thinned out, and very rugose above and below, and does not continue its margin into the rim of the cup. In the second vertebra, the diapophyses are very large, vertical, and with a horizontal portion rising in a curve to join the middle of the lateral margin of the cup. Neural spine narrowed upward, and keeled behind.

Measurements.

	M.
Length of the centrum of the anterior vertebra	0.064
Diameter of the ball, vertical	0.030
Diameter of the ball, transverse	0.039
Length of the posterior	0.064
Diameter of the ball, vertical	0.030
Diameter of the ball, horizontal	0.043
Expanse of the anterior zygapophyses	0.055

The first vertebra was found by the writer at the foot of a bluff on the lower part of Butte Creek; the second was procured by Prof. B. F. Mudge, from a point one mile southeast of Sheridan, near the North Fork of the Smoky River.

It is this species that I compared with the *Mosasaurus depressus*, Cope, in a report on the collection made by Professor Mudge (Proceedings of the American Philosophical Society, 1871, p. 168). The size is similar, but the form of the articular surfaces of the vertebræ is very different.

PLATECARPUS MUDGEI, Cope.

The characters distinguishing this saurian are the following: Vertebræ without rudimental zygosphen; quadrate bones with plane surfaces from the proximal articular surface and the external obtuse-angled ridge to the meatal pit; the latter, therefore, not sunk in a depression as in the other species.

The determination of this species rests on a series of specimens from the yellow chalk at a point six miles south of Sheridan, Kans. They consist of three vertebræ and fragments of atlas, with numerous portions of cranium and proximal extremity of scapula.

The parts of *cranium* preserved are the frontal bone without the anterior extremity, and with the adjacent parietal almost complete; parts of the basisphenoid; the suspensorium; the ossa quadrata; and the greater part of the surangular. The frontal is flat, with thin edge, longitudinally hollowed on each side of the median line, which is marked by a low but acute keel. There is an abundance of foramina and delicate grooves on the surface, and posteriorly elevated striæ, which converge to the median keel. The median square extension of the border of the parietal is in advance of the lateral portion of the same, and not behind it as in *Clidastes propython.* The fontanelle is large. A marked feature is that the parietal crests unite into a low median ridge a short distance behind the fontanelle, and are not, as in *C. propython*, separated by a horizontal plane. The sutures of the bones forming the side of the brain-case are very obscure. Nevertheless, it appears that the descending margin of the parietal does not descend to the front of the alisphenoid, but is margined inferiorly by the latter to the postorbital expansion. No part of the inferior margin of the alisphenoid can have reached the sphenoid, as it terminates in a thin edge, except for a short distance medially, where it is broken off.

The inferior aspect of the parietal and frontal bones presents a furcate keel corresponding to the divergent parietal crests, and a very large funnel for the epiphysis of the brain. The olfactory groove is deep and regular, and open like that of *P. ictericus.*

The *surangular bone* is characterized by the prominent longitudinal crest, which descends on the inner side, from the front of the glenoid cavity to below the posterior attachment of the coronoid bone, where it terminates in a thin edge; also, by the short distance between the margin of the glenoid cavity (cotylus) to commencement (or end) of coronoid suture, indicating a shortening of the posterior part, at least, of the cranium. The bone is continued forward only immediately under the coronoid (cfr. *P. ictericus*).

The proximal extremity of the *quadrate* is characteristic, and exhibits features intermediate between those of *Platecarpus ictericus*, Cope, and the typical species of *Mosasaurus*, as *M. fulciatus*, *M. dekayi*, etc. The proximal articular face is much like that of *M. depressus* (Transactions of the American Philosophical Society, 1869, p. 181, Fig. 48, No. 3). The internal angle is much smaller than in the Liodons, and more anterior; nevertheless, it is continued distally as a ridgelike angle, separating the antero-lateral from the postero-lateral faces as in them, and not presenting the gradual blending of the two surfaces characteristic of the genus *Mosasaurus.* The postero-lateral face is thus flat proximally; and the meatal pit, which is well developed, cannot be seen from the antero-lateral face. The distal part of the quadrate is lost, so that I cannot determine the character of the ridges there.

The basal element of the axis bears a strong hypapophysis without articular faces, but very rugose surfaces The same portion of the atlas is a convex parallelopipedon, with median rugose tuberosity and very rugose extremities. Its surface is not separated from its body anteriorly by a deep groove, as in *P. ictericus.*

The articular facets of the *scapula* are much broader than in the other species here described, indicating a head or wider articulation of humerus. No limb-bones are preserved.

The vertebræ are too much injured to be characteristic. One posterior dorsal now has a compressed centrum, or, at least, not depressed. The inferior face is convex transversely, and there is a slight concavity below each diapophysis; but it is clear that it has been so modified by pressure as to render its normal shape a matter of uncertainty.

Measurements.

	M.
Parietal, length	0.074
Parietal, width between the anterior ends of the crests	0.048
Parietal, least width	0.022
Frontal, interorbital width	0.092
Quadrate, width above	0.020
Quadrate, length from the pit to the proximal end	0.023
Surangular, length of the lower edge	0.015
Surangular, depth in front of the cotylus	0.350
Surangular, depth at the end of the coronoid	0.055
Posterior dorsal, length	0.0495
Scapula, proximal width	0.051

This species differs from all those of *Mosasaurus* and *Liodon* in which the form of the quadrate is known in the character of that bone. From *L. lævis* and *L. congrops*, in which that element is unknown, it differs in the stouter or less slender vertebræ; from *L. proriger*, in its much smaller size.

Its size is a little less than the *P. ictericus* or *L. validus*. It is dedicated to Professor Mudge in recognition of the valuable results of his investigations as State geologist of Kansas.

Platecarpus tectulus, Cope.

Established on a number of cervical and dorsal vertebræ of smaller size than those characteristic of the other species of the genus. The centra have not suffered from distortion under pressure. The articular surfaces are depressed transverse-elliptic in outline, with a slight superior excavation for the neural canal. A well-marked constriction surrounds the ball.

There is a rudimental zygosphen, in the form of an acute ridge, rising from the inner basis of the zygapophysis, and uniting with its fellow of the other side, forming a production of the roof of the neural canal. The combined keels become continuous with the anterior acute edge of the neural spine. Thus, the form is quite different from that seen in the previously-described species, and constitutes a lower grade of rudiment. The fact that this zygosphenal roof is separated on each side from the zygapophyses by an acute groove gives the former a distinctness more apparent than real.

The fixed hypapophyses are short and broad. The centra are not elongate. Those of the anterior dorsals present an obtuse keel below.

Measurements.

	M.
Length of a median cervical	0.043
Diameter of the ball of a median cervical, vertical	0.029
Diameter of the ball of a median cervical, transverse	0.033
Length of the anterior dorsal	0.042
Width of the cup	0.032

Found by the author on a low bluff, or "break," on Butte Creek, fourteen miles south of Fort Wallace.

A second specimen of this saurian has since been discovered by Professor Mudge. The frontal bone is thick, and presents a median keel. The quadrate is flat on the posterior inner face, so that the stapedial pit is excavated in a plane surface; the internal proximal angle is nearly right. The vertebræ are small, and the hypapophyses short, and with horizontally truncate articular faces, as in the type-specimen.

This species is the smallest known *Platecarpus.*

LIODON, Owen.

Vertebræ without zygosphenal articulation, and with very weak zygapophyses; the chevron-bones not coössified to the centra. Teeth with opposite acute edges, compressed, lenticular in section. Humerus small, narrow.

The quadrate bone in the known species of this genus is of small proportions, and presents a very prominent internal proximal angle and longitudinal ridge. The structure of the cranial bones is light. The zygapophyses are weaker, and disappear more anteriorly than in any other genus, approaching nearest to *Mosasaurus* in this respect.

There are four species of the genus known from the Kansas chalk, all of which have the end of the premaxillary bone protuberant and truncate. A species of similar character has been described by Mr. Hector, from the Cretaceous of New Zealand. Three species from the greensand of New Jersey are similar in many respects; but the forms of their muzzles are unknown.

The typical species of this genus (*Liodon anceps*, Owen) is very little known, but few remains having so far been obtained from the English chalk, its locality and horizon. Numerous North American species resemble it in the forms of the crowns of the teeth, and it is probable, though not certain, that they agree in other respects also. Several names have been proposed for our species, the earliest of which is *Macrosaurus*, Owen. This name applies to species with compressed dorsal vertebræ, as *L. lævis* and *L. mitchillii*, both from the New Jersey greensand. For the species with depressed dorsal vertebræ, as *L. validus* from New Jersey, *L. perlatus* from Alabama, and *L. proriger* from Kansas, the name *Nectoportheus* was proposed, and briefly characterized (Extinct Batrachian Reptilia of North America, 1870, p. 208). Professor Marsh subsequently gave the Kansas species the name of *Rhinosaurus*, which name being preöccupied more than once, I changed it to *Rhamphosaurus*.[1] This name will remain for species of the type of *L. proriger*, if they be found to represent a genus distinct from *Nectoportheus* or *Liodon*, of which there is as yet no evidence.

Liodon proriger, Cope.

The original description of this large Mosasauroid was based on material in the Museum of Comparative Zoölogy, Cambridge, Mass., brought by Prof. Louis Agassiz from the Cretaceous beds in the neighborhood of Monument, Kans., and near the line of the Kansas Pacific Railroad. It consists of the greater part of the muzzle from the orbits, with the right dentary and left pterygoid bones nearly complete; one cervical vertebra (with hypapophysis); one dorsal; one caudal with diapophysis; and ten caudals without diapophysis.

The characters presented by the vertebral column indicate an exceedingly elongate reptile; the transverse diameter of one of the distal caudal vertebræ is less than one-fifth that of a proximal with short diapophysis; while four consecutive ones of the former show but little variation in dimensions. This diminution amounts to two-sevenths of a transverse diameter of the larger form. With this ratio as a basis, fifty-three two-thirds vertebræ would form a complete series from caudals one-half the diameter of the last of the four to the proximal caudal above mentioned. There have been, no doubt, several caudals in advance of the latter, as the diapophyses are small. From the slow rate of diminution of the columns of other species examined, it may be

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

supposed that sixty caudal vertebræ is below rather than above the true number.

The cervical and dorsal vertebræ have been slightly crushed, as they laid on the side, and present a narrower diameter than is normal; the cup of the cervical has not been distorted, and is deeper than wide, presenting the character of *Macrosaurus*. The rudimental zygosphen consists of a continuation of the roof of the neural canal in front, to adapt itself to the inner face of the down-looking zygapophysis of the preceding vertebra. The latter is thus received into a groove on the inner side of the up-looking posterior zygapophysis. The dorsals and caudals exhibit, with the cervicals, that minute, sharply-defined rugosity which characterizes all the projecting margins, especially those of the hypapophyses and diapophyses, in this genus and *Clidastes*. The whole surface of the cervical is marked with either inosculating striæ or impressed punctæ. The same character marks the cranial bones, though they do not present such rugosity as the vertebræ.

The proximal caudal presents a subhexagonal section, of which the inferior and supero-lateral sides are longest; articular faces about as broad as high. A broad, smooth space between the chevron-bones. Diapophyses with broad, ovate transverse section.

A caudal without diapophyses, anterior to the middle of the series, estimated by the size, is but slightly deeper than long, and with parallel lateral outlines of the articular faces. The neural arch is very much narrowed antero-posteriorly, but has a greater transverse extent at its lowest part; above, the spine is much compressed, but not widened. The zygapophyses remain as rudiments just above the small neural canal, but do not probably touch each other. There are two anterior and two posterior narrow ribs on the upper portion of the neural spine. The more distal caudals have wider neural spines, and the arch has also a greater antero-posterior extent. The zygapophyses are scarcely traceable, and the neural spine is strongly striate. The reverse arrangement is observed in *Clidastes propython*, where the neural spine of the proximal caudal has considerable extent, while those of the posterior and distal vertebræ are almost cylindric, especially the neurapophyses.

Dimensions.

	Inches.
Dorsal, length	3.25
Dorsal, width of the cup	2.50
Dorsal, depth of the cup	2.77
Proximal caudal, length	2.14

	Inches.
Proximal, width of the cup	3.43
Proximal, depth of the cup	3.23
Caudal without the diapophyses, No. 1, length	1.6
Caudal without the diapophyses, No. 1, depth of the cup	2.65
Caudal without the diapophyses, No. 1, width of the cup	2.6
Caudal without the diapophyses, No. 1, height of the neural canal	0.4
Caudal without the diapophyses, No. 1, antero-posterior width of the neural spine	0.8
Caudal without the diapophyses, No. 2, length	1.2
Caudal without the diapophyses, No. 2, depth of the cup	2.15
Caudal without the diapophyses, No. 2, width of the cup	1.86
Caudal without the diapophyses, No. 2, width of the neural spine (antero-posterior)	1.07
Caudal without the diapophyses, distal, length	0.5
Caudal without the diapophyses, distal, depth of the cup	0.85
Caudal without the diapophyses, distal, width of the cup	0.64
Caudal without the diapophyses, distal, antero-posterior diameter of the neural spine	0.40

The points of attachment of the chevron-bones on the distal vertebræ are strongly-marked pits; on the anterior, the anterior margins of the pits are raised and continuous with the chevrons.

The muzzle presents the usual characters of the large Mosasauroids, but adds a peculiarity in the prolongation of the premaxillary bone into a cylindric mass, forming an obtuse beak beyond the premaxillary teeth. The bone is narrowed anteriorly, and does not descend regularly, as in *Mosasaurus*, sp., but continues to its abrupt and narrowed termination described. The extremity is deeper than wide. Immediately in front of and between the anterior premaxillary teeth, a short acuminate projection interrupts the surface, and, in front of this, a transverse depression. Above, the surface becomes flattened, and presents two shallow longitudinal depressions continuous with the nostrils. Where the premaxillary rather suddenly contracts into its spine, it is materially wider than the maxillary on each side of it; in *M. missuriensis* it is narrower, according to Goldfuss. The maxillary border of the nares is rather suddenly concave at the anterior extremity of the nares, narrowing the maxillaries. The latter gradually widen by the expansion of their inner margins.

No part of the frontals is preserved, but a considerable part of the left prefrontal remains. It unites by a very coarse, overlapping suture with the maxillary, whose outline forms an irregular chevron, with the apex pointing forward in the middle of the maxillary bone. This, it will be seen, is very different from the form given by Goldfuss in the *M. missuriensis*, where the most anterior point of the suture is on the nareal margin. The external margin of the bone behind, is contracted considerably within the maxillary border previous to its outward extension toward the orbit. This is much less marked in the *Clidastes propython*, but is distinct in *M. missuriensis.*

The maxillo-premaxillary suture gradually descends toward the alveolar border, at the extremity of the maxillary bone, where it descends abruptly, forming an interlocking suture quite different from that squamosal type already observed in other species of the order. The length of the premaxillary anterior to this point is three-fourths the length of the same to the beginning of the nares.

The number of teeth on the maxillary bone was probably thirteen; twelve alveolæ and bases remain, and I add one in the position of the posterior tooth of *M. missuriensis*, if such existed. This may be questioned, in consideration of the small number of mandibular teeth. Premaxillary teeth, two on each side, the anterior with bases separated only by a groove. Throughout the whole series, the bases of the teeth are considerably more exposed on the inner than the outer side.

The crowns are everywhere subcylindric at the base; the inner face more convex than the outer. Posteriorly, there is a posterior cutting-ridge, as well as a marked anterior one, both minutely crenulate; but the former gradually disappears till, in the anterior teeth, there is only an anterior edge, the posterior face being convex and continuous with the inner. There is a trace of cutting-edge on the outer portion of the extremity of the crown in the most anterior teeth. The anterior ridge remains very strongly marked. The surface is quite rough with longitudinal ribs, of which eight may be counted on the outer aspect of the second maxillary. These are not strongly marked, and are separated by concave facets. The basal part of the crown is marked by numerous fine, sharp striæ, which are most distinct on the inner face.

The external face of the maxillary bone presents three series of foramina. These rise superiorly on the premaxillary, and increase in number, and become irregular on its extremity.

The ramus of the mandible is massive, and differs from that of *Mosasaurus giganteus* in continuing its proportions to its extremity. Its depth at the latter point is as great as the sixth tooth from the front. It is prolonged beyond the first tooth in correspondence with the prolongation of the premaxillary. This extremity is compressed and obtuse; its inner face is very rugose, as though there had been a closer union at the symphysis than usual, though it would not appear to have been other than ligamentous. The groove for Meckel's cartilage is very large, and is exposed below the last two teeth, as the splenial terminates at the third. Two series of foramina on the external face of the ramus. There are alveolæ and bases for thirteen teeth on the dentary bone. This, it will be observed, is one more than in *M. gracilis* Owen, and one less than in other species of *Mosasaurus*. The posterior extremity of the dentary shows its marks of reception into the notch of the coronoid; it is more compressed and less club-shaped than the corresponding part of *L. mitchillii*, and would indicate less lateral flexibility than in some other types.

The right palatine is of less elongate form than in some other species. It presents the sutural face for union with the maxillary on the outer anterior extremity, and narrows to an apex a little in advance. The dentigerous face is widest at the anterior third of the length, where the outer margin is expanded. This then contracts, and is compressed vertical at the tenth tooth, where it is broken off. The transverse process is given off a little anterior to the ninth tooth. The interior face of the bone is a vertical plane, without projection, except a slight obliquity at the anterior extremity; and it is clear that there has been some interval between this palatine and its fellow. The superior margin is obtusely rounded.

The bases of the palatine teeth are exposed for two-thirds their length on the outer side of the bone. The antero-median are large, and the anterior most closely placed. Their crowns are strongly recurved, round in section, and with a fine sculpture of straight striæ, most marked near the base and on the inner side. They are more spaced posteriorly than any other species except *L. mitchillii*, and are relatively larger than in any except the same species. They have not the compressed form with basal shoulder characteristic of the *M. dekayi*.

Measurements of the muzzle.

	Inches.
Length of the fragment	31.
Length from the end of the muzzle to the prefrontal	21.5
Length from the end of the muzzle to the nares	11.75
Length from the end of the muzzle to the maxillary	5.75
Length from the end of the muzzle to the first tooth	2.5
Width of the muzzle at the end	1.5
Width of the muzzle at the anterior extremity of the nares	8,
Width of the premaxillary at the anterior extremity of the nares	3.3
Width of the maxillary between the tenth and the eleventh tooth	3.2
Depth of the mandible at the extremity	2.5
Depth of the mandible at the sixth tooth	3.5
Depth of the palatine at the transverse process	2.5
Width of the palatine at the transverse process	1.4

	Inches.
Width of the palatine in front	2.2
Length of the palatine anterior to the transverse process	7.2
Length of the crown of the fifth palatine tooth	1.
Length of the crown of the second maxillary tooth	1.9
Diameter of the crown of the second maxillary tooth at the base	1.1

The vomers are, as usual, separate and narrow. They are in close contact from the second maxillary to the second premaxillary tooth. Throughout this part of their length, they are embraced by posteriorly-produced vertical laminæ of the premaxillary bone. These laminæ unite anteriorly just behind the second premaxillary teeth, and form a single prominent keel, which disappears between the first premaxillaries.

The fine specimen which is the subject of the preceding description was discovered by Colonel Connyngham and Mr. Minor near Monument Station, Kansas, and sent by them to Professor Agassiz.

This is the most abundant of the large species of the Kansas chalk. The writer found a muzzle consisting of premaxillary and portions of maxillary and dentary bones in the spur of the lower bluffs of Butte Creek, and numerous fragments of cranium and vertebræ on a denuded tract in the same neighborhood. Both of these belonged to individuals of smaller size than the type, the opportunity of examining which I owe to Professor Agassiz. The more complete Butte Creek specimen belongs to a huge animal; the size is grandly displayed by a complete premaxillary bone, with its projecting snout, and large fragments of the maxillary. These furnish characters confirmatory of those already given as above. The vertebræ are remarkable examples of flattening under pressure, without fracture; some of them having a vertical diameter no greater than one's hand. The cervicals are less flattened, and give the impression that they were not transversely elliptic. This is consistent with our knowledge of the perfect specimen, where it is, as described, furnished with vertically ovate articular surfaces. In this, the cup is symmetrical and apparently not distorted, but the ball is a little compressed by pressure.

The most important addition to the knowledge of this species furnished by the Butte Creek specimen is the character of the quadrate bone.

The internal longitudinal angular ridge is very prominent, and extends to the distal end. It supports a hook-like prolongation of the proximal articular surface; almost as large a one as in *Clidastes propython*, and more narrowed. The ridge is so prominent as to create a wider face or surface behind the basis of the great ala than exists between the latter and the edge of the auricular meatus. This basis is quite convex inward, and embraces a relatively smaller space than in any other Pythonomorph. A section of the bone at the meatus is subtrilateral, with a notch behind. The distal articular surface is prolonged below the origin of the great ala, and receives the keeled termination of the internal ridge.

Measurements.

	M.
Total length of the quadrate	0.153
Length from the superior to the inferior origin of the great ala	0.080
Length of the external angle from the basis of the ala	0.052

The two usual ridges pass inward and downward from the meatal knob.

The above quadrates are flattened from within outward by pressure.

A portion of the palatine bone, supporting the teeth, displays the characters of the type, viz, the inner face vertical and deeper than the outer, and forming a strong parapet of bone on the superior or toothless aspect; the outer face a little expanded laterally; the bases of the teeth exposed. It is proper to add that the locality ascribed to the type-specimen, "near Fort Hays, Kansas," which was originally given me on inquiry, is erroneous.

Liodon dyspelor, Cope

The type-specimen, which first indicated the characters of this species, was obtained from the yellow beds of the Niobrara epoch of the Jornada del Muerto, near Fort McRae, New Mexico. The greater part of the remains have been described by Professor Leidy,[1] and a few only of the vertebræ came under my inspection. A second specimen, more complete in all respects, was discovered by my party during my expedition from Fort Wallace, Kansas, in 1871, which is fully described and figured in the present work.

In the first specimen, the centra of the dorsals are much depressed, quite as in *L. perlatus*, Cope, and *Mosasaurus brumbyi*, Gibbes. Their articular faces are of transverse lenticular form, the superior arch being a little more convex than the inferior, and obtusely emarginate for the floor of the neural canal. The superior outline is thus bilobed; the lobes rounded. The transverse curvature of the articular ball is quite regular, and not, as in *Mosasaurus maximus*, more steeply inclined at the external or lateral angles. A rather

[1] Report of the United States Geological Survey by Hayden, vol. I, p. 271.

broad, smooth band separates the edge of the ball from the surfaces of the centrum adjacent. The latter are rather finely striate-ridged from the edge of this band. The inferior outline of the centrum is strongly concave, and, with two venous foramina, separated by a wide interval. The basis of the diapophysis on a lumbar is very broad, measuring more than half the length of the centrum. In general characters, this lumbar resembles the dorsal, including the emargination for the neural canal, but is shortened in relation to its length. The depressed form of the lumbar centra gives place gradually on the caudals to a more elevated pentagonal outline, which is still more reduced in width in more posterior regions. The hæmal arches are articulated on the anterior caudals to slightly elevated bases; on the more posterior, the bases are reduced in height and more widely and deeply excavated. I have not seen the most distal caudals, and hence cannot determine whether their chevron-bones articulate in pits, as is the case with those of *L. perlatus*, *L. proriger*, etc. On a caudal, where the depth of the centrum a little exceeds the transverse diameter, the diapophysis has become narrow and thick. The excavation for the neural canal is strongly marked on the more anterior caudal. The smooth border of the articular ball is here narrow, and the superficial rugæ are fine, and confined to the anterior part of the centrum.

Measurements.

	M.
Transverse diameter of the ball of the posterior dorsal	0.144
Vertical diameter of the ball of the posterior dorsal	0.097
Vertical diameter of the anterior caudal	0.094
Transverse diameter of the anterior caudal	0.107
Length of the centrum of the caudal	0.071
Transverse diameter of the neural canal	0.0145
Transverse diameter of the basis of the diapophysis	0.032
Transverse diameter of the basis of the diapophysis of a more distal caudal	0.0278
Longitudinal diameter of the chevron articulation of the caudal	0.023
Length of the centrum	0.068
Depth of the ball of the centrum	0.093
Width of the ball of the centrum	0.091
Length of the centrum of a lumbar	0.106
Width of the articular ball	0.125

The characters of the Fort Wallace saurian are as follows:

The *fronto-nasal septum* is convex in transverse section. The *maxillary bone* is much attenuated anteriorly, and supports thirteen teeth. The *ramus mandibuli* is light and slender; the angle is quite produced, and the median articulation indicates considerable mobility. The *palatine bones* are narrower than in any of the species previously described. They are deeply notched for union with the pterygoids, and the superior posterior process terminates in an acute cone. In front of the articulation, the bone is a vertical plate, slightly concave on the inner side; the anterior half is subquadrate in section; the outer face subvertical; the inner regularly rounded. The inferior surface is marked with a groove which passes from the inner side to the outer. The portion on the outer side of this groove is on the distal third of the bone produced downward into a prominent keel or ridge. The anterior extremity is an acute point. Each bone bears eleven teeth, all of which have the external faces of their roots exposed. The bones are curved outwardly from the fourth tooth from behind; opposite the sixth, there is a longitudinal concavity on the inner face.

The occipital region and suspensoria are not present, but both *quadrates* were found perfectly preserved, excepting the thin ala. They present marked characters, being most nearly allied to those of *L. proriger* and *L. validus.* The proximal articular surface exhibits an obliquity in the transverse direction. It presents a large internal angle, which, instead of being nearly at right angles to the axis of the main portion of the surface, is nearly in the same line. The decurved posterior hook is very short. The distal articular surface has, like that of other Liodons, a small transverse extent, and is divided by a concavity into two tuberosities. The outer of these receives at its angle the prominent narrow portion of the internal ridge, which extends from the internal proximal angle. The prominence of this ridge is greater than in any other species except *L. proriger;* it is acute throughout its length, and has a gentle sigmoid flexure. The basis of the great ala includes a smaller area than usual, and is continuous with a prominent narrow ridge, which proceeds from outside the meatal crest. This meatal crest takes the place of the "knob" in such *Mosasauri* as *M. dekayi;* it projects strongly backward and outward as an angle of two ridges, the inferior being acute and curved, and terminating above the middle of the distal condyles. The meatal pit is not concealed between ridges, but is internal; its form is peculiar, being a narrow oval, three times as long as wide, directed downward and forward. Thus, the characters of this element are well marked among those pertaining to the other species.

The *teeth* are not much compressed, and have a cutting angle on the anterior and posterior margins, which separate nearly equal faces.

The *vertebral centra* change in form from the anterior to the posterior regions. The ball of the axis is round; those of the vertebræ early succeeding are moderately depressed. The balls of the dorsals are transverse elliptic, with a slight concavity for the neural canal; the plane a little oblique to that of the long axis. The centra are more depressed posteriorly, where the balls of the dorsals present rounded lateral angles. On the lumbars preceding the caudals, the base of the neural canal becomes more elevated, and the articular faces assume a slightly pentagonal outline. This form continues as far as our specimens of caudals extend. On three lumbars, the centra present two longitudinal angular ridges below, at whose posterior ends the chevron articular surfaces appear on the first caudals. All present an incised annular marginal groove to the ball. The surface, especially the inferior, is strongly rugose up to this groove, especially on the dorsals.

The *axis* is much shorter than in any other species here noted where known. The neural spine has a very oblique superior margin, and is expanded behind. The diapophyses are narrow, and continued as vertical plates to the inferior face of the centrum at its anterior margin. The diapophyses of the other cervicals have the usual horizontal limb, which is, however, shorter than the vertical. In the anterior dorsals, they are directed more obliquely upward, and are longer. These and all other dorsals maintain a connection between the rim of the cup and the anterior basis of the diapophysis by a smooth area apparently capped by cartilage in life, as exists in *P. curtirostris*. As we pass posteriorly, these processes descend, and become narrower, until finally they thin out and lengthen into the ribless diapophysis of the lumbars. Those of the caudals are long and subcylindric. Their extremities are deeply striate-grooved. The neural spines of all the vertebræ are longitudinally striate-keeled. The zygapophyses are remarkable for their narrow form and surfaces.

The *atlas* is shorter on the outer and longer on the inner face than in *L. validus*. This is caused by the fact that the posterior articular face is not transverse, but very oblique, and, instead of being vertical and narrow, is obliquely longitudinal in its long axis. It is separated from the inner face by a wide rugose groove behind; its lower edge sends a keel downward. There is no process at the thinned infero-anterior angle.

The *scapular arch* is small, especially the scapula, which is absolutely smaller than that of the *Platecarpus ictericus*, a very much smaller reptile. The posterior margin is thickened, the anterior thinner, and less elevated. The superior is arched upward and backward. The general form is less oblique than in *P. ictericus.* The *coracoid* is twice as large, and is flat and thin. Its inner margin is regularly convex; the posterior concave and thin; the anterior thickened. The foramen is present.

The *humerus* is different in form from that observed in *P. crassartus, P. ictericus, Clidastes,* &c. It is relatively less expanded proximally and especially distally; there is but one deltoid crest, which is proximal, and near one extremity of the articular surface, and disappears into the general plane above the middle of the shaft. The general form is flat, partly due to pressure. The distal extremity is but little convex, and displays the terminal muscular insertions but little produced. Near the inferior end, there is an external expansion for articulation with the ulna.

The *radius* is lost. The ulna, or a bone which is like that, regarded as such in several species described by me, has the extremities in different planes, which cross each other obliquely. The proximal is triangular and very wide; too wide for the humeri in their present state. It is also too long, leaving but little space for a radius. The distal extremity is as expanded, but much narrower, and presents two articular surfaces, a large and wide and a narrow, connected by a wide isthmus. The bone was taken out near a humerus, but not in position.

The *pelvic arch*, as above remarked, was found perfect, and with all the elements present, with a femur with the head in relation with the acetabulum. The articular extremities are somewhat depressed, and do not precisely fit. The *pubis* is a straight, flattened bone, dilated moderately at the proximal articular extremity, where it is pierced by a foramen. It is coarsely rugose-striate at both extremities. The *ilium* is a longer bone than the pubis; is more slender, and more expanded at the articular extremity, where it is also thickened. The shaft is curved so as to be oblique in position; it shows no trace of union with a vertebra.

The *ischium* is a broader bone, with the axis transverse to that of the body, and sigmoidally curved, first slightly forward, then gently backward. The common suture is about as wide as the proximal extremity. The anterior margin is somewhat thickened; the posterior is produced into a short process directed backward, which is the homologue of that seen in the *Testudinata*, and which is connected with the distal end by a thin concave margin.

The *femur* is rather more slender than the humerus; the distal extremity is about as much dilated; the head less so. The great trochanter is a thick convex ridge, with a truncate discoidal articular extremity, which is nearly separated from the head by a groove. Both extremities are moderately convex. The *fibula* is similar to that of other species in its broad three-quarters discoidal form. Both articular extremities are strongly convex, and are continued on the inner side on the thinned inner border. The external margin is thickened and deeply concave, and without tuberosity. The *tibia* is a more slender element, with subcylindric shaft and much expanded extremities. The proximal is oval, and is continued as a narrow ridge on the inner side, for contact with the corresponding ridge of the fibula. The distal extremity is an equilateral spherical triangle, of which the inner angle is on a different plane from the remainder.

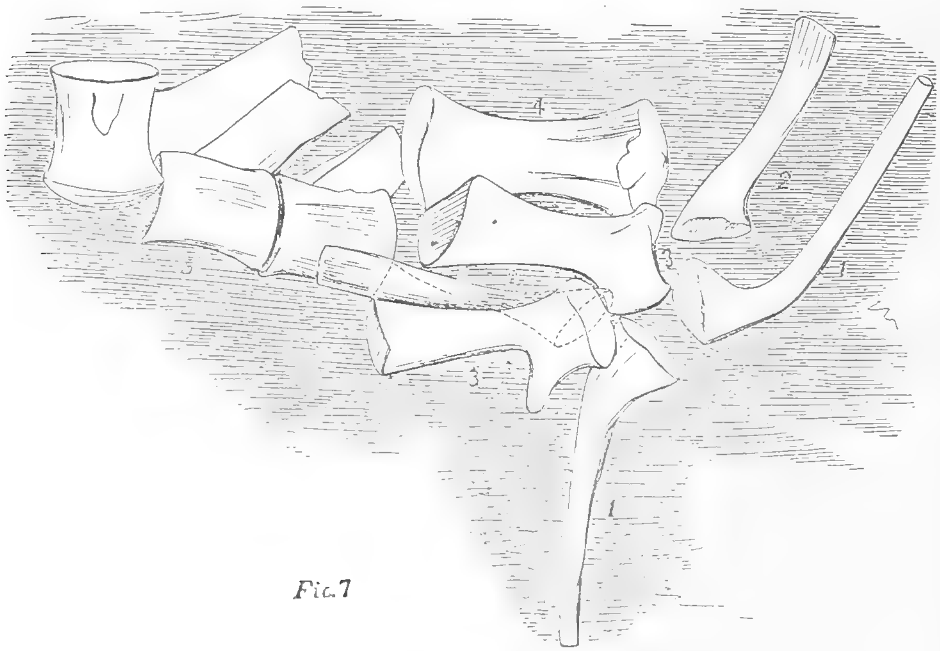


FIG. 7

FIG. 7.—Sketch of the pelvic bones and adjacent vertebræ in the relative positions in which they were found on removing the superincumbent rock: 1, ilia; 2, pubes; 3, ischia; 4, femur; 5, posterior lumbar vertebræ. Size much reduced.

The *phalanges* are slender, with cylindric shafts and expanded extremities, which support oval articular surfaces. Those of the two extremities appear to be similar. The distal ones are extremely small and flat, with expanded extremities.

Of *doubtful bones* may be mentioned two with flat expanded distal extremity and thick proximal, bearing an oval articular surface, with an angulate extremity which terminates in a thin edge. The form is like that of a narrowed radius of *P. ictericus*, but it is much too short for the ulna. As it was found with the scapula, it is probably a portion of the fore-limb, and hence may be a metacarpal. A somewhat similar but narrower bone may be a metatarsal. A piece which is probably the free *hypapophysis* of the atlas is a transversely elliptic piece, with an oblique smooth articular face at one end, the posterior face rugose, the inferior with a flat truncate process directed downward and backward. If correctly identified, its great peculiarity consists in its thinness antero-posteriorly, and the large process. (See Pl. xxxi, fig. 1 *d.*)

In comparing this species with the *L. proriger*, its nearest ally, I have already observed the difference in the form of the articular surfaces of the cervical vertebræ, which are in that species vertically oval, in the present transversely so. The comparison is made between posterior cervicals of both, which, in *L. dyspelor*, are less depressed than the others. As it is possible that the form in the type-example of *L. proriger* may be slightly affected by pressure, I compare other points. Thus, the palatine bones are more slender anteriorly, and the outer edge descends lowest in a ridge; in *L. proriger*, the inner is produced downward as a longitudinal rib. In this species, there are eleven teeth; in that one, nine. The quadrate bone of *L. proriger* presents a longer internal angle, and more prominent internal ridge, with smaller space inclosed by the basis of the great ala. My statement, in a published letter to Professor Lesley, that the ends of the mandibles were acute, thus differing from *L. proriger*, is an error, due to my having inadvertently mistaken the palatines for the dentaries while writing. The posterior extremity of these bones in *L. proriger* is unknown.

The only species whose dorsal vertebræ are known to resemble, in the stoutness of their form, those of *L. dyspelor* is the *L. crassartus;* the manifold differences of the latter will be at once discovered on reading the description already given.

Measurements.

	M.
Atlas, length of the inner articular face	0.065
Atlas, length of the posterior articular face	0.054
Atlas, depth of the posterior articular face	0.037
Axis, length at the middle of the side	0.075
Axis, depth anteriorly	0.081
Axis, elevation of the neural spine	0.075
Axis, width of the neural spine (plane)	0.045
Axis, diameter of the ball, vertical	0.070

	M.
Axis, diameter of the ball, horizontal	0.070
Cervical, diameter of the ball, vertical	0.066
Cervical, diameter of the ball, horizontal	0.076
Cervical, length	0.090
Anterior dorsal diameter of the ball, vertical	0.065
Anterior dorsal diameter of the ball, horizontal	0.087
Anterior dorsal length below (with the ball)	0.100
Anterior dorsal length of the diapophysis	0.047
Anterior dorsal depth of the diapophysis	0.040
Posterior dorsal length of the centrum	0.097
Posterior dorsal diameter of the ball, vertical	0.076
Posterior dorsal diameter of the ball, horizontal	0.105
Posterior dorsal height of the neural spine (of another)	0.120
Lumbar, length of the centrum	0.090
Lumbar, diameter of the ball, vertical	0.073
Lumbar, diameter of the ball, horizontal	0.090
Lumbar, length of the diapophysis	0.096
Caudal (anterior), length of the centrum	0.073
Caudal (anterior), depth of the ball, horizontal	0.085
Caudal (anterior), depth of the ball, vertical	0.075
Caudal (anterior), length of the diapophysis	0.120
Caudal (posterior), length of the centrum	0.067
Caudal (posterior), length of the diapophysis	0.109
Caudal (posterior), height of the neural spine	0.087
Caudal (posterior), diameter of the ball, vertical	0.080
Caudal (posterior), diameter of the ball, horizontal	0.084
Maxillary bone, length	0.650
Maxillary bone, length of the bases of two of the teeth (largest)	0.090
Mandible, depth behind the cotylus	0.110
Mandible, length behind the cotylus	0.110
Width of the nasal septum	0.021
Length of the palatine on the tooth-line	0.380
Depth of the palatine at the third tooth from the front	0.039
Quadrate, length	0.150
Quadrate, length of the proximal internal angle	0.029
Quadrate, width of the face from the meatus to the external ridge	0.029
Quadrate, width of the area of the basis of the ala	0.040
Quadrate, width at the condyles	0.070
Scapula, height (axial)	0.120
Scapula, width	0.183
Coracoid, width	0.187
Coracoid, length	0.200
Coracoid, thickness at the cotylus	0.027
Humerus, length	0.189
Humerus, proximal width	0.120
Humerus, distal width	0.127
Ulna, length	0.179
Ulna, width, proximal	0.115
Ulna, width, distal	0.116
Ulna, thickness proximally	0.060
Pubis, length	0.245
Pubis, width, proximal	0.039
Pubis, width, distal	0.178
Ilium, length on the curve	0.350
Ilium, width, proximal	0.018
Ilium, width, distal	0.087
Ischium, length (straight)	0.195
Ischium, length to the posterior process (axial)	0.125

	M.
Ischium, width, proximal	0.085
Ischium, width, distal	0.075
Femur, length	0.185
Femur, width, proximal	0.093
Femur, width, median	0.064
Femur, width, distal	0.130
Fibula, length	0.116
Fibula, width, proximal	0.100
Fibula, width, distal	0.118
Fibula, proximal thickness	0.052
Fibula, median width	0.080
Tibia, length	0.103
Tibia, width, proximal	0.045
Tibia, width, median	0.025
Tibia, width, distal	0.052
Tibia, thickness, proximal	0 042
Tibia, thickness, distal	0.030
Phalange (posterior), length	0.080
Phalange, terminal, length	0.015

This specimen is one of the most instructive which has yet been discovered, including, as it does, fifty vertebræ from all parts of the column, a large part of the cranium, with teeth, and both quadrate bones; the scapular arch complete, except back of coracoid on one side; both humeri, radius, and numerous phalanges of fore limb; the pelvic arch complete, with one hind limb complete to tarsus, with phalanges. The premaxillary is wanting, but the adjacent suture of the maxillary remains.

Portions of a second individual of this species, or of *L. proriger*, were found on the Fox Cañon. They belonged to a larger animal, one equal to the New Mexican first described. Professor Mudge has fragments of still larger specimens.

The principal specimen above described was excavated from a chalk bluff. Fragments of the jaws were seen lying on the slope, and other portions entered the shale. On being followed, a part of the cranium was taken from beneath the roots of a bush, and the vertebræ and limb-bones were found farther in. The vertebral series extended parallel with the outcrop of the beds, and finally turned into the hill, and was followed so far as time would permit. It was abandoned at the anterior caudal vertebræ.

The outcrop of the stratum was light-yellow. The concealed part of the bed was bluish. Yellow chalk left on the specimens in thin layers became a white, or nearly so. The yellow and blue strata are definitely related in most localities, the former being the superior; but in others they pass into each other on the same horizon.

In instituting a comparison between this and other known *Mosasauridæ*, it will be necessary to consider species referred to *Mosasaurus* as well as to *Liodon*, from the fact that some of the former may really be Liodons. The Liodons with compressed or round dorsal or lumbar vertebræ may be dismissed from comparison. Of the depressed species, *L. perlatus*, Cope, is known from specimens of one-third or less the size of the present one, which are further peculiar in having the diapophyses of the lumbars to stand on the anterior half only of the centrum.

Among *Mosasauri* with depressed vertebral centra, it is to be noted that none present so great a degree of depression and lateral extension except the *M. brumbyi* of Gibbes. They are all also much smaller. The *M. brumbyi* was founded by Dr. Gibbes on two lumbar vertebræ from the Cretaceous of Alabama, which resemble those of the *M. dyspelor* in form, and also in size. It is probably its nearest ally, and may be a *Liodon*. Dr. Gibbes established the genus Amphorosteus for it, but without sufficient evidence to support it. The principal point of distinction between it and the *L. dyspelor* which I observe is the lack, in the former, of the strong emargination of the superior margin of the articular surface for the floor of the neural canal, which is so marked in the latter. I have only the figures of Gibbes to rely on for this particular, and it is scarcely probable that the artist would have overlooked it had it existed. Should the bounding prominences have been worn off, then the restored centrum would have had a notably greater vertical diameter than in the *L. dyspelor* in the same portions of the vertebral column. As a second character, I note that, relying as before on Gibbes's figures, the external angles of the depressed ball are not so extended laterally in *M. brumbyi*.

In size, the vertebræ of the present animal exceed those of the *M. brumbyi*. The latter has been hitherto the largest known species of the order *Pythonomorpha*, exceeding twofold in its measurements the *M. giganteus* of Belgium. So the present saurian is much larger in dimensions than the New Jersey species I have called *M. maximus*. If, as appears certain, the Mosasauroid discovered by Webb measures seventy-five feet in length, and the *M. maximus* measured eighty, the *M. dyspelor* must have been the longest reptile known, and approaches very nearly the extreme of the mammalian growth seen in the whales, though, of course, without their bulk. Such monsters may well excite our surprise, as well as our curiosity, in the inquiry as to their source of food-supply, and what the character of those contemporary animals preserved in the same geologic horizon.

The locality whence this reptile was first procured is near Fort McRae, in New Mexico. It was discovered by Dr. W. B. Lyon, surgeon at that post, and by him sent to the Army Medical Museum, at Washington, whose director placed it in the collection of the Smithsonian Institution. The attention to the paleontology of his neighborhood by Dr. Lyon will always be cause of satisfaction to students, and his name will be remembered with that of Turner (discoverer of the *Elasmosaurus platyurus*, Cope), Sternberg, and others.

LIODON NEPÆOLICUS, Cope.

Rhamphosaurus nepœolicus, Cope, MS.

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

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

The *quadrate* resembles that of *L. dyspelor* in various respects. The internal longitudinal ridge is very prominent, and extends from the proximal angle to the distal articular face in line with the plane of the short acuminate hook. The great ala is narrow, and rather stout; the proximal articular face slopes steeply outward. The stapedial pit is a narrow, straight groove (perhaps partly closed by pressure). The knob is represented by a longitudinal crest, bordering the meatus below on the outer side, and not continuing to the distal articulation. The surface of the latter is crescentic, with an angle on the outer anterior border. This angle is the summit of a short, low, rugose ridge, which extends part way to the knob. Outer edge only of the great ala radiate-grooved; posterior angle of distal condyle produced.

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

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

Measurements.

	M.
Length of the bases of the two premaxillary teeth	0.026
Width of the bases of the two premaxillary teeth	0.034
Length of the bases of the two maxillary teeth	0.042
Depth of the anterior suture of the maxillary	0.028
Depth of the maxillary at the end of the nares	0.038
Length of the quadrate	0.082
Length of the distal condyle	0.040
Width of the distal condyle	0.017
Width of the great ala on the inner side	0.032
Width of the inner face above the meatus	0.037
Length of the hook from the stapedial pit	0.028
Length of a dorsal vertebra	0.059
Diameter of the ball, vertical	0.029
Diameter of the ball, transverse	0.048

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

PISCES.

LITERATURE OF THE SUBJECT.

1856. Leidy, Proceedings Academy Philadelphia, p. 73. *Lepidotus* from Judith River.

Leidy, *l. c.*, p. 256. Two species of *Enchodus* and *Cladocyclus* described.

Leidy, *l. c.*, p. 312. *Mylognathus priscus*, from the Fort Union epoch, described.

1857. Leidy, *l. c.*, p. 167. *Phasganodus dirus* described.

1858. Marcou, North American Geology, p. 33. *Ptychodus whippleyi* described.

1868. Leidy, Proceedings Academy, Philadelphia, p. 207. *Ptychodus occidentalis* described.

1870. Leidy, *l. c.*, p. 12. *Xiphactinus audax* described.

Cope, Proceedings American Philosophical Society, p. 529. Family of *Saurodontidæ* established and defined, and one new genus and four new species described.

Cope, Hayden's Report on Geological Survey of Wyoming, p. 424. *Apsopelix sauriformis* described.

1871. Cope, Proceedings American Philosophical Society, p. 170. Genera *Portheus* and *Anogmius* described.

1872. Cope, *l. c.*, p. 327. Descriptions of twenty species and nine genera; characters of latter and of families *Saurodontidæ* and *Stratodontidæ* extended.

Cope, Proceedings Academy, Philadelphia, 280. *Erisichthe nitida* described.

1873. Leidy, Vertebrate Fauna of Western Territories, in Hayden's Report of United States Geological Survey, vol. I, p. 288. Twelve known species redescribed and figured.

Cope, Proceedings Academy Philadelphia, p. 337. *Portheus lestrio* and *P. gladius* described, and genus *Daptinus* defined.

1874. (April.) Cope, in Hayden's Bulletin of United States Geological Survey of the Territories, p. 39. Synopsis of all the species; ten added; genus *Empo* more fully defined.

1875. Cope, Proceedings Academy Philadelphia (January). Gar-fishes in Fort Union beds of Milk River.

In the present work, the families, genera, and species are more fully defined than has been heretofore practicable.

? PERCESOCES.

SYLLÆMUS, Cope.

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 supraöccipital. 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 the femoral bones can be distinctly seen. These 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 continuous 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.

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 supraöccipital, 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 preöperculum	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 found by Lieutenant Marshall, of the Wheeler United States Geographical Survey, "near the summit of Pike's Peak," Colorado. The specimen has the appearance of having been derived from the Cretaceous or possibly Jurassic beds at the base of this granitic mountain, and its occurrence where found was doubtless accidental.

PELECORAPIS, Cope, *gen. nov.*

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

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

PELECORAPIS VARIUS, *sp. nov.*

Represented by portions of perhaps two individuals, the larger of which includes a considerable part of the body, the head and tail being absent. On this specimen, it is evident that the scales diminish in size toward the posterior part of the body, where they are small; on the anterior region, there are two scales exposed, in an oblique series, in six millimeters; on the posterior region, three and one-half and four in the same. The concealed portions of the scale are sculptured with minute contiguous concentric grooves, without any radii. The exposed portion is thickened with a cementum-like layer, which is marked with a few radiating lines of pores, which sometimes unite into irregular grooves. Teeth of the comb numerous and strong. Depth of body at pelvis, $0^{m}.074$; length of pelvis, $0^{m}.040$; of lamina, $0^{m}.022$; of rod, $0^{m}.022$; greatest width of pelvis, $0^{m}.023$; width at basis of rods, $0^{m}.014$; length of seventeen consecutive vertebræ, $0^{m}.105$; diameter of a dorsal vertebra, $0^{m}.007$.

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

ISOSPONDYLI.

SAURODONTIDÆ.

This family embraces carnivorous fishes, many of them of large size and interesting structure, which have as yet only been discovered in the beds of the Cretaceous formation. They are of interest to the student of comparative anatomy, and also to the paleontologist, as they appear to have been the predominant type of marine fishes during the Cretaceous period in the North American seas, and to have been abundant in those of Europe.

The characters already assigned to the family are confirmed by the new species discovered, and many additional ones added, as follows:

The cranial structure can be nearly made out, and the following points may be regarded as ascertained. The *brain-case* is not continued between the orbits, and the *basis cranii* is double and with the muscular tube open. There are no exoccipital condyles, and that of the basioccipital is a conic cup. The homologies of some of the bones that constitute the *cranial walls* are difficult to determine. The basioccipital is longitudinally excavated below. The exoccipital is probably a small bone, which embraces the basioccipital closely, so that it is difficult to say whether the bone that joins the opisthotic below is the former or latter. The opisthotic has considerable transverse extent, and an articular surface behind, probably for the posttemporal. The supraoccipital is keeled or longitudinally crested above, and is preceded by, or continued into, a longitudinal median extension, which continues as far as the frontal bones on the middle line, separating entirely the lateral elements. It is uncertain whether this be supraoccipital, or, by homology with the Siluroids, conjoined parietal bones. If this homology be true, we can easily refer the elements which bound the exoccipitals above, and the supraoccipitals on either side, to the epiotics. They occupy the position of the epiotics in *Salmo*, and are produced upward and backward into crests which have free margins, both on the upper and postero-interior margins. The appearance of these formerly led me to suspect the presence of a fontanelle, which I am now able to assert has no existence. The extent of these supposed epiotics anteriorly is limited by the approach of the more lateral elements to the middle line. These elements are wide, and, offering attachment to the opisthotic, hyomandibular, and postfrontal, must be regarded as pterotic. The postfrontal is a well-developed bone. The frontals terminate posteriorly near the middle of the skull, and are well developed. They are bounded in front by the prefrontals and ethmoid. The prefrontals are stout bones, directed obliquely downward, and terminate in a large truncate articular face for a facet of the palatine. The ethmoid is generally wide, and terminates in an apex. It presents a large facet downward and laterally for the anterior articular surface of the maxillary, opposing a corresponding facet of the vomer. Anterior and exterior to this point it exhibits a lateral excavation for the superior condyle of the premaxillary.

FIG. 8.—Cranium of *Portheus molossus*, Cope, one-fourth natural size (linear); *a*, supraoccipital bone; *b*, exoccipital; *c*, basioccipital; *d*, parietal; *e*, pterotic; *f*, epiotic; *g*, postfrontal; *h*, frontal; *i*, prefrontal; *k*, ethmoid; *l*, hyo-mandibular; *m*, metapterygoid; *n*, quadrate; *o*, ectopterygoid; *p*, palatine; *q*, sclerotic; *r*, suborbital; *s*, parasphenoid; *t*, premaxillary; *u*, maxillary; *v*, accessory maxillary; *w*, dentary; *x*, articulo-angular. The opercular bones are wanting.

Viewing the cranium on the *inferior aspect*, the parasphenoid and vomer are seen to form a stout axis, the former running well posteriorly, and fissured behind for the muscular tube. Neither supports teeth in any known species. Just behind the line of the orbits, the parasphenoid gives off a lateral process, at the base of which are one or more foramina. The postfrontal shares with the pterotic the support of the hyomandibular. The proötic is elongate, and sends a crest downward and forward to the basis of the above-mentioned process of the parasphenoid. Superiorly, it bounds, with the pterotic and sometimes (*Portheus*) opisthotic, a large foramen.

The *premaxillary bones* are short, and form but a small portion of the upper jaw. The maxillary is elongate and simple. The hyomandibular is rather narrow, and does not present an elongate support for the operculum. The symplectic is well developed, entering far into the inferior quadrate. The latter is a broad bone, large, in contact with the metapterygoid, which is itself a thin plate, nearly attaining the pterotic. In *Portheus*, the pterygoid is well developed as a broad plate extending to the inferior boundary of the orbits. The palatine exhibits a marked peculiarity in the genera of this family. It is a shortish bone, soon uniting postero-inferiorly with the ectopterygoid, but supporting as its supero-anterior extremity a body comparable to the head of a hammer. This *malleolar body*, as it may be called, is a shortened cylinder, with one extremity articulated to the prefrontal and the other to the posterior superior of the maxillary facets. This gives the latter bone a firmness of support unusual among fishes. It also probably permits of some movement of the maxillary in a horizontal plane, which, though small, would have the effect of considerably expanding the gape of the mouth, thus enabling these fishes to swallow large bodies, in the manner of the Mosasauroids of the same sea and epoch.

The ectopterygoid is a large bone, and extends down on the front of the inferior quadrate Neither it nor the palatine supports teeth in any of the known genera.

The *sclerotica* of the eye is ossified in *Portheus* and *Ichthyodectes.* This ossification does not cover the eye, is not a complete circle, and is unsegmented.

Little can be said respecting the *hyoid apparatus* in this family. Some superior branchihyals, preserved in *Portheus thaumas*, are short flat rods. Two long flat bones, in place between the dentaries of a *P. lestrio*, appear to be the distal ceratohyals. They terminate in some crushed basihyals, and are covered with minute teeth *en brosse* on the inner faces and superior margins.

No specimen exhibits the entire *scapular arch*, but several preserve the scapula with adjacent parts; two, a *Portheus* and probably an *Ichthyodectes*, display most of the elements in place, and several others exhibit the articulation of the pectoral fin. In the genera named, the clavicle is a wide bone antero-posteriorly, and is connected with the epiotic by a strong osseous bar, and probably with the apex of the parietal by another bar. The posterior part of the arch between these connections is occupied by the stout scapula. Its posterior face is principally occupied by three convex articular facets. It sends a short laminar continuation downward behind the clavicle, and turns inward above, with a massive body at right angles to its long axis. This transverse portion is supported by the coracoid, which is a stout, flat rod, narrower than the clavicle, and is appressed to the inner face of the latter nearly to its distal end. Its posterior border is separated from the clavicle by a deep groove, but the anterior margins are continuous. Above, it incloses a large foramen with the exterior part of the scapula. It is not now possible to state whether there is any præcoracoid (Parker; "*spangenstück*," Gegenbaur); but the upper part of the bone here called coracoid occupies the position of the præcoracoid in some fishes, articulating with the superior instead of the inferior extremity of the scapula, as is usual. Except in the elevated position of the scapula, the entire arrangement approaches that of the Siluroids; but the inferior part of the scapular arch is not horizontal as in those fishes, but vertically compressed.

The articular facets of the scapula are convex: the inferior and largest is oblique; the median and smallest is situated behind the axis of the others. Behind the superior two, on the transverse part of the scapula, are two round fossæ, in line, adapted for the reception of the condyles of two basilar bones.

The *pectoral fin* is composed of osseous rays, of which the first is much the largest, forming a powerful defensive weapon. As the fossils are found, a number of these rays usually lie in close apposition, edge to edge; but they are not coösified, and in life probably diverged in the usual manner, extending the intervening membrane. Their component halves differ much in form, and are easily separated; and, as they often occur in this condition, inexperienced persons may be led to regard them as entire spines.

The *femoral bones*, or those supporting the ventral fins, are preserved in specimens of *Ichthyodectes* and *Portheus*. They resemble those of many physostomous fishes, but present a number of characteristic peculiarities. Their posterior portion is massive and is expanded on the outer side to support the facets for the ventral rays. They are also expanded on the inner side, and strongly united, in the case of *Portheus*, by suture. The anterior part of these bones is thinner, and consists of two parts,—an inner rod, and an outer lamina at the base of the rod. The rods, or styles, are directed forward, parallel to each other; the lamina is turned outward and upward (see Plate XLV, fig. 7, and cut, fig. 9). In *Ichthyodectes anaides*, the outer portion of the lamina is extended backward as well as forward; in a species of *Portheus* (fig. 9), forward only. The face of attachment of the ventral fin is infero-lateral, and in antero-posterior line with the anterior rod; it is therefore within the line of the external margin of the lateral ala of the femur. The face is expanded in a vertical direction, and is subround. Its manner of articulation with the spines of the ventral fin presents a close analogy with the corresponding articulation of the pectoral spines with the scapula, so far as regards the first rays. Thus, there are two plane articular facets,—the one superior, the other inferior. Between these is a prominent and narrow transverse tuberosity, which bears an articular facet directed partially backward. Behind this, instead of the fossæ of the scapula, there is another tuberosity, which is directed posteriorly. Thus, there are four facets, of which the largest pair supports the diverging halves of the base of the first ventral spine. The middle tuberosity is probably in contact with a portion of the second spine; and the posterior tuberosity with the base of the third.

I have alluded to the *ventral rays* as spines, and such are the first three. Whether there are additional spines is more than doubtful, as in *Portheus*, at least, there are no other articular surfaces than those described. A pair of ventral fins, found in relation with their femoral supports, by Professor Merrill, and sketched on the spot before removal from the rock, embraces only the three spines; the halves of the first being separated, as is often the case in isolated specimens. Whether additional soft rays existed is also improbable; but, if existing, they must have been very few, as the basis for their support, such as exists in *Salmonidæ* and other physostomous fishes, is absolutely wanting. It is therefore improbable that the internal basilar bone was similar to that in the above recent fishes; though from the analogy of the pectoral fins, one would expect to find ventral basilars. There are two small bones in the specimen described, which, according to the sketch, occupied the position of basilars; and such they probably are. Each is an irregular discoidal body, with one, a concave facet on one side.

The osseous condition of the ventral rays is a remarkable character in fishes of the general physostomous affinities of the *Saurodontidæ*. It is a point of resemblance to the physoclystous or spinous fishes, for which the structure of the superior walls of the skull in some measure prepares us.

A third kind of spinous ray was originally described by me as pertaining to the *Portheus thaumas*, and had been previously referred by Professor Agassiz to the genus *Ptychodus* (*vide* Poissons Fossiles). This is composed of closely-appressed osseous rays of different widths, each of which is composed of narrow, oblique segments. The sutures of these segments are of different character in almost every ray: being in the marginal ray *en chevron*; in others, step-like; and, in others, dovetailed (see p. 200, and Plate XLIV, fig. 4). I suppose this compound spine to belong to one or other of the borders of the caudal fin.

The vertebræ in all the species certainly assignable to this group are, where known, deeply two-grooved on each side, besides the pits for the insertion of neurapophyses and pleurapophyses, except in the cervical region, where the lateral grooves are wanting. There are no diapophyses. The caudal vertebræ are rather numerous, but not so much so as in *Amia*, nor are they so much recurved as in that genus.

Affinities of the Saurodontidæ.—More perfect specimens received since the description of the cranial structure on p. 183 was printed, render it almost certain that the median bone of the superior cranial walls is a supraoccipital; that the parietals are produced upward into an angle (epiotic, p. 183) on each side; and that the epiotics (opisthotic, p. 183) form the posterolateral angles of the skull. If this interpretation be true, there is no opisthotic bone. It is quite possible to interpret the superior cranial structure of the Siluroids in the same way, while the arrangement is very different from that seen in *Salmonidæ*, *Cyprinidæ*, *Characinidæ*, and *Esocidæ*, where the opisthotic is present, and where the supraoccipital does not present any such anterior prolongation. The structure of the scapular arch, if we except the position of the scapula, has much in common with that of the Siluroids; while the two basilars and double articulation of the pectoral spine are striking points of resemblance to the same group. As characters of more typical *Physostomi*, we have the maxillary arcade of the mouth, the form and position of the ventral fins, and the apparent absence of dorsal spines. The form of the bones of the mouth, the presence of symplectic, subopercular, and postfrontal bones, the basioccipital muscular tube, and the unmodified anterior vertebræ, distinguish the *Saurodontidæ* widely from the *Nematognathi*, and ally them to the *Isospondyli*; and with the latter I have for the present allowed them to remain. It must not be forgotten, however, that the long supraoccipital and osseous ventral rays are physoclystous characters, and that the form and position of the femora are much nearer to those of *Belone* than to those of any physostomous fish known to me. The three persistent vertebræ of the caudal fin recall *Salmo*, while the dorsals nearly resemble those of the *Clupeidæ*. The peculiar malleolus of the palatine bone is closely imitated by the *Pomolobus pseudoharengus* (alewife); but in that *pseudoharengus* (alewife); but, in that species it articulates posteriorly with a process of the ethmoid, instead of the prefontal. In the bluefish (*Pomatomus saltatrix*) there is a nearer approach; here, the malleolus articulates with the prefontal and maxillary, but with the latter only by a squamosal joint. The same species betrays a resemblance to this family in the insertion of the teeth by roots in alveoli, but the roots are much shorter in the living genus. They are also accompanied by a series of foramina on the inner side of the dentary, as in *Saurocephalus.*

Six genera are enumerated below as belonging to this family, of which one, *Erisichthe*, Cope, is placed in it provisionally:

Synopsis of genera.

I. Jaws without foramina on the inner face below the alveolar margin:
  α. Teeth cylindric:
    Teeth of unequal lengths; some of them greatly developed .... *Portheus.*
    Teeth of equal lengths .... *Ichthyodectes.*
  αα. Teeth compressed, knife-like:
    Teeth of unequal lengths; some of the anterior greatly developed .... *Erisichthe.*
    Teeth equal .... *Daptinus.*
II. Dentary bones pierced by foramina below the alveolar border:
    Teeth with subcylindric crowns .... *Saurodon.*
    Teeth with short, compressed crowns .... *Saurocephalus.*

There are some other forms to be referred to this family, whose characters are not yet fully determined. Thus, *Hypsodon*, Agass., from the European chalk, is related to the two genera first named above, but, as left by its author in the "*Poissons fossiles*," includes apparently two generic forms. The first figured and described has the mandibular teeth of equal length. In the second, they are unequal, as in *Portheus*, to which genus this specimen ought, perhaps, to be referred. Both are physostomous fishes, and not related to the *Sphyrænidæ*, where authors have generally placed them. Retaining the name *Hypsodon* for the genus with equal mandibular teeth, its relations to *Ichthyodectes* remain to be determined by further study of the *H. levesiensis.*

The view of the superior walls of the cranium given by Professor Agassiz presents characters quite distinct from what I have observed in *Portheus.*

A species of *Ichthyodectes,* from the chalk of Sussex, England, is figured, but not described, by Dixon in the Geology of Sussex.

A number of forms, erroneously placed by Agassiz and Dixon in the genus *Saurocephalus,* have been referred by Leidy to a genus he calls *Protosphyræna,*[1] with two species, *P. ferox* and *P. striata.* The latter much resembles a *Saurocephalus,* having equal teeth; while the former probably includes several species, and probably genera. The teeth first referred to it resemble those of *P. striata;* while others resemble those of *Portheus.* An examination of the figures of the mandibles of some of these in Dixon's work, shows that the large and small teeth occupy different areas, separated by grooves, in a manner quite distinct from anything seen in *Portheus;* but it can scarcely be regarded as typical of *Protosphyræna,* which name, moreover, has never been accompanied by the necessary description.

Dr. Leidy applied the name *Xiphactinus* to a genus indicated by a spine in some degree like those regarded above as ventrals of *Saurodontidæ.* Whether it belongs to any of the genera above enumerated, or, if so, to which of them, is a question which can only be settled by future investigation.

The history of the definition of this family may be found in the following references: Proceedings of the American Philosophical Society, 1870, p. 529; Hayden's Survey of Wyoming, etc., 1871, p. 414; Proceedings of the American Philosophical Society, February, 1872.

PORTHEUS, Cope.

Proceedings of the American Philosophical Society, 1871, p. 173; *l. c.,* 1872, February.

Teeth subcylindric, without serrate or cutting edges, occupying the premaxillary, maxillary, and dentary bones. Sizes irregular; the premaxillary, median maxillary, and anterior dentary teeth much enlarged. No foramina on inner face of jaws. Teeth on the premaxillary reduced in number. Opercular and preopercular bones very thin. Cranial bones not sculptured.

The fishes of this genus were rapacious, and, so far as known, of large size. They constitute the most formidable type of physostomous fishes known. Five species are known to the writer from the Niobrara Cretaceous of Kansas. These are represented by numerous fragments of many individ-

[1] Transactions of the American Philosophical Society, 1856.

uals, which include large portions of the cranium, two almost entirely complete. Others embrace jaws, and one a large part of the vertebral column, with segmented caudal rays. In one, these rays were found with the cutting pectoral ray above described, while the simple flat ventral rays occur with several specimens. In none have any traces of symmetrical spinous rays been found, nor strong interneurals capable of supporting such. In none of the more perfect specimens with crania have the segmented rays been found; but the fossil of *P. thaumas*, where they occur, is represented by a vertebral column and its appendages, which do not differ appreciably from those of *P. molossus.*

In the cranium of this genus, there is a well-marked supraorbital rim. Each opisthotic forms a prominent angle, directed posteriorly on each side of the exoccipital. The parasphenoid is a stout and narrow bone, deeply emarginate behind for the passage of the muscular canal. It has a transverse expansion in front of the base of the proötic, which rests on a backward continuation of the same. This expansion is pierced behind by two round foramina. The shaft is abruptly contracted in front of the expansion, and is trigonal in section. The prefrontal extends downward and forward, and carries inferior and anterior articular faces for the maxillary; the latter vertically transverse. The postero-inferior portion of the ethmoid bears on its posterior extremity a concave articular face, which opposes that of the vomer. The floor of the brain-case in front of the proötics is supported by a vertical style, which is bifurcate above, and rests on the parasphenoid below.

There are large thin supernumerary bones attached to the upper side of the distal half of the maxillary, as in various clupeoid genera. There is a chain of thin suborbital bones. The crest of the vertex is compressed, and, in one, at least, of the species, greatly elevated and overlapped by a superficial thin bone, which forms a laminar extension of the crest in front of it. There is neither enamel nor sculpture on the cranium in any of the known species.

Of the teeth in general, it may be added that their pulp-cavity is rather large at the base but rapidly diminishes in the crown. The mode of succession is by direct displacement from below. The young crown rises into the pulp-cavity, and destroys the vitality of the crown while the root is absorbed

Numerous empty alveoli are to be found in all the jaws of this genus, in which examination will often detect the apex of the crown of the young tooth.

All the bones of the palatine arch are present in this genus. The ectopterygoid is curved and concave on its lower border; the pterygoid is, on the other hand, thickened and concave on its upper border, where it is also strongly beveled outward, forming the inferior internal boundary of the orbit. The metapterygoid is a large, flat, and thin bone, joining the greater part of the superior border of the quadrate. It does not inclose a foramen with the other bones of the arch as is seen in *Characinid* fishes. These bones are all in place on a block, which also contains pectoral spines of *Portheus.* On another block of the same specimen, the bones of the cheek are exhibited in connection with the quadrate. One is a greatly-expanded, thin bone, with the middle portion of its surface coarsely pitted. It is adjoined by a much smaller laminar bone of an irregular, semi-discoid form, with the middle of the convex side with three obtuse processes separated by fissures. The corresponding bone in *P. molossus* is figured in Plate XL, fig. 9. The interoperculum is a subparallelogrammic bone, with an open sigmoid articular surface at one end. In *P. molossus*, there are two short articular faces on the other end. There is, therefore, no doubt, a suboperculum, though I have not identified it.

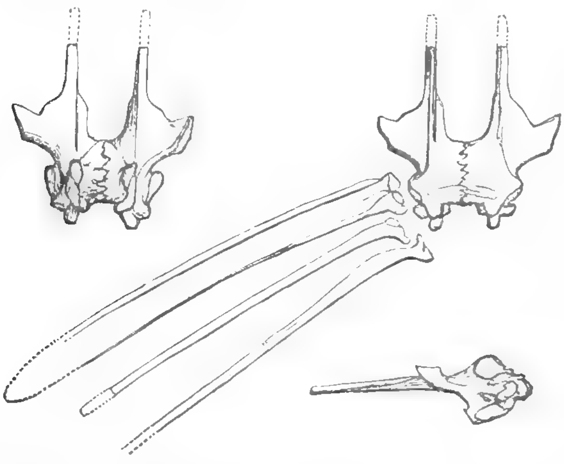


FIG. 9.—Femoral bones and ventral fin of a ? *Portheus:* right-hand upper figure, from above; lower figure, from the right side; left-hand figure, from below.

The proximal part of the hyomandibular of another large specimen displays a continuous narrow articular surface for the pterotic. The posterior portion is a protuberant condyle; the middle part narrower and concave; the anterior part truncate, and presenting forward. Not far below the proximal end, on the posterior border, is a condyle for the operculum. It is sessile and not very protuberant, and is a vertical oval in outline. This bone closely resembles the corresponding one of *Ichthyodectes anaides.*

An incomplete skeleton of another *Portheus* includes pectoral arch and spines, branchial arches, etc. The arches are extended posteriorly, and the inner surfaces of the branchihyal bones are covered with minute teeth *en brosse*, and support a few tuberosities. The branchial fringe is preserved, consisting of long and slender processes.

The spine supported by the scapular arch in *Portheus* and *Ichthyodectes*, is a defensive weapon. Proximally, it presents a concave articular surface for the scapula, with a short hook-like projection bounding one end. A specimen in relation, but somewhat mutilated, exhibits a flat, discoidal basilar bone, which is probably applied to one of the scapular facets. Two rod-like basilars are visible, and two round condyles, projecting from the mass at the base of the fin-rays, fit into the scapular cotyli. The principal spine is flat and curved; the convex edge trenchant beyond the middle. The posterior edge is obtuse but narrow, and exhibits a slight groove on one side medially. Proximally, there is a shallow rabbet, whose floor is transversely rugose. Several layers of the tissue of the spine beyond the basal portion are delicately longitudinally striate. The distal half is broken away. Length of fragment, 1 foot; width, 1.5 inches; thickness at middle, 5 lines. The largest pectoral spine of *Portheus* in my possession measures 2.75 inches in width.[1]

The vertebræ in this genus are rather short, but not so much so as in sharks. In *P. thaumas*, nearly eighty dorsals and caudals were preserved; those without lateral grooves, or cervicals (the term not appropriate), are not numerous. There are not more than three vertebræ entering the caudal fin; a fact which is difficult to determine, owing to the concealment of the terminal centra by bases of radii. There are seven hæmapophyses in the support, all flat except the first, which is like those anterior to it. The second is articulated freely to its centrum, and is wider than the others. Its condyle is characteristic, being double, and with a foramen between it and the produced extremity of the posterior margin of the bone. It is slightly separated distally from the third, but the remainder are in close contact. The radii of the superior lobe of the caudal fin extend at least as far down as near the end of the third hæmal spine from below. The structure of these parts in the *P. molossus* is as in the *P. thaumas*, so far as preserved.

An outline-restoration of this genus is given on Plate LV.

The species of this genus may be distinguished as follows:

a. Two premaxillary teeth:
- Maxillary arch thin, deep, with narrow anterior condyle; large maxillary teeth five; third mandibular tooth large, behind a cross-groove .... *P. molossus.*
- Maxillary large teeth three; third mandibular small, without cross-groove in front of it .... *P. thaumas.*

aa. Three to five premaxillary teeth:
- Maxillary arch stout, deep, with heavy anterior condyle; larger teeth five .... *P. lestrio.*
- Maxillary arch thick and shallow; larger teeth five .... *P. mudgei.*

aaa. Premaxillary teeth unknown:
- Maxillary bone deeply concave; small .... *P. arcuatus.*

[1] See Plate XLII, fig. 4.

Portheus molossus, Cope.

Proceedings of the American Philosophical Society for 1871, p. 173.

Represented by four individuals: one from Fox Cañon, near Fort Wallace, with complete cranium, and many vertebræ and radii; a second from another part of the same, with large part of cranium; and a third and fourth from Lower Butte Creek bluffs, both with fragments of cranium and other portions. In the first specimen, the jaws are perfect and dentition complete.

The *premaxillary* is vertically oval, convex externally, nearly flat within, and more than half underlaid by an anterior lamina of the maxillary. The anterior or median margin is regularly convex, and exhibits no surface or suture for union with the bone of the opposite side. Its posterior margin extends obliquely backward to beneath the superior articular condyle of the maxillary, and has a ragged edge, though the suture is squamosal. Its superior margin is deeply inflected in front of the condyle, and then convex and thickened. The anterior margin is thick and rugose with tubercular exostoses. There are but two teeth, which are very large, and directed obliquely forward; the first is two-thirds the diameter of the second.

The *maxillary* is a large laminiform bone, with the upper margin considerably thickened proximally, but much thinned distally. It is abruptly contracted at the distal two-thirds its length, apparently for the attachment of a supernumerary bone. The extremity is curved saber-shape upward, and has an acute toothless edge. The teeth are four small, five large, and eighteen small. These teeth, except the largest, have cylindric bases; the crowns (and bases of the latter) are slightly compressed or oval; they are straight and regular, and lean backward. The middle one of the five is largest, being six times as long as the small ones, but little more than half as long as the large premaxillary or mandibular. The surface of the maxillary is rugose with small tubercles on its lower half, and has shallow grooves for nutritious vessels running downward and forward.

The *mandibular rami* are short and deep, and have but little mutual attachment at the symphysis. They are not incurved at that point, and were bound by ligament only. There is no coronoid bone, and the articular is distinct. It is short, of a rather irregular wedge-shape, and supports half the cotylus, above which it sends a short acuminate process. The angular has a prominent angle, like half an ellipse, somewhat contracted at the base; below it is a rough, prominent, muscular insertion. The bone extends in a long sword-shaped process, on the inside of the ramus, to beyond its middle; externally, it is soon covered by the thin truncate edge of the dentary. This element is very large. From the angular it rises steeply to a coronoid process, which has a slight outwardly-twisted eminence, and then follows a gently concave line to the symphysis. The teeth are as follows: Two large—a transverse groove; three large; four very small; nine medium; and two very small—total, twenty. These teeth have straight cylindric-conic crowns, with cementum without striæ or facets. The larger are a little compressed.

Measurements of the jaws and teeth.

	M.
Length of the premaxillary bone on the alveolar border	0.045
Depth of the premaxillary bone on the alveolar border	0.093
Thickness on the alveolar margin	0.016
Length of the crown of the second tooth	0.046
Diameter of the crown of the same at the base	0.014
Length of the maxillary bone from the premaxillary	0.270
Depth of the maxillary bone at the condyle	0.080
Depth of the maxillary bone at the middle	0.046
Length of the crown of the third large tooth	0.028
Diameter of the crown at the base	0.011
Length of the crown at the second small tooth from the large	0.006
Diameter of the crown at the base	0.004
Length of the ramus mandibuli	0.350
Length of the angle	0.040
Length of the angular bone exteriorly	0.080
Depth at the coronoid process	0.112
Depth at the fourth tooth	0.080
Length of the crown of the first tooth	0.038
Diameter of the crown at the base	0.011
Length of the crown of the fourth tooth	0.055
Diameter of the crown at the base	0.016

The *opercular bones* are thin; the operculum broad; the preöperculum rather narrow. The latter is without armature, and has some shallow grooves radiating toward the circumference. Length of bone vertically, $0^{m}.245$; radius from inner curve, $0^{m}.09$.

The *vertebræ* display deep lateral grooves; articular faces smooth. Length of centrum, $0^{m}.028$; diameter, $0^{m}.043$. The fan-shaped hæmal spine, or second of the caudal fin, is like that of *P. thaumas*, but smaller. The last caudals contract in size very rapidly; the cup of the penultimate, or last, is transverse diamond-shaped.

The fragments of the saber-shaped *ventral spine* display several layers of parallel striate dense bone; and the edge is tubercularly dentate, and one side is much more rugose than the other. At the base, one side is flat, the other convex; and there is a transversely rugose band near one edge.

The *scales* are thin and cycloid, and, though large, are not remarkably so for the size of the fish. They are not readily preserved.

Measurements of the cranium.

	M.
Length from the angle of the opisthotic to the anterior extremity of the ethmoid	0. 30
Length from the angle of the opisthotic to the front of the proötic	0. 11
Length from the postfrontal to the prefrontal across the orbit	0. 11
Length from the occipital condyle to the transverse process of the parasphenoid	0. 117
Length from the occipital condyle to the bottom of the parasphenoid emargination	0. 055
Length of the parietal bone on the outer suture	0. 07
Width of the parietal bone at the middle	0. 014
Width of the parietal bone to the edge of the pterotic	0. 07
Width of the frontal at the middle of the orbit	0. 04
Width of the parasphenoid at the middle orbit	0. 03
Length of the inferior quadrate	0. 10
Length of the condyle of the inferior quadrate	0. 03
Length of the symplectic	0. 064

This cranium is figured on Plate xxxix.

The gape of the mouth of the *Portheus molossus* extended the whole length of the cranium proper, and far beyond the orbits, since the maxillary reaches to opposite the occipital condyle. The orbits were large. The lower jaw was deep, and gave the countenance that bull-dog expression from which it derives its name. The body was stout and moderately elongate.

A complete cranium of a *Portheus*, probably the *P. molossus*, for which I am indebted to my friend Professor Merrill, of Lincoln University, at Topeka, Kans., furnishes several points of interest previously unknown. The mouth is nearly vertical, somewhat as in *Osmeroides*, while the vertex is surmounted by an elevated crest. Hence, the superior and inferior facial outlines meet at a right angle at the muzzle. The eye is small, and there is a suborbital chain of laminiform bones. The elevation of the skull is 16.75 inches, while the length is only 12.75 inches. Cut 8, page 184, represents this specimen.

PORTHEUS THAUMAS, Cope.

Saurocephalus thaumas, Cope, Proceedings of the American Philosophical Society, 1870, November; Hayden's Survey of Wyoming, &c., 1871, p. 418.

This large species rests on a specimen without cranium, originally procured by Prof. B. F. Mudge. The parts preserved are not distinguishable from the corresponding ones in two individuals obtained by myself in Western Kansas, which include the greater portions of the jaws and suspensorial apparatus. These indicate larger animals than those of *P. molossus*, and one of the most powerful of the physostomous fishes, rivaling in this respect many of the saurians, which were its contemporaries.

The distinguishing features of the species have been already pointed out.

The *premaxillary* is an obliquely oval or subpentagonal bone; the suture, with the maxillary, is not toothed, and the anterior or free edge is smooth, not tubercular, as in two specimens of *P. molossus.* There are but two teeth, of which the anterior is immense, and the second little more than half its diameter. The *maxillary* is stout, and supports in front four very small teeth; then three very large, of which the median is largest. The teeth recommence very small and are closely placed in the same line; but, as the extremity of the maxillary is lost, the number cannot be stated.

The *dentary* is similar in form to that of the *P. molossus*, but has rather more numerous teeth. Counting from the front, there are two large, one rather small; two large, and eighteen small and medium following; the smallest from third to ninth, inclusive. None of the crowns are preserved, but the alveoli are round, or nearly so. The large tooth of the premaxillary, if proportioned as in *P. molossus,* must have projected $0^{m}.0755$, or three inches, above the alveolus; the fourth mandibular was but little smaller.

Measurements of the jaws.

	M.
Length of the premaxillary	0.075
Depth of the premaxillary	0.09
Depth of the maxillary at the condyle	0.08
Thickness of the maxillary just behind the condyle	0.025
Length of the dentary	0.25
Depth of the dentary at the symphysis	0.08

The various portions of *cranial bones* preserved are much like those of *P. molossus*, but stouter. The hyomandibular is nearly perfect; it is thin, but has a convex rib extending to its acuminate extremity at the postero-inferior angle of the metapterygoid and the superior extremity of the symplectic. The preöperculum is attached by a thickened grooved margin, and is not overlapped by the hyomandibular. It extends in a curved form round toward the condyle of the inferior quadrate. Three elongate bones, closely appressed, I suspect to be part of this bone, with the interoperculum and superior ceratohyal adherent. The last is rather narrow, and with smooth distal articular surface, without suture. The superior branchihyals are a little like phalanges of *Mosasaurus* in form, being subsimilar and expanded at the ends, and much flattened. The parasphenoid is similar to that of *P. molossus.* The position of the hyomandibular is vertical to the axis of the basioccipital, the superior part directed forward.

Measurements.

	M.
Length of the basioccipital to the end of the muscular foramen	0.077
Length of the hyomandibular	0.260
Length of the inferior quadrate (oblique)	0.113
Length of the condyle of the inferior quadrate	0.036
Length of the preöperculum preserved	0.305

A portion of one of the flat unsegmented or ventral spines preserved exhibits an irregular rabbet on each edge of one side; width, $0^{m}.042$. The sclerotic bones are as already described.

A second specimen is still stouter in proportions, as the following measurements show:

Measurements.

	M.
Diameter of the maxillary condyle	0.034
Diameter of the maxilla above, behind the condyle	0.033
Length of the angle of the jaw (exteriorly)	0.056
Diameter of the parasphenoid at the middle of the proötic	0.03
Diameter of the dorsal vertebra (crushed)	0.067

The diameter of the vertebra must be corrected by a little reduction.

The largest fish-vertebræ I obtained may be here mentioned. They are peculiar in having numerous concentric grooves on the articular faces, as in *Ischyrhiza.* They are otherwise as in this genus. Length, $0^{m}.04$; diameter, $0^{m}.062$.

A peculiarity of *dentition* is observable in the two specimens first described, and in less degree in *P. molossus.* A considerable number of alveolæ support no functional teeth (though included in our enumeration), but are occupied at some point by successional teeth. In some cases, the mouth of the alveolus appears to be narrowed by ossification, even where the tip of the young tooth is in sight; in one case, so far developed as to close up to the projecting apex. In other cases, the orifice is entirely stopped by the ossification, which presents the appearance of a scar with radiating lines of pores.

The first specimen was discovered in a denuded area among the lower bluffs of Butte Creek. The flat cranial and jaw-bone occupied the summit of a cone of twenty or more feet in height, a relic of the ancient blue limestone strata spared from the surrounding denudation. The flat bones had shed off the water, which, running off on all sides, had formed the cone. The second specimen came from Fossil Spring Cañon, near the remains of *Platecarpus curtirostris.*

This species is also represented by wholes or parts of from seventy to eighty vertebræ, with numerous neural and hæmal spines and fin-radii, and, perhaps, some ribs. There are no teeth nor cranial fragments. The bulk of the vertebræ is double that of those of *Daptinus phlebotomus.*

The vertebræ present the usual two inferior, two lateral, and two superior grooves—the last for the neural arch. There are no cervical vertebræ; for these characters show them all to be dorsals and caudals. The suture for the neurapophyses forms a regular angulate convexity projecting downward. The arch is not closed above anteriorly, and is expanded laterally, while the spine is directed very obliquely backward. The concavities of the articular extremities are equal in the dorsals; but, in the caudals, one surface is much more deeply concave than the other, one being funnel-shaped, and the other nearly plane in a few.

A number of consecutive vertebræ which represent the posterior portion of the caudal series are preserved One of these is fortunately the very extremity; and they demonstrate the tail to have been vertebrated or heterocercal, after the manner of *Salmo.* On the anterior three of the series, the lateral grooves have disappeared from the centra; the neural canal is very small, and the spines are very massive and curved backward, but much less so than in the more posterior parts of the column; they are flattened, wider than deep, and in close contact with each other, except the anterior of the three, which presents a narrowed edge forward. The hæmapophyses are thin, and suturally united to the centrum by a flat gomphosis. The terminal series embraces six vertebræ, which have a minute or obsolete neural canal, but hæmal canal distinct, but apparently interrupted. The hæmal arches are united to the centra by a rather smooth suture. The general direction of these vertebræ forms a light upward curve. The hæmal spines are flat and laminar, and their margins in contact; they decrease in width and length to the end of the series. The neural spine lies obliquely backward, and has a narrowed anterior ridge, but stout shaft.

The anterior hæmal spine in place exhibits a subglobular base, like an articulation, and its shaft is wider than those posterior to it. It is a subtriangular flat bone, with neck and subglobular extremity, which applies very well to a concavity between the anterior pair of pleurapophyses, but does not in that position preserve contact with the anterior margin of the succeeding spine. One margin of the enigmatical bone is thin and divergent; the other expanded laterally and straight. The latter gives off a transverse prominence, like half a globular knob, before reaching the extremity. Just within the latter are two large foramina, which are connected with the extremity by a groove on each side, which meet in a notch where the thin edge passes into the knob.

Both sides of the neural and hæmal spines are concealed in this species and in the *Ichthyodectes prognathus* by numerous parallel osseous rods, which are somewhat angulate in section. They lie along the centra of the anterior series of caudal vertebræ, but are not to be found on vertebræ of any other part of the column. Numerous loose and fragmentary rods of the same character accompany the loose and attached caudal vertebræ, and all of them according to Professor Mudge, belong to the "posterior swimming organ" of this animal. There is also a collection of these rods from the anterior region of the body, which Professor Mudge thought occupied the position of an anterior limb. They do not, any of them, present a segmentation such as would be exhibited by the cartilaginous radii of caudal and pectoral fins, and their nature might have remained doubtful but for the explanation furnished by the anterior compound ray or spine of the posterior, probably caudal, fin. This ray, as in the case of the pectoral spine and first anal rays of some existing siluroid and loricariid fishes, is composed of a number of parallel rods closely united. These are in their distal portions remarkably and beautifully segmented, of which a very simple form has been figured by Kner, as existing in the pectoral spine of the siluroid genus *Pangasius*. This segmentation becomes more obscure proximally, and finally disappears altogether, leaving the spine and rods homogeneous. This portion of them is quite identical with the rods found in the positions of fins already described, and I therefore regard these as fin-radii of the attenuated form presented by cartilaginous rays of most fishes, but ossified sufficiently to destroy the segmentation. They are thus in the condition of the anterior rays of the dorsal fin of some of the large *Catostomidæ*, or marginal caudal rays of some *Characinidæ*, where they are proximally homogeneous and bony, distally segmented and cartilaginous.

The segmentation above alluded to presents the following characters The spine consists of four principal parallel rods, of which the external on each side thins, the one to an obtuse, the other to a thin edge. The more obtuse edge presents a groove on one side, which is occupied by a very slender rod, and a shallow rabbet along the flat edge is occupied by a slender flat rod. Of the four principal rods, the two median are the most slender, and the flat marginal the widest. Of the two median, that next the latter is the wider. The stout marginal, or probably anterior, rod is segmented *en chevron*, the angle directed distally and lying near the free margin. The suture of the resulting segments is entirely straight, except, when returning, it approaches the margin, where it suddenly turns to the margin at right angles to it. The next rod is segmented without chevron obliquely backward and inward; where it leaves and reaches the margins, it is at right angles to them, and the margin projects obtusely at those points. Between the ends, the suture is very irregular and jagged, sending processes forward and backward. The segmentation of the next rod is similar, but more regularly serrate; distally, it becomes as irregular as in the last. The transverse marginal termini of the sutures are serrate in both. The inner and widest rod presents a still more regularly serrate oblique suture with the truncate extremities; but, owing to the width of the rod, the near approximation of the sutures continues for a longer distance. When broken, the suture appears steplike.

Measurements.

	M.
Length of a fragment of the (?) caudal spine	0.25
Width of the fragment at the proximal fracture	0.06
Greatest thickness at the proximal fracture	0.013
Width of the posterior rod at the proximal fracture	0.0245
Length of six distal caudal vertebræ	0.10
Width of the hæmal spine of the second of the series	0.024
Vertical diameter of the centrum of the first of the series	0.025
Length of the neural spine and centrum of the anterior caudal	0.108
Transverse diameter of the neural spine of the anterior caudal at the base	0.0235
Antero-posterior diameter of the four anterior caudal neural spines in contact	0.069
Length of the centrum of a dorsal	0.04
Vertical diameter of a dorsal	0.0615
Transverse diameter of a dorsal (crushed)	0.041

These remains were found in place by Prof. B. F. Mudge; he states that their extent was eight feet. As they embrace no cervical vertebræ nor portions of cranium, two feet are probably to be added, giving a total of near ten feet for the length of this fish. It was discovered at a point on the bank of the Solomon or Nepaholla River, in Kansas, one hundred and sixty miles from its point of junction with the Kansas River.

PORTHEUS LESTRIO, Cope.

Represented by a portion of the cranium, including both mandibular rami, and the maxillary and premaxillary bones of one side, all with dentition nearly complete, of one individual; by the tooth-bearing bones, palatine arch, muzzle, and sclerotic bones, of a second; by the tooth-bearing bones, with fin rays, of a third; and by many cranial bones, with vertebræ, of a fourth. Three of these individuals had reached a larger size than those of the *P. molossus* which have come under my observation,[1] and represent the largest species of the Kansas Cretaceous.

It differs from the *P. molossus* in the possession of three, and sometimes four, premaxillary teeth. Three is the usual number, but one specimen exhibits a minute fourth, which is present and still larger in another jaw. As *P. molossus* may in like manner present a variation in the possession of a *third* minute tooth, it is necessary to note other differences. While the premaxillary and anterior portions of the maxillary have the same transverse depth in the specimens of the two species, these elements are notably thinner and lighter in *P. molossus*, so that the anterior condyle of the maxillary is much narrower and smaller in it than in the *P. lestrio*. The depth of the maxillary distal to its posterior condyle is also proportionately less in the *P. molossus*. The measurements of corresponding parts in these species and the *P. mudgei* may be compared as follows:

Measurements.

	P. molossus.	*P. lestrio.*	*P. mudgei.*
Depth of the premaxillary	$0^{m}.094$	$0^{m}.094$	$0^{m}.070$
Depth of the maxillary behind the posterior condyle	.050	.065	.040
Width of the anterior condyle of the maxillary	.011	.016	?
Width of the maxillary behind the posterior condyle	.016	.018	.020

In the specimen first enumerated, the first premaxillary tooth is very large, the two others of moderate size. These are followed by a long rugose diastema before the maxillary teeth begin; these are, one small, five large; twenty-two small, and eleven or twelve very small. The mandibular teeth are, one very large, one immense, one small, one medium, four small, eight large, and two small—total, eighteen. The teeth are all simply round or oval in section, and the external, probably cementum, layer is smooth. The maxillary bone has two large superior proximal condyles, separated by a space; the anterior is the narrower, and is directly behind the premaxillary condyle. The anterior margin of the latter bone is very rugose.

Measurements.

	M.
Length of the tooth-line of the upper jaw	0.300
Length of the tooth-line of the premaxillary	0.058
Depth of the premaxillary (axial)	0.095

[1] See Proceedings of the American Philosophical Society (on the fishes of the Kansas Cretaceous), January, 1872.

	M.
Depth of the maxillary at the second condyle	0.095
Depth of the maxillary at the twentieth tooth	0.065
Diameter of the base of the first premaxillary tooth	0.018
Diameter of the bases of five of the large maxillaries	0.052
Length of the dentary above	0.270
Depth at the second large tooth	0.095
Depth at the last tooth	0.105
Diameter of the base of the first large tooth	0.013
Diameter of the base of the second large tooth	0.020
Length of the crown of the second large tooth	0.050
Length of the crown of the sixth tooth from behind	0.025

If of the same proportions as the *P. molossus*, the vertical diameter of the head of this fish would be twenty-three inches.

The type-specimen of *P. lestrio* was procured by Prof. B. F. Mudge, of Manhattan, Kans., during his survey of 1872, near the Solomon River. Professor Merrill's specimen was obtained from the same region.

PORTHEUS MUDGEI, Cope.

Represented by portions of the jaws, with vertebræ, of a single individual, discovered by Prof. B. F. Mudge in Trego County, Kansas. The prominent character is seen in the possession of four subequal teeth in the premaxillary bone, which, therefore, presents a relatively long alveolar border for their accommodation. The bone is also more massive than in the other species, and is peculiarly thick on the free anterior edge. The maxillary bone presents a similar character, and shows this fish to have been the most robust species of the genus. The width of the superior border of the maxillary is greater than in the others, although the vertical extent of the bone is considerably less (see the measurements under *P. lestrio*). There are five or six subequal large teeth behind an edentulous space on the maxillary bone, while those on the posterior part of it are small. The specimen is smaller than is usual in other species of the genus.

Measurements.

	M.
Width of the premaxillary bone	0.054
Elevation of the premaxillary bone above the first tooth	0.060
Thickness of the premaxillary bone at the middle	0.021
Depth of the maxillary at the condyle	0.057
Depth of the maxillary at the fifth large tooth	0.040
Length of the bases of the five large teeth	0.036
Length of an anterior vertebra	0.019
Diameter, vertical	0.031
Diameter, transverse	0.031

Occasionally, the *P. lestrio* exhibits one, or even two, minute additional premaxillary teeth, but it exhibits but three large teeth in contradistinction to the four large ones of the *P. mudgei*.

Portheus arcuatus, Cope.

The smallest species of the genus, equaling *Ichthyodectes ctenodon* in size, is represented by incomplete maxillary and palatine bones, and perhaps by accompanying vertebræ and other pieces. Apart from its small size, this species may be known by the compressed and concave alveolar border behind and below the posterior maxillary condyle, and the very small size of the teeth which protrude from its subacute edge. The superior border behind this above-mentioned condyle is oblique, and its anterior border an acute edge. The interior face of the maxillary is convex; the exterior plane, and anteriorly dotted with radiating lines of pore-like impressions.

This species is less nearly related to the preceding species of *Portheus* than they are to each other.

Measurements.

	M.
Depth of the maxillary behind the second condyle	0.025
Thickness of the maxillary behind the second condyle	0.004
Width of the second condyle	0.007
Length of the articular segment of the palatine	0.010

From the yellow chalk of the Solomon River, Kansas. Found by Prof. B. F. Mudge.

Observations on the pectoral and ventral spines of the genus Portheus.

As already stated, the fin-rays of this genus are readily separated into their constituent halves. The superior elements of the pectoral fin are laminiform and concave on the side in contact with the inferior halves, which they somewhat exceed in width. The inferior halves are massive, and exhibit a strong superior rabbet on the posterior margin for an overlapping border of the second ray. On the anterior margin is a more shallow rabbet, which soon disappears, which is covered by the superior lamina. The posterior rabbet also disappears at a point varying with the species. The superior lamina bears the cotylus and adjacent hook, which embrace the superior scapular facet; the inferior half supports the facets which correspond to the inferior two of the scapula. The front of the pectoral spine is sharp-edged, forming a thin blade, hardened by a deposit of dense bone, which is transversely roughened. The blade is the edge of the superior lamina, which extends beyond the equally acute border of the inferior half, the latter fitting closely to the concave inferior face of the former. Both faces of the spine are covered with a dense layer of bone, which is marked with delicate longitudinal grooves; and, when the superficial layers are broken away, the deeper ones are found to be grooved in the same manner. This pectoral spine is a formidable weapon, measuring between two and three feet in length and two inches in width in a *Portheus thaumas* whose mandibular ramus is a foot in length.

The ventral rays considerably resemble the pectoral, but are relatively weaker. The second and third are much smaller than the first, have a longitudinal rib on the side of one of the angles, and are scarcely flattened. The first is much flattened, and exhibits a sharp anterior edge, formed by the projecting border of the thinner half. The capitula of all the rays are strongly curved to a beak-like apex, bearing a tuberosity on the convexity in the two smaller ones. They differ from those of the anterior pectoral spines in the convexity of their articular facets, as they do not embrace the facets of the femur as do the pectorals those of the scapula. Like the latter, the dense superficial layer of bone is often finely striate-grooved.

ICHTHYODECTES, Cope.

Proceedings of the American Philosophical Society, 1870, November; Hayden's Geological Survey of Wyoming, etc., 1871, p. 421.

Teeth equal, subcylindric, in a single row, sunk in deep alveoli. Premaxillaries short. No foramina at the bases of the teeth on the inner alveolar walls. Vertebræ deeply grooved laterally.

The species of this genus are, so far as known, smaller than those of the last, and, as their remains are more perishable than those, form less striking objects among the fossils of Kansas. They are, nevertheless, very abundant, especially in species, five of which are now described.

The general structure in detail is much like that of *Portheus.* The maxillary bone is not contracted distally for a supernumerary bone, as in *Portheus.* The quadrate is similar, and the symplectic has a wide exposure on its outer face in *I. anaides.* An entire anterior spine of the pectoral fin of *I. anaides* is preserved, the halves partially separated (see Plate XLV, fig. 8). The superior half is wider than the inferior. and projects beyond it, forming the trenchant anterior border, which is roughened by a deposit of dense osseous material. The inferior half is but little thicker, and has an acute posterior border; its surface is delicately striate-grooved. The spine widens distally, and thins out to an oblique, irregular edge, and was doubtless continued as cartilage. A ventral spine accompanies the bones of *I. prognathus* and *I. multidentatus,* which is of a more robust form than the above-mentioned pectoral, but not so wide.

The vertebræ are deeply longitudinally grooved, as in *Portheus,* with the exception of a few of the anterior.

In a series of vertebræ similar to those of this genus, those included in the basis of the caudal fin are not more than three in number.

The species are distinguished as follows:

Premaxillary teeth 5, second most prominent; maxillary not concave; dentary with 30 teeth, and biconvex alveolar border, with obtuse extremity .... *I. anaides.*
Premaxillaries ?; maxillary straight, large, with 40 teeth; dentary straight, not produced at end; teeth 26 ...... *I. ctenodon.*
Premaxillaries 5, first most prominent; maxillary concave, narrow; teeth small; dentary with a hook at apex, teeth 25 .... *I. hamatus.*
Premaxillaries 7, first most prominent, compressed; smaller. *I. prognathus.*
Premaxillaries 12, second most prominent; the bone much narrowed above, smaller .... *I. multidentatus.*

The English species of this genus is figured by Dixon in the Geology of Sussex, Pl. xxxii, Figs. 9 and 9*. I can find no letter-press nor name relating to it, and cannot determine its specific characters from the fragmentary character of the piece of mandible figured.

Ichthyodectes anaides, Cope.

Indicated by two individuals: one with both dentary bones and teeth, with vertebræ; the other with many portions of cranium, fin-rays, vertebræ, and other elements more or less separated. The latter were all taken from the upper face of a spur of a limestone-bluff, elevated about five feet from the ground-level, where they were denuded and exposed as on a table.

It is the largest species of the genus, and the anterior premaxillary teeth are larger than the posterior. The *premaxillary bones* are oblique ovoids, very convex on the external face, thinning laterally and above. The superior margin presents a thickening bearing an articular surface, while behind it is an open gutter-like inflection. The large teeth are quite cylindrical. Both these bones are preserved. But part of the right *maxillary* remains. It is thickened above in front of the condyle, and is regularly convex at that point. The teeth are small, there being 10.5 in an inch. The margin is not concave.

The mandibular rami are preserved almost entire. They are short and deep, and have a short angular process, which is relatively shorter than in

Portheus. The margin rises steeply to the dentary, which presents a narrowed rectangle behind. The alveolar margin has two convexities, with a depression between; the symphyseal angle is not prominent. The lower posterior angle of the dentary is quite prominent for muscular insertion. The crowns of the teeth are cylindric, slightly curved inward. The dentary bones of the second specimen coincide with these in all respects.

Thirty-three *vertebræ* are preserved, all deeply two-grooved on the sides. The ribs are articulated by a sigmoid surface to a broad, short element of a sigmoid form, which is inserted in the lateral groove of the inferior face, or articulated by gomphosis.

The ventral spines already noticed are quite flat, without serrate edge, but with some rugosities near the edge on one side only. There are no grooves on the upper side, but the dense bone is delicately striate.

Measurements.

	M.
Length of the premaxillary	0.033
Depth of the premaxillary	0.045
Depth of the maxillary at the condyle	0.037
Thickness of the maxillary just behind the condyle	0.012
Length of the mandibular ramus	0.172
Length of the angular process	0.014
Depth at the coronoid process	0.058
Depth at the symphysis	0.041
Length of eight vertebræ	0.212
Width of the articular face	0.030
Width of rib	0.004
Width of the ventral spine at the middle	0.025
Length of the ventral spine (fragment)	0.155
Length of the condyle of the inferior quadrate	0.020

The scales associated with this species were thin and cycloid, and difficult to preserve.

From near the Smoky Hill River, Kansas.

Ichthyodectes ctenodon, Cope.

Proceedings of the American Philosophical Society, 1870, November; Hayden's Geological Survey of Wyoming, &c., 1871, p. 421, part.

Found by Professor Mudge on the North Fork of the Smoky Hill River; common in many other localities.

This species is established on one complete maxillary bone, and three-fourths of the other, a large part of the dentary bone, with the entire dental series, and numerous portions of cranial bones. These, according to Professor Mudge, were found together, and, to all appearance, belong to the same animal.

The dental characters differ from those of *Saurocephalus*, as above pointed out, and resemble more those of *Saurodon leanus*. The crowns of the teeth are more exserted and slender. The inner face of the crown is more convex than the outer; but there is no angle separating the two aspects. The apex is moderately acute, and directed a little inward, owing to a slight convexity of the external face. Enamel smooth. The alveoli are very close together, and are probably only separated in their deeper portions. There are forty-two teeth and alveoli in the maxillary bone. The superior condyle is low, and its anterior border falls opposite to the last tooth, or the indented surface which was occupied by the premaxillary bone. The more proximal part of the maxillary curves inward and backward behind the position of the premaxillary, more than in *S. prognathus*. The maxillary is a rather thin and narrow bone, with a broad obtuse and thinned extremity. Its superior margin is marked with one or more acute ridges, which look as though it had a contact with a large preörbital bone. The alveolar border is nearly straight.

The dentary bone is remarkable for its straightness and laminar character, and for the depth of the symphysis. The length of the latter is preserved, while posteriorly to it the lower margin of the dentary is broken away. The alveolar margin is slightly concave, and unites with the symphyseal at an angle of 65°. There are twenty-six teeth and alveolæ, which grow a little larger to the posterior extremity of the series; anteriorly, the alveoli are confluent externally, but, posteriorly, the septa are frequently complete, though thin. In neither this bone nor the maxillary are to be found the foramina along the bases of the teeth, characteristic of *Saurocephalus* or *Saurodon*, as pointed out by Harlan and Hays.

Measurements.

	M.
Length of the maxillary bone	0.158
Depth at the condyle	0.031
Depth at the extremity	0.022
Length of the crown of a tooth	0.0061
Diameter of the crown at the base	0.0038
Length of the alveolar border of the dentary	0.106
Depth of the symphyseal border of the dentary	0.047
Length of the opercular condyle	0.018

Several osseous ventral rays accompany the cranial bones; they are probably interior in position, and are much more slender than the ventral spines observed in *I. anaides* and *I. prognathus*. They are subquadrate in section, not sculptured nor enameled; there is a shallow groove on the side.

Ichthyodectes hamatus, Cope.

Represented by a considerable number of remains of an individual from the blue Cretaceous shale, near Russell Spring, on the Smoky Hill River.

The characters which distinguish this species from *I. anaides* are numerous; but they are less marked when compared with those of *I. ctenodon*, partly because the premaxillary bones of the latter have not been preserved. In the first place, the dentary bones of the two are of equal length, and support the same number of teeth, while the maxillary of *I. hamatus* is shorter, and supports more teeth; it is concave at the proximal part of the tooth-line, but is straight in the corresponding part of *I. ctenodon*. The end of the dentary is furnished with a strong obtuse process or hook directed upward and forward, not seen in *I. ctenodon*. The maxillary behind the premaxillary is in this species thickened, and with two articular surfaces; the proximal looking outward, the distal inward, and separated by an oblique ridge from the condyle. In *I. ctenodon*, there is but one smooth surface, gradually narrowing with the thinning of the bone from the condyle.

The *premaxillary* is less extended antero-superiorly than in the species already described, but supports, as in it, an articular face. There is no groove behind it, as in *I. anaides* and *Portheus*. It displays a surface for osseous articulation to near its extremity on the inner side; while below it, and on the external face, near the basis of the first and second teeth, the surface is rugose. Maxillary teeth, forty-three. The dentary supports twenty-five. The anterior hook is obtuse, and rises abruptly to above the apices of the crowns of the teeth. It is knobbed above, and supports a tooth not larger than the others.

All the cranial bones preserved are not sculptured.

Portions of the thin flat *ventral spines* display the delicately-grooved striation already observed, while the trenchant edge is bordered on one side by raised *longitudinal* striæ. The other side is minutely pitted.

The *vertebræ* are anterior, and without lateral grooves. Three of them are $0^{m}.06$ in length; an undistorted one is a little wider than deep, and the cup is $0^{m}.026$ across.

Measurements.

	M.
Length of the ramus mandibuli	0.174
Depth at the symphysis	0.055
Depth of the premaxillary (oblique)	0.043
Length of the premaxillary (oblique)	0.026

	M.
Depth of the maxillary at the condyle	0.027
Depth of the maxillary behind the condyle	0.023
Depth of the maxillary near the middle	0.027
Width of the ventral spine	0.031

This species and the two preceding were not very unlike in size; the two following are smaller.

ICHTHYODECTES PROGNATHUS, Cope.

Proceedings of the American Philosophical Society, 1870, November (*Saurocephalus*); Hayden's Geological Survey of Wyoming, &c., 1871, p. 417.

In this species, the premaxillary is more rhomboid in outline than in the others, and is less convex externally. Of its more numerous teeth, the first is not larger than the last, differing thus from all others of the genus; it is in line with the nearly straight anterior margin of the bone, and is more compressed than in the other species. The surface of the bone is peculiar in a minute sculpture of impressed lines, or lines of punctæ. There is a very small articular surface on the superior extremity.

This species is represented by a premaxillary and attached proximal portion of the maxillary bones of the right side, and by a large number of vertebræ and other bones. These portions were associated in the collections placed in my hands by Professor Mudge, and relate to each other in size, as do those of the preceding species and the *Ichthyodectes ctenodon.*

The premaxillary is characterized by its great depth as compared with its length, and by the shortness of its union with the maxillary. The palatine condyle of the maxillary reaches a point above the middle of the alveolar margin of the premaxillary. The latter contains alveolæ of seven teeth, the anterior of which only presents a perfect crown. It is elongate, compressed, equilateral, smooth, and acute. Its direction is even more obliquely forward than the anterior outline of the bone, which tself makes an angle of 50° with the alveolar border.

The vertebræ consist of cervicals, dorsals, and caudal's, to the number of about sixty, most of which are supposed to have been derived from the same animal. The grooves are as in *D. phlebotomus;* there being two below, two on each side, and two above. The latter receives the bases of the neurapophyses, which are in many cases preserved. The inferior pair of grooves becomes more widely separated as we approach the cervical series, leaving an inferior plane, which is longitudinally striate-grooved. This plane widens till the grooves bounding it disappear. The inferior lateral groove becomes widened into a pit, which some of the specimens show to have been occupied by a pluglike parapophysis, as in *Elops*, etc., or a rib-head of similar form. The neurapophysial articular grooves become pits anteriorly, and these only of all the grooves, remain on the anterior two vertebræ in the collection. Some of the posterior caudals preserve large portions of the neural arches and spines. They form an oblique zigzag suture with the bodies, consisting of two right angles on each, one projecting upward anteriorly, another downward behind. The neural spines are very wide and massive, and in close contact antero-posteriorly; these probably support the caudal fin. They are deeply and elegantly grooved from the basis upward. The centra exhibit no lateral grooves.

An unsymmetrical ventral fin-ray accompanied these remains, and, from its mineralization, color, size, and sculpture, probably belongs with them. The anterior margin is thinned, and with obtuse denticulations; the posterior truncate. The section is lenticular, with a deep rabbet on one side of the posterior edge; section at the base circular, apex lost. The sculpture consists of fine, longitudinal, raised striæ, which bifurcate and send numerous similar ridges to the teeth of the anterior margin. This ray differs from the corresponding one of *I. anaides* in its greater relative thickness, its anterior rugosity, and peculiar sculpture.

Measurements.

	M.
Long diameter of the spine	0.0245
Basal diameter of the spine	0.019
Length of two cervicals (not distorted)	0.033
Diameter of the anterior	0.021
Length of a dorsal	0.016
Length of a caudal	0.014
Width of the neural spine of the caudal at the base	0.012
Length of the alveolar margin of the premaxillary	0.022
Length of the anterior margin of the premaxillary	0.020
Depth from the condyle of the maxillary	0.026
Length of the crown of the premaxillary tooth	0.0042
Diameter of the crown of the premaxillary tooth	0.002

A fragment of a large flat bone exhibits very delicate radiating grooves, which are marked by spaced impressed dots.

From the North Fork of the Smoky River, Kansas, six miles south of the town of Sheridan. Prof. B. F. Mudge.

This species was about two-thirds the size of the species last described.

ICHTHYODECTES MULTIDENTATUS, Cope.

This species was first described from a premaxillary and part of a maxillary bone, from the Smoky Hill River; a second and more perfectly-preserved skeleton, obtained by Prof. Merrill from the headwaters of the Solomon River, adds much to our knowledge of it. The first-mentioned specimen was described as follows:

"In this fish, we have the convex *premaxillary* of the larger species, with more numerous (twelve) teeth than in any other of the genus. Those of largest size are the first three, the last being small. The second and third are about equally prominent, and more so than the first. The bone is much contracted above; there being an excavation on the anterior border, and contraction from behind. The superior edge is thin, and *without trace of articular surface.* Alveolar edge somewhat rugose. The *maxillary* is both narrow and thin, but is only partially preserved. It bears five teeth on $0^m.01$. One of these, with complete crown, displays a longitudinal angle on the antero-interior face. Length of the premaxillary, $0^m.039$; depth of the premaxillary (oblique), $0^m.023$; length of its tooth-line, $0^m.025$."

The second specimen is represented by a cranium with maxillary bone and scapular arch, vertebræ and ventral spines, etc. The specific characters are well exhibited in the dentition. There are thirty teeth and eighteen empty alveoli in the maxillary bone; and the anterior apex of the same, which is broken off, probably supported four additional ones. The crowns have a subround section, and differ from those of other species in being marked with shallow sulci and longitudinal angles and ridges. The most prominent ridges are, one on the middle of the external face, and one on the outer side of the anterior face, but there may be two or three on the outer face and on a few posterior teeth; the outer face is smooth. The fragment with tooth, above described as typical, belongs to the distal part of the jaw. There are shallow grooves at the bases of the crowns of most of the teeth.

The cranium has an elevated crest, which stands on the narrow median bone which I suppose to be supraoccipital. On each side, and just behind the crest, the parietal bone rises as a posteriorly-directed process. The epiotic also forms a strong latero-posterior angle. The pterotic extends roof-like on each side; its anterior part abruptly depressed below the posterior. The postfrontal forms a short transverse process, which is preceded by a concave excavation of its free border. The vertical position of the malleolar process of the prefrontal shows that this species possessed the subvertical mouth already ascribed to the *Portheus molossus.*

The scapula is much like that of *Portheus*, and in the specimen stands on a level with the orbit. The ventral spine is of relatively large proportions, and its superficial dense layer is marked with rows of delicate, impressed punctæ, which are sometimes confluent into grooves. The first cervical vertebra is unmodified and grooveless; the dorsal vertebræ are grooved. Length of cranium, $0^m.154$; diameter of first vertebra, $0^m.020$; depth of maxillary at middle, $0^m.023$; width of ventral spine, $0^m.020$; length of articular face of scapula, $0^m.031$; width of clavicle below scapula, $0^m.040$.

DAPTINUS, Cope.

This genus was proposed for *Saurocephalus phlebotomus*, Cope. The form of the crowns of the teeth is that of *Saurocephalus* and *Erisichthe;* but it differs from the latter in their perfect equality of size. It differs from the former in the position of the nutritious foramina of the inner side of the dentary bone; for, instead of forming an isolated series, as in that genus, they only appear as notches on the inner margins of the alveoli.

The mode of articulation of the premaxillary and maxillary bones with each other and with the prefrontals is similar to that already described in the genus *Portheus.* The maxillary underlaps the premaxillary on its inner face, forming a very extensive squamosal suture, and presents the two superior condyles, the anterior for the ethmoid, the posterior for the palatine bones. The palatine presents the malleolar segment which connects the maxillary and prefrontal articular faces, and then continues downward and backward, as a vertical lamina, without teeth on its free margin. Immediately in front of each of these bones is a triangular element, compressed, with an acute apex upward and truncate base downward, the posterior border in contact with the anterior edge of the palatine. The vomer is toothless.

The anterior vertebræ present pits for the neurapophyses, but no others, as far as the third. On the fourth and subsequent centra, there is a deep lateral pit, and a smaller one above and behind it, near, and a little posterior to the neurapophysial pit.

The teeth in *Daptinus* are not a little like those of the existing genus *Pomatomus*, which includes the bluefish.

DAPTINUS PHLEBOTOMUS, Cope.

Represented by all the tooth-bearing elements of three individuals, from distinct localities, with portions of crania and vertebræ. These show that the jaws are long and slender, and that the teeth are closely set, and with the roots but little compressed, while the crowns are very much so. Eight alveolæ may be counted in fourteen millimeters. The dentary bones have a vertical and transverse truncation at the symphysis, and are thickened so as to afford strong attachment for something; the absence of the usual obliquity in the one or the other direction is noteworthy. The teeth continue to the symphysis, but of slightly reduced size. The internal groove of the dentary is deep, and continued to near the symphysis. The cotylus of the articular bone is presented largely backward.

The premaxillary is a large oval plate, gently convex on the outer side, and of greater vertical than transverse extent. It differs from that of *Portheus* in lacking the condyle on the superior border. In the best-preserved specimen, a large piece is broken from its posterior alveolar border; in that which remains, nine alveoli remain.

In two of the specimens, the anterior part of the cranium is preserved. The anterior part of the ethmoid is broad and convex above, and rapidly contracts to an acute, flat apex. Laterally, it overhangs the fossa in which the anterior maxillary condyle enters, and furnishes a flat surface for the posterior condyle of the same bone. The vomer is excavated laterally in front, so as to be somewhat cross-shaped, the apex being rather produced. It is edentulous.

Measurements.

	M.
No. 1, depth of the premaxillary	0.054
No. 1, depth of the maxillary at the middle	0.025
No. 1, depth of the triangular bone of the palate	0.038
No. 1, depth of the symphysis of the mandibuli	0.026
No. 2, length of three anterior vertebræ	0.040
No. 2, diameter of one anterior vertebra	0.016
No. 2, depth of the dentary	0.041
No. 2, depth of the symphysis	0.026
No. 2, width of the ethmoid above	0.0155
No. 2, width of the cranium at the prefrontal facets	0.022
No. 2, length of the muzzle to the prefrontal facets	0.023

A third specimen consists of some vertebræ and portions of the cranium; the latter including the dentary, maxillary, part of the premaxillary, the palatine and vomerine bones, compressed into a mass by pressure, the separate pieces preserving nearly their normal relations. From the latter, the following characters may be derived:

Palatine bones toothless; teeth of both maxillary and dentary with compressed crowns, which are longer than wide at base, and closely placed; those of the dentary twice as large as those of the maxillary. Maxillary bone proximally deep; dentary shallower; the maxillary with elongate suture with the premaxillary behind.

The teeth are equilateral, without intermarginal groove or barb, and with smooth enamel-surface, or only minutely striate under the microscope. A series of larger foramina extends along the alveolar margin of the maxil lary and dentary bones, one foramen to each tooth. The alveolæ are confluent as they approach this margin.

There are three vertebræ, which present two pairs of deep longitudinal grooves, viz, two on each side, two on the inferior, and two on the superior face of the bone; the last receives the basal articulation of the hæmapophyses. The centra are crushed. Their measurements, with those of the jaws, are as follows:

Measurements.

	M.
Length of the centrum	0.025
Long diameter (crushed)	0.035
Short diameter (crushed)	0.0175
Depth of the maxillary bone anteriorly	0.031
Depth of the dentary bone anteriorly	0.015
Length of the crown of the inferior tooth	0.006
Length of the crown of the superior tooth	0.0046

Number of inferior teeth in $0^{m}.01$, 3; number of superior teeth in $0^{m}.01$, 4.5.

The vertebræ are about as large as those of a fully-grown "drum-fish," *Pogonias.*

From the yellow chalk of the Upper Cretaceous of Kansas, found on the Solomon or Nepaholla River, Kansas, at a point one hundred and sixty miles above its mouth, and in Trego and Rooks Counties, by Prof. B. F. Mudge, professor of natural science in the State Agricultural College of Kansas.

SAUROCEPHALUS, Harlan.

Leidy has pointed out the mode of implantation of the teeth in the typical species of this genus. The mode of succession of the teeth has not yet been indicated, but is well displayed in a specimen of the jaw of *S. arapahovius*, Cope. It is known from Harlan's description that a large foramen issues on the inner wall of the jaw, opposite each root. The fractured ends of the specimen exhibit the course of the canal which issues at this foramen. It turns abruptly downward between the inner wall of the jaw and the fang of the functional tooth, and not far from the foramen. Its course is interrupted by the crown of the successional tooth. This is situated obliquely as regards the long axis of the jaw.

It is thus plain that the successional appearance of teeth is different in this genus from what I have described in *Portheus* and *Ichthyodectes.* In them, the foramen is wanting, and the young crown rises within the pulp-cavity of the functional teeth, as in the *Crocodilia.* In this genus, on the other hand, it is developed outside of the pulp-cavity and fang of the old tooth, and takes its place, as in many *Lacertilia* and in the *Pythonomorpha*, by exciting the absorption of the latter. The conic form of these fangs in *Saurocephalus* is appropriate to such a succession, and their great length seems to preclude the nutrition of the young tooth from their bases. The use of the foramina on the inner face of the jaw is thus made apparent, viz, the nutrition of the successional teeth from without. I cannot trace the canal below the crown of the young tooth to the base of the pulp-cavity of the old tooth; and there are canals in the jaw below the latter, one of which probably carried the dental artery.

Species of this genus are less abundant in the part of Kansas examined by me than those of the preceding genera. Two only have been observed up to the present time, as follows:

SAUROCEPHALUS LANCIFORMIS, Harlan, *l. c.*

Medical and Physical Researches, 362; Leidy, Transactions of the American Philosophical Society, 1856, plate.—*Saurodon lanciformis*, Hays, Transactions of the American Philosophical Society, 1830, 476.

Established on a right superior maxillary bone, from a locality near the Missouri River. It differs from that of the other species in having a very elongate superior suture with the premaxillary bone, and in the very short dental crowns, which are as wide as deep. The largest species; known from the jaw only.

SAUROCEPHALUS ARAPAHOVIUS, Cope.

Established on a portion of a maxillary bone with a part of a suture, perhaps for attachment to a supernumerary maxillary. The size of the species is nearly that of *S. lanciformis*, and the crowns of the teeth are rather short, as in that species, and less elongate than in *D. phlebotomus*. The teeth are very closely set, and the fangs are separated by very narrow septa. The crowns are expanded so that the edges overlap in some cases. The form of these is much compressed; width about equal to height; the edges convex and acute. The enamel is smooth and without facets. The roots are without the facets shown by Leidy to exist in *S. lanciformis*, and appear to be longer than in that species, exceeding the length of the crown nearly four times. None are, however, perfectly enough exposed for complete measurement. As usual, there is a large foramen opposite each fang, below the inner alveolar margin; and, between the latter and the series of foramina, the surface is slightly convex and minutely rugose.

Measurements.

	M.
Depth of the bone	0.035
Thickness at the rugose band	0.0055
Total length of a tooth (?)	0.02
Length of a crown	0.0043
Width of a crown	0.0035
Number of teeth in one inch, 8.	

The size of this fish was probably about equal to that of the *Ichthyodectes anaides* above described.

The type-specimen was found loose on a bluff of blue shaly limestone, fifteen miles south of Fort Wallace, Kansas.

ERISICHTHE, Cope.

Proceedings of the Academy of Philadelphia, 1872, p. 280.

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

While this genus agrees with *Portheus* and *Ichthyodectes* in the absence of nutritious dental foramina on the inner face of the dentary bone, and especially with *Portheus* in the irregular sizes of the teeth, the crowns are compressed and knife-like, and closely similar to those of *Saurocephalus*. But the form of the maxillary is so different from anything known among *Saurodontidæ* as to render it probable that the genus pertains to another family-division.

The *Portheus angulatus*, Cope, from North Carolina, perhaps belongs to the genus *Erisichthe*, differing from *E. nitida* in its greater size and less degree of compression of the crowns of the large fangs.

Erisichthe nitida, Cope.

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

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

Measurements.

	M.
Length of the maxillary bone above	0.088
Depth proximally	0.030
Length of the crown of a large tooth	0.0150
Width of the crown at the base	0.0065
Length of the hyomandibular	0.1000

In size this fish exceeded all of the *Saurodontidæ* excepting the large species of *Portheus*.

Niobrara epoch of Phillips County, Kansas.

Discovered by Prof. B. F. Mudge.

STRATODONTIDÆ.

In this group, I have arranged several genera, which resemble *Enchodus*, the longest known of its forms. They are physostomous fishes, as indicated by the relations of bones of the superior arch of the mouth, the absence of spinous dorsal radii, the cycloid scales, and the general relationship to *Esox*. Agassiz and others have regarded some of them as allied to *Sphyræna*. This opinion was probably derived from a consideration of the forms of the teeth, which, to some degree, resemble those of *Sphyrænidæ* and *Trichiuridæ*. This is, however, like many other minor characters, one of those which appear in both of the great groups of osseous fishes.

In all of the genera, the maxillary bone is well developed, and supports teeth; but the extent to which it enters into the superior arcade of the mouth varies. It is shortest in *Empo*, and longest in *Pachyrhizodus*. The premaxillary is greatly extended in *Empo*, and shortest in *Tetheodus* and *Stratodus*. The teeth differ from those of the *Saurodontidæ* in their mode of attachment; instead of being inserted by long roots into deep alveoli, they are anchylosed by the base to the alveolar border of the jaw, which may sometimes be elevated on the outer side so as to give the roots a pleurodont attachment. This is the case in the genus *Pachyrhizodus*. Although a large amount of material representing the forms referred to this family has come under my observation, I have in no case seen any remains of spinous fin-rays; in the pectoral fins in place, in two specimens of *Empo*, spines are wanting.

The vertebral column is only known in *Empo*, where the caudal fin embraces three and possibly four centra, being thus a little more heterocercal than *Salmo*.

The genera are readily distinguished by the following, among other characters:

I. Premaxillary bone with several rows of teeth:
   Palatine teeth numerous, large; all with pulp-cavity.... *Stratodus*.
II. Premaxillary with two rows of teeth:
   Maxillary bone short; dentary with equal large inner teeth and outer rows *en brosse* .... *Empo*.
   Maxillary bone very long; one row of equal dentaries... *Pachyrhizodus*.
III. Premaxillary with one or no row of teeth:
   A large premaxillary fang; anterior maxillary and dentary teeth enlarged; cutting-edges not opposite; unsymmetrical .... *Enchodus*.
   Premaxillary toothless; anterior maxillary and dentary enlarged .... *Tetheodus*.
   Large anterior tooth with a cutting-edge in front and a shorter one opposite and posterior .... *Phasganodus*.

Owing to the fragility of many of the bones of the cranium, their characters remain unknown. It is, however, certain that none of the above-named genera present the prefronto-palatine articulation seen in the *Saurodontidæ*. For a similar reason, the structure of some of the fins remains unknown. In some of the genera, the body is protected by scuta as well as by scales.

PACHYRHIZODUS, Agassiz.

The genus as seen in our fossils is defined as follows: Muzzle flat; premaxillary bones rather long, with two larger teeth together near the anterior end behind the usual external series; maxillary and mandibles with single series of simply cylindric subequal curved teeth; mandibular rami closely articulated by a ligament. The teeth possess short stout fangs, occupying alveoli, of which the inner side and part of the anterior and posterior walls are incomplete. The teeth are, in fact, more or less pleurodont, but the extremity of the root is received into the conic fundus of the alveolus. They bear a superficial resemblance to those of a mosasauroid genus. Their mode of succession appears to be as follows: The crown of the young tooth was developed in a capsule at the base of the crown, or on the inner side of the apex of the thick root. The absorption which followed excavated both the former and the latter; but the crown was evidently first shed. Finally, the old root disappeared, and the new one occupied the alveolus, leaving a free separation all round. Finally, on the accomplishment of the full growth of the root, it became anchylosed to the alveolus all round. The pleurodont position of the tooth facilitated the shedding of the root very materially.

The premaxillary bones are well developed, but the maxillaries are more so, and enter largely into the composition of the border of the mouth. There is a well-developed angle of the mandible, but no coronoid bone.

Well-preserved fragments of a large specimen of *P. latimentum* include a number of bones whose relations are not readily determined. A subrhombic element, with a sutural edge turned ?upward, and the ?upper surface sculptured with ridges, has a small patch of teeth *en brosse* on the ?lower face. An elongate bone, with gently concave longer sides and crenate edges, is very dense; perhaps a preörbital. A large flat parallelogrammic bone, with a narrow articular surface at both ends, the one shorter than the other, with thin lateral borders, is possibly interopercular. The hyomandibular has its pterygoid articular border forming an obtuse angle with that for the inferior quadrate, and the latter a right angle with the line of junction with the operculum. Between the latter is a concave border marking half a circle. If the relations of this piece be properly determined, there is no peduncle for the operculum.

More complete specimens of species of this genus show that vertebræ of the type which I have described (p. 240) under the name of *Anogmius* belong to them.* The latter name may be used for this genus should it be ascertained that our species cannot be included in the one typified by the European *Pachyrhizodus basalis*, Dixon.

The posterior half or more of the cranium of a species allied to the *P. latimentum* is preserved, with both the maxillary bone and teeth, and the basioccipital element separated from its connections, adherent. Above, the latter exhibits two subtriangular articular faces in close contact, for the exoccipitals. Below, there is a strong median carina, or crest, which is strongly grooved on the free margin; this groove probably represents the muscular tube. The exoccipital facets stand on a horizontal triangular face; but, in front of this, the sides of the bone are beveled to the plane of the base, for sutural adaptation to the proötic, etc.

The structure of the superior walls of the skull may be largely discerned in this specimen. The cranium is flat and wide, and pressure has probably somewhat increased the effect in this instance. Exoccipital, supraoccipital, epiotic, pterotic, parietal, and frontal bones are clearly distinguishable; but there are points at which the sutures are obscure. The best defined are the epiotics, which are subtriangular bones, presenting the apex inward, and bearing a small round facet for the supratemporal on the posterior angle. The pterotics and postfrontals may be easily distinguished from adjoining bones, but not so well from each other. They have a thin outer margin, and their upper surface is marked by bands of irregular small fossæ, and an obtuse, longitudinal ridge. The middle line of the skull is occupied by the supraoccipital. Its proximal portion probably separates the exoccipitals, but this is not certain. It extends well forward, and the line of separation from the frontal is not well defined. Its anterior part has a massive transverse elevation, which sends a short median process backward, producing a T-shaped body; the frontal suture is probably in front of this. The supraoccipital is contracted behind this body, and its postero-exterior suture presents a remarkable peculiarity in a straight and wide truncate articular face. This is opposed by a corresponding face of the parietal bone; the latter is of an irregular form, and carries on its outer portion next the pterotic

* As suggested Proceed. Amer. Philos. Soc., 1872, p. 355.

a stout protuberance. This is at the inner end of a strong ridge, which disappears near the outer edge of the pterotic. The protuberance looks as though adapted for an articulation. The frontals send a process backward, between the "supraoccipital" and the pterotic or postfrontal, to the base of the tuberosity of the parietal. The suture between the exoccipital and parietal is not clear. A suture is distinct enough, bounding the latter behind, but whether an expansion of the supraoccipital intervenes or not is not certain. The exoccipitals appear to be flat and quadrant-shaped, having convex antero-lateral borders. Each bears a strong condyle.

An isolated bone has the appearance of an ethmoid, or more probably a vomer. It is cross-shaped, with the entering angles roofed by the continuous margins, nearly flat on one side, and convex and rough on the other (? superior) side. There are two parallel fossæ on the under side of the subconic apex, and four just behind the cross-arms (two external large, and two median small). There are no teeth.

The structure of the skull in this genus greatly elucidates that of the *Saurodontidæ*, the cranium of an unknown species of which is figured on Plate XLVII, figs. 7–8. It seems to possess the same composition posteriorly, but to be so extended horizontally as to render the identification of the component parts much more easy. From a comparison of the two, it appears that the bone supporting the crest on each side of the middle line is the parietal, and as such bears an articular facet for the supratemporal. That bearing the inferior facet of the same, becomes the epiotic. The T-shaped bone of *Pachyrhizodus* (*Anogmius*) is homologous with the anterior basis of the median crest of the *Saurodontidæ*, which exhibits a section of this form; and we may suppose that this element in *Pachyrhizodus* does not belong to the frontal bone, but to the supraoccipital.

The rootless teeth, and, perhaps, the exoccipital condyles, separate this form as a distinct family from the *Saurodontidæ*, while the exoccipital condyles, and parieto-?occipital articular facets, are not found in *Enchodus* and its allies.

This genus was of less rapacious habits than the *Saurodontidæ*, and is of less powerful construction. It was probably a bottom fish, with habits something like those of *Batrachus*, to which the known parts, especially the teeth, bear some resemblance.

This genus was established by Professor Agassiz on a jaw-fragment from Sussex, England, with a brief description. The Kansas remains resemble this fragment in their corresponding parts, and I refer them to the same genus for the present.

The genus *Conosaurus*, Gibbes, from South Carolina, is perhaps allied to this one. Its dentition is fully described by Leidy, who changes the name to *Conosaurops*, mainly on account of the inappropriateness of the Greek *σαυρος* to a fish. This word was, however, employed by the ancients to designate a fish; and the only use made of the word, out of composition, by modern zoölogists, is for species of that class, so that it does not seem improper to use it here.

Three, perhaps four, species left their remains in the strata examined by the expedition.

Pachyrhizodus caninus, Cope.

Established on portions of perhaps two individuals, which embrace one nearly complete maxillary bone; two premaxillaries of opposite sides; two nearly perfect rami of the mandible, with numerous other portions in a fragmentary condition.

These indicate a cranium of about a foot in length by six and a half inches in width, oval in outline, with moderately obtuse muzzle. The mandibular teeth are directed somewhat outward. The premaxillary is horizontal in front, and the maxillary narrow. From these facts, I derive, that the head was probably depressed, as in the modern *Sauri*, and very different from the prevalent compressed form of the *Porthei* and allies.

The *premaxillary* is several times longer than wide; posteriorly, it is a subvertical plate; anteriorly, it terminates a narrow obtuse portion. Just behind this portion, it is enlarged on the inner side, forming a knob whose upper surface supports the articulation with the ethmoid. It supports the two large teeth below on a common elevation of the jaw. The outer margin of the bone supports ten subequal teeth, which are one-third smaller than the posterior pair. The outer alveolar ridge is a little more elevated than the inner, though a little less so than on other bones which support teeth. The external face of the bone is nearly smooth, and the inner unites with the maxillary by striate squamosal suture.

The *maxillary* preserved is nearly perfect, and may belong to another animal; its depth coincides with that of the premaxillary. It is quite elongate; about nine times as long as deep; perhaps a little more. It supports forty-two closely-packed teeth, not all in functional service at once. The distal end is contracted and grooved, and ridged on the inner face, as though for union with a supernumerary bone. The external face is longitudinally striate on the posterior half; the striæ running out to the margins, forming sharp rugosities on the alveolar border. The superior (?palatine) articular surface is more than one-fourth the total length from the anterior extremity; it is narrow, and somewhat lens-shaped. Both behind and in front of it, strong striæ run from the outer to the inner side of the superior margin sublongitudinally. Posterior to the superior articular surface on the outer face is a swelling like a muscular impression, from which grooves and keel extend posteriorly. The bone is concave on the outer face in front, to accommodate the *os premaxillare*.

The *mandibular rami* are abruptly incurved at the symphysis, which is not serrate, and is subround, with an emargination entering from the inner inferior side. The dentary bone is much narrowed behind. The *angular bone* extends anteriorly on the inner face to the end of the posterior two-fifths of the dental line. The ramus is not very deep at the coronoid region. The articular cotylus is composed more largely of the angular than the articular. Its long diameter extends inward and backward, and is strongly convex; in the transverse direction, slightly concave. Below and in front of it, the lower margin of the jaw is acute. The angle is oval and rather small; it is prominent on the middle line on the inner side; the edges are thin, the upper curved outward, concealing part of the cotylus. There are twenty-nine teeth on the dentary, whose sizes diminish toward its extremities. Their roots are very large and longitudinally striate and porous. Opposite the interval between the first two teeth, there is a tooth exterior to the general row, and another on its inner side. They are not enlarged.

No *teeth* are preserved except on the maxillary. These are not very elongate cones, with round section, and well curved inward. Dense external layer entirely smooth.

This species differs from the type *P. basalis*, Dixon, in that the radical portion of the tooth is less swollen and more conic, and does not project above the exterior alveolar wall, as in that fish.

Measurements.

	M.
Total length of the mandibular ramus	0.267
Total length of the tooth-line	0.170
Transverse diameter of the symphysis	0.018
Transverse diameter of the base of a tooth	0.004
Length of the premaxillary	0.063
Length of the premaxillary to the large tooth	0.010
Greatest depth of the premaxillary	0.019
Diameter of the large tooth at the base	0.007
Length of the maxillary to the first tooth	0.171
Depth of the maxillary at the first tooth	0.019
Depth of the maxillary at the last tooth	0.014
Depth at the articular surface	0.0245

Found by the writer near Fossil Spring, near Fort Wallace, in Western Kansas.

PACHYRHIZODUS KINGII, Cope.

Established on the proximal portion of a maxillary bone with the articular surface and bases of twelve teeth. It is a species of nearly the same size as the last; but the bone contracts more rapidly than in that one, and presents a stronger interior longitudinal ridge. The superior articular face is smaller and narrower, being subcrescentic, while the insertion-like tuberosity is nearer, and on the inner edge of the outer face, and connected with the articular face by a ridge, and not separated by a groove, as in *P caninus.* The outer face is depressed below the articular face much more than in that species, so that its lower portion becomes more convex. The roots of the teeth are of the same length as in *P. caninus*, and, as they are more numerous, they are more closely packed and more cylindric. Their pleurodont character is also more strongly marked. The superior surface of the bone is striate-grooved longitudinally, not transversely nor obliquely. Total depth of bone at superior articular face, $0^{m}.022$; depth at tenth tooth, $0^{m}.0155$.

This species was found near the preceding. It is dedicated to Dr. William Howard King, post-surgeon at Fort Wallace, to whom, and not less to his excellent wife, I am indebted for hospitality and other assistance of a kind essential to the success of my explorations in Western Kansas.

PACHYRHIZODUS LATIMENTUM, Cope.

Represented by both mandibular rami and numerous lateral cranial bones of a specimen from the Solomon River, and a portion of a mandible from the Smoky Hill, Kansas. The rami are relatively deeper than those of *P. caninus;*

and the shallow wide symphyseal surface is divided by a deep groove from the outer side, into which opens the mental foramen. There are two external planes of the dentary: the superior, or narrower, supporting the teeth, is bounded by a shallow groove below; the inferior and deeper plane terminates in a free, thin edge, excepting near the symphysis, where it is a little thickened, and stands at an angle of 45° with the symphyseal surface.

The dentary is deeply doubly emarginate posteriorly, to receive the large angular; the upper emargination is in the superior plane, the inferior in the inferior, and the ramus is deepest at the fundus of the notch. From the two posterior apices, the ramus contracts gradually, the inferior border to the end of the long oval angle, the superior outline abruptly to the cotylus. The upper plane behind the upper emargination is occupied by a large longitudinally-oval fossa. A dentary, from which about an inch has been broken from the posterior upper end, supports thirty teeth, with one on the symphysis within the anterior one. From their reduced size, I suspect that the posterior teeth of the specimen were not followed by others. The crowns are conic, without cutting-edges, with smooth enamel, and strongly incurved.

Measurements of No. 1.

	M.
Length of the mandibular ramus	0.305
Depth of the mandibular ramus at the last tooth	0.060
Depth at the coronoid angle	0.065
Depth at the cotylus	0.019
Width of the symphysis	0.022
Length of the crown of a tooth	0.009
Length of the root of a tooth	0.010
Length of the hyomandibular bone	0.074

This species is about the same size as the *P. caninus*. The coronoid angle of the mandible is elevated above the cotylus 45^{mm}; in *P. caninus*, of the same size, 25^{mm}.

In the second specimen, the general form appears to have been deeper than in the *P. caninus*, while the size of the teeth is similar. The external face of the bone near the alveolar border is convex, and not particularly rugose. The external alveolar wall is well elevated above the inner. Below the latter, the dentary bone exhibits a strong longitudinal ridge. The extremity of the dentary takes a wider curve from the symphysis than in *P. caninus*, giving a broader chin (whence the name) and muzzle. The symphyseal surface is smooth, transverse trilobate; the two outer lobes being separated by an emargination in the position of the foramen mentale. This form is very different from that in *P. caninus*, where the symphyseal surface is subround.

The anterior teeth are smaller than the median, and have the inner alveolar wall nearly as much elevated as the external. The crowns are scarcely distinguishable from those of the *P. caninus*, being curved-conic, with round section and smooth cementum. They form an incurved row next the symphysis, and a single tooth stands within the anterior one. Number of teeth in an inch at middle of ramus, 4.5.

PACHYRHIZODUS SHEARERI, Cope.

Associated with the bones of the *P. caninus* is a slender bone of oval section, which is marked on one edge by twenty-two transverse alveoli, whose outer margins are a little higher than the inner. No teeth preserved. It may belong to a fish of this genus, and is probably a superior maxillary bone. Consistently with this position, its outer extremity is more compressed than the proximal; the thickening being especially seen in the superior margin. A shallow concavity passes obliquely across this border from within outward and distally, as in *P. caninus;* but the articular face is not preserved. There is a longitudinal angle on the external face; and the superficial layer of bone is nowhere grooved or rugose. The pleurodont character of the tooth-attachment is more marked proximally. Length of piece, $0^{m}.041$; vertical diameter, $0^{m}.007$; greatest transverse diameter, $0^{m}.0033$.

This species is dedicated to Doctor Shearer, assistant post-surgeon, to whose interest in the subject the geology of Kansas is indebted to many useful discoveries.

PACHYRHIZODUS LEPTOPSIS, Cope.

Represented by portions of the right and left dentary bones, with other portions of the cranium. The symphyseal part of the ramus is not incurved as in *P. caninus* and *P. kingii*, but is obliquely truncate, indicating that the chin had a compressed form, and was not rounded, as in them. The lower portion of the bone is thin and laminiform, to a deep groove, which extends from the edge of the symphyseal face, along the inner side, at one-third the depth of the ramus from the inner bases of the roots of the teeth. The latter are thus supported on a thickened basis. They are rather remote in a functional condition; each interspace being entirely occupied by the alveolar fossa of the shed tooth. These bases are very stout, and composed of dense bone; their apices rise a little above the edge of the external alveolar border. The bases of the crowns are oval, and they display an anterior cutting-edge, which descends from the apex, thus differing materially from those of the *P. caninus.* The teeth diminish in size from the middle of the dentary bone to the symphysis; besides the latter are two teeth of reduced size. The outer face of the dentary is smooth, except some small impressed fossæ. The mental foramina are small, and do not issue in a groove. Below them, on the outer face, is a fossa, with level floor to the inferior margin.

Measurements.

	M.
Length of the margin bearing four teeth	0.050
Depth of the ramus at the third tooth	0.025
Elevation of the tooth-basis	0.008
Long diameter of the base of the crown on the same	0.006

STRATODUS, Cope.

This genus is well characterized by its dentition, which is remarkable for the small size and large number of the teeth, and their peculiar form. I possess one premaxillary, a considerable part of the maxillary, and nearly the whole of both palatines, besides other bones, of one species. I have, unfortunately, no dentary bone of *Stratodus.* The outer row of palatines resembles, in some measure, those figured in *Cimolichthys levesiensis,* Leidy, by Agassiz.

The premaxillary teeth are in two series. They are stout at the base and oval in section, and are contracted and flattened rapidly upward. On this basis is set an oval, sharp-edged, flat, or spade-shaped crown; the long axis of compression being placed at right angles to that of the compression of the apex of the base. This gives a barbed appearance. The *maxillary* teeth are similar in form, but are in but few rows. The *palatine* teeth are constructed on the same plan, but they are longer, and the bases are subcylindric and slightly curved. All the teeth possess a large pulp-cavity.

The *premaxillary bone* displays some of the density of composition seen in *Enchodus.* Its upper anterior surface meets the inferior at an acute angle It is a broad oval, and is slightly concave. The inner face forms a truncate rim round the bases of the inner teeth, and terminates in a vertical crest of dense bone. The external face is, on the other hand, perpendicular, and extends obliquely upward and backward. An acute anterior angle of the *maxillary* underruns it below, so far as to exclude all but one or two of the premaxillary teeth from the outer row. The external lamina of the premaxillary forms an extensive squamosal suture with this part of the maxillary by overlapping it from above. This arrangement shows a certain similarity to *Esox*, especially in the large number of palatine and small number of maxillary teeth. It differs materially in the lack of articular surfaces between the maxillary, palatine, etc., in the upward prolongation of the premaxillary, and the peculiar forms of the teeth.

STRATODUS APICALIS, Cope.

Established on one incomplete individual, as above mentioned.

The maxillary teeth are mostly smaller than the premaxillaries, and diminish in size posteriorly; there are four or five series of them anteriorly; seven to nine rows on the palatine bones; they are slender, and curved downward from oblique bases, and cylindric in section; they contract to a neck, and then expand into the ovate spade-shaped cutting apex. They are in every respect the largest of the teeth, some reaching a half-inch in length. Those on the inferior or outer margin are most slender; those of the inner stouter and more conic. All the spade-like apices are black in the specimen, while the shanks are pale, except the premaxillaries. The *palatine bones* are flattened in one plane, and contracted at both ends. At the anterior, there is an external concavity, perhaps for maxillary or premaxillary. A ridge divides the upper surface lengthwise; the outer edge is thinned posteriorly, and there are three long grooves which extend to the posterior extremity, probably for sutural union with the pterygoid. The *premaxillary* bears a slight resemblance to the mandibular bone of a chimeroid turned upside down.

Measurements.

	M.
Length of a portion of an *os palatinum*	0.128
Length of same restored	0.148
Greatest width	0.020
Greatest thickness on the margin	0.003
Length of the premaxillary (fragment)	0.043
Length of the premaxillary, inner side	0.025
Length of the premaxillary, outer side to the maxillary	0.012
Width of the premaxillary in front above	0.010
Length of a premaxillary tooth	0.005

This fish was considerably larger than *Esox reticulatus* or *E. lucius*. In the lack of mandible, its habits cannot be fully inferred; but the armature of the superior bones of the mouth is less powerful, relatively, than in those fishes.

Found by myself in the blue limestone near Fort Wallace.

EMPO, Cope.

This genus is represented by very numerous remains in the chalk of Kansas, and a considerable amount of material pertaining to it has come under my observation. The best-preserved remains are vertebræ and the jaws; all other portions of the skeleton are so fragile as to be difficult of extraction from the matrix, but a few specimens preserved by the care of Professor Mudge, of Kansas, have thrown especial light on these little-known parts of the structure.

The *premaxillary bones* are longer than in any other genus here described, and terminate anteriorly in a compressed-conic apex of dense bone. Medially, they have greater transverse thickness and a semicircular section; while, distally, they are compressed, and extended vertically. There is an unsymmetrical crest on the superior border, the only point of contact with the ethmoid. The maxillary is continuous from this point, and is usually attached by the coössification of a squamosal suture. It is vertical and flat, and probably of no great extent. The extremity is broken off in the specimens. While the premaxillary supports two series of teeth, the maxillary presents but one.

The *dentaries* support several series of teeth; one of large ones on the inner side, and several smaller on the outer. The small ones are double-edged, and diminish in size to the external margin; the inner ones are like the large ones of the maxillary series, with a flattened cutting apex. A striking character observed in two species of the genus (*E. nepæolica* and *E. semianceps*) is the absence of any angular process of the mandible; the narrow angular bone being truncate vertically from the transverse cotylus.

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

The teeth of the larger class are without pulp-cavity. The indication of the mode of succession of the teeth is furnished by various specimens. The crown of the successional tooth appears in a small excavation on the inner side of the basis of the tooth. The absorption, commencing at this point, no doubt removes the basis, so that the crown falls away.

A specimen of *E. nepæolica* exhibits the cranium from the inner side. The frontals are distinct; the pterygoids and ectopterygoids are displayed, with a series of teeth standing either on the anterior part of the latter or on the posterior part of the palatine bone. Posterior parts of crania of *E. nepæolica* and *E. semianceps* show that the muscular tube was not open, and probably did not exist; although a shallow fossa in the base of the basioccipital marks its position. There is no articular surface on the side of the basioccipital for the extremity of the lower limb of a post-temporal. The supraoccipital projects forward in a quadrate plate on the superior cranial surface, and sends out a high crest from its *posterior* face, which bears a fossa on each side of the superior base of the crest. In a specimen of *E. semianceps*, where the quadrate and adjacent bones are well preserved, I cannot discover any symplectic.

The cervical vertebræ are separate, and not modified in structure. They present large fossæ for pleurapophyses on the inferior face, except the first, which, in *E. nepæolica* and *E. semianceps* (sp. No. 2), present two short parallel crests directed downward. The anterior dorsals are marked with narrow grooves and ridges laterally, which finally give place to a nearly smooth or only line-grooved lateral face on the greater part of the column. Posteriorly, deep lateral grooves appear, which extend to the end of the series. Excepting a short distance anteriorly, the neural canal is bounded by a vertical lamina on each side; the neurapophysis rises from the centrum outside of this, and, forming a strong rib on the lamina, rises to unite with its fellow. A corresponding lamina bounds the hæmal canal of the caudal vertebra, and the hæmapophysis appears as a rib on its outer side, and then joins the corresponding one of the opposite side. There are vertebræ included in the caudal fin.

The ribs are well developed, and the abdominal cavity not elongate. Ventral fins are not visible in the abdominal position in the best-preserved specimen of *E. nepæolica.* No strong fin-rays can be certainly referred to the genus. The pectoral fins are attached to the lower part of the clavicular arch. The body was covered with very large scales on the side and on the middle line of the back; some of the latter having the character of shields. They have the surface, in some species, marked with raised radiating ridges, or inosculating ridges, whose edges are sometimes serrate. In a specimen without a head, probably to be referred to the *E. semianceps*, the posterior part of the side near the tail is covered with large, thin scales, with radiating ridges on the exposed surface, which do not reach the edge. Some of them bear the groove of the "lateral line;" but whether this was above or below the vertebral axis cannot be ascertained. On the abdominal region of the same specimen, there are three longitudinal rows of rhombic scuta: the two inferior nearly in contact; the upper separated by a short interval. The apices are directed forward, and the surface has a reticulate sculpture. In another species, they appear to be smooth.

The anterior part of the vomer is unknown I have, on a former occasion, called the premaxillary bone the maxillary, and referred a premaxillary bone of a species of *Enchodus*, found mingled with bones of the *E. semianceps*, to this genus. The true premaxillary and maxillary being coössified in this genus, I was long in discovering the real structure, which is described above.

I formerly referred some of the species of *Empo* to the genus which embraces the fish called by Leidy *Cimolichthys levesiensis;* but I find that they do not possess the same type of teeth. The *Empo nepæolica* belongs to it. The generic characters originally assigned to the latter express the peculiarities of dentition of the distal part of the premaxillary bone. The genus therefore takes this name. From several allied genera here enumerated, it differs in the presence of the outer series of small teeth on the dentary bone, and the inner series of the maxillary, with the absence of long teeth on the front of the former.

EMPO NEPÆOLICA, Cope.

Represented by many specimens; the most perfect embracing a crushed cranium, with body nearly to the posterior part of the abdominal cavity. The cranial bones are light, and sculptured on the upper and external faces with raised radiating ridges. There are large rhombic scuta on the dorsal region and middle of the sides, which have radiating sculptured ridges; no scuta below the line of the vertebræ are preserved on the specimen. Up to the fourteenth vertebra, the neural canal is not bounded by vertical laminæ. The neural spines are expanded on the anterior base, as in many recent fishes. The centra are grooved-striate, and without large longitudinal fossæ anterior to the thirteenth.

The premaxillary bone is somewhat curved in a longitudinal direction. At its anterior extremity, there is a short series of large teeth, which continues gradually or abruptly into a series of much smaller teeth along the inner or posterior border of the alveolar face. This terminates in one or two abruptly larger teeth near the distal end of the bone. The outer alveolar border is occupied by a row of teeth of large size, similar to those at the proximal end, which commences opposite the most distal of the latter. Their size is reduced opposite to the two large distal ones, and is recovered again in the single row on the narrow distal portion of the maxillary. The teeth are compressed at the tip, and generally bear one or more cutting-edges.

The dentary bone would support about twenty large teeth, directed obliquely inward and upward, were they placed at regular distances; but they are in all specimens unequally spaced, owing to frequent shedding and replacement. The bases of the teeth are round, and the crowns become compressed to the tip. They are strongly curved backward, and acute. The anterior margin is particularly convex and acute, forming a cutting-edge; but there is no edge on the posterior face. The surface is rather finely striate-grooved on the inner and posterior faces. The teeth of the exterior series are in several rows; that next the large teeth being considerably larger than the others. They are curved inward, and are flattened, having cutting-edges on both anterior and posterior margins. Cementum smooth. The external smaller teeth are shorter in relation to their length, not curved, and two-edged.

The dentary bone is narrow wedge-shaped, contracting regularly to the symphysis, and is thickened just within the inferior margin. The symphyseal surface is small, and presents a marked fossa. The external face of the bone is divided by a deep longitudinal groove, which is overhung by the produced extremity, and which gives exit to the mental foramen. The external face of the dentary has an impressed groove along its lower third anteriorly, and its surface is sculptured with deep longitudinal sulci, which often run together.

Measurements.

	M.
Length of a fragment	0.28
Depth at the first tooth	0.01
Depth at the seventh tooth	0.028
Depth at the eleventh tooth	0.040
Total elevation of the fifth tooth	0.041

The restored cranium of this fish is about one foot to eighteen inches in length. It is of lanceolate form, with a very wide gape of mouth, which opens terminally. The entire length of the fish, estimated on the basis of *E. semianceps*, would be about forty inches.

EMPO MERRILLII, Cope.

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

Measurements.

	M.
Width of the maxillary inferiorly at the middle	0.012
Depth of the maxillary distally	0.018
Depth of the maxillary proximally	0.011
Depth of the ?palatine	0.018
Width of the tongue-shaped bone at the middle	0.009

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

EMPO CONTRACTA, Cope.

Considerable portions of a cranium of a species of the lesser size of the *E. semianceps* resemble corresponding parts of that species, with certain marked exceptions. These are seen in the flatness of the maxillary bone, and the large size of the inner row of teeth. The inner face of the premaxillary is very narrow, by reason of the depression of form. The proximal end of the same is, on the other hand, a little compressed. A single row of large teeth occupies it, extending along the inner alveolar border. Those of the outer row appear to be wanting for a considerable distance, and are at first no larger than those of the inner. On the outer face, at the distal end, the usual fossa on the upper half is wanting; the face from the alveolus being continuous with that of the rising lamina. The tongue-shaped bone is flat, and expanded behind. The dentary is acuminate distally; and the mental foramen issues in a groove, which passes round the distal end. The inferior external fossa commences some distance behind the foramen. External face of dentary striate.

Measurements.

	M.
Length of the premaxillary and maxillary (reconstructed from fragments from opposite sides)	0.118
Width below at the middle	0.011
Depth of the inner face	0.004
Depth of the outer face	0.011
Length of the bases of five proximal teeth	0.027
Width of the tongue-shaped bone at the middle	0.010
Depth of the dentary 2mm from the end	0.012

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

EMPO SEMIANCEPS, Cope.

Represented by numerous specimens of various individuals from the Kansas chalk. These embrace all the cranial bones in a fragmentary condition, several vertebral columns, and scales.

These belong to smaller individuals than those referred to the *E. nepæolica.* Characters of the species are to be seen in the ?pterygoid and larger mandibular teeth. The former are minute, and cover one side and margin of the bone *en brosse* without larger series. The latter have a cutting-edge on the posterior aspect of the apex as well as on the anterior. It extends but a short distance, while the anterior rises near the base, and is strongly convex. The tooth curves backward; the base is round in section. The convex posterior and inner faces are rather finely striate-grooved. The larger teeth of the external series are convex on the inner face; they are two-edged, and slightly incurved.

The outer face of the *dentary bones* is strongly longitudinally parallel-sulcate. The inner face and the surfaces of all the other bones are minutely striate, exactly as in some of the Mosasauroids. The anterior extremity of the *premaxillary* is straight on one side, and obliquely beveled on the other to an obtuse compressed apex. The bevel becomes subvertical posteriorly, supporting teeth much as in *E. nepæolica.* Two of its anterior teeth are a little larger than those that follow. The supposed *pharyngeal* is narrowed to a beak posteriorly, and presents an elevated longitudinal and obtuse ridge on the middle line. This supports a row of nine teeth, five of them having mates. The bone expands at the other end for a squamosal articulation with other elements. The pharyngeal teeth are smaller than the larger dentaries.

The *caudal vertebræ* are elongate, and much contracted medially; the rims of the cups are thickened, and the cups themselves very deep. There is a trace of a single median longitudinal groove. The neural and hæmal arches are represented by broad longitudinal laminæ in the specimens. The vertebræ are thus very different from those of the *Saurodontidæ*.

In a second specimen, with jaws and vertebræ, the pharyngeal bone is a tongue-shaped piece, wide and flat at one end, and contracting to a narrow apex, with subtriangular apex. A series of sixteen teeth and bases extends from near this point backward. The superior half of the dentary bone is almost smooth; the symphysis quite narrow and acuminate. The cranial bones are marked with radiating ridges, which are delicately denticulate.

In a specimen represented by a nearly entire vertebral column, we count forty-three vertebræ, of which twenty-three support entire hæmal arches. The anterior two-thirds of these are the longest of the series; the centra shortening in both directions, most rapidly to the caudal fin. The middle part of the side of the centrum is entire on all but the last fourteen or fifteen, where it is marked by a deep longitudinal fossa. The dorsal centra are marked with several narrow grooves and ribs laterally.

There are three series of elongate diamond-shaped scuta on the sides of the abdomen opposite the dorsal vertebræ of this specimen. Their surface is radiate and concentrically rugose-sculptured. On the anterior caudal vertebræ, the neural and hæmal laminæ are higher in front of the spine than behind it. On the posterior dorsals, there is a short, slender process, projecting forward from the middle of the centrum below, at right angles to the ribs. Neural spines and ribs slender.

Measurements of No. 2.

	M.
Length of the dentary to the twelfth large tooth	0.067
Depth of the dentary at the first large tooth	0.005
Depth of the dentary at the tenth large tooth	0.020
Depth of the ? pterygoid bone	0.018
Thickness of the ? pterygoid bone	0.003
Diameter of the occipital cotylus	0.014
Length of the four anterior cervicals	0.056

Measurements of No. 3.

	M.
Length of eighteen of the dorsal vertebræ	0.275
Length of eighteen of the caudal vertebræ	0.320
Depth of the head at the opercular borders	0.155
Longitudinal width of the operculum	0.050
Length of the abdominal dermal scutum	0.050
Width of the abdominal dermal scutum	0.014

Numerous specimens from Professors Merrill and Mudge, and collected by myself during the expedition of 1871.

PHASGANODUS, Leidy.

The characters of this genus are as yet but little known; but isolated teeth may be known by the existence of a straight cutting-edge in front, and shorter one extending downward from the apex behind, to different lengths in the different species. The form is near to *Enchodus*, especially in the elongate anterior teeth; but, in that genus, the long teeth have unsymmetrical cutting-edges, which are not in the long axis of the dentary bone.

PHASGANODUS CARINATUS, Cope.

Founded on a shed example of one of the long teeth, taken from the matrix attached to the dorsal vertebræ of the *Elasmosaurus platyurus*. The tooth is more elongate in outline than that of the *S. speciosa*, Leidy, *l. c.;* more than twice as long as wide at the base. The anterior margin is the more oblique, and its smooth face is margined by a faint line posteriorly, and is continued to the extremity. The convex inner face of the tooth behind is sculptured with a few fine deep grooves, which are separated by acute ridges, which do not extend over more than half the length of the tooth. Length, three lines.

From the Upper Cretaceous of the neighborhood of Fort Wallace, Kans.

PHASGANODUS GLADIOLUS, Cope.

Represented by a single elongate tooth, which is intermediate in character between those of the two species last described, but much larger than either. It is large for an anterior maxillary tooth of *Phasganodus anceps*, and, should it pertain to the end of the mandibular series, will in so far resemble the genus *Enchodus;* but the cutting-edges are opposite to each other, and not, as is usual in that genus, on one side, leaving the inner face very convex. In this species, the crown is rather slender, and compressed above the base. The anterior cutting-edge extends to the bottom, while the posterior reaches only half-way down; there is no barb. The section of the base exhibits an angle in continuation of the latter. The inner face is a little more convex that the outer; its pôsterior half is rather coarsely striate-keeled. The posterior half of the outer face is finely striate. The inner posterior aspect of the root presents a cavity of absorption for the successional tooth, as in *P. anceps.* The cutting-edge and tip of apex are glossy black. Length from fossa, $0^m.019$; diameter at fossa, $0^m.006$.

From a locality at a short distance from the *Phasganodus anceps.*

PHASGANODUS ANCEPS, Cope.

Established on portions of a right maxillary bone of one individual, and perhaps the premaxillary of a second. The former supports six teeth and four empty alveoli; teeth on the maxillary. The maxillary has a flattened anterior termination, somewhat as in *Stratodus apicalis;* the superior face being excavated and widened, and gradually descending to meet the inferior. The line of junction, where also the premaxillary commences, is oblique from before inward and backward. The anterior tooth is a little larger than those following. The form of the teeth differs much from that seen in the species of *Empo.* They have an oval section at the base, but speedily become much compressed in a direction oblique to the long diameter of the bone, and develop cutting-edges opposite to each other, and separating equal faces. The crown is a little more convex on one edge than the other, and has a slight inward curvature. The apex is sharp. The cementum of the crown is smooth; but the surface of the basal portion below the commencement of the cutting-edges is minutely striate-grooved; some grooves being deeper than others; the surface having a silky luster.

The inferior face behind the tooth expands gradually to its base, which is marked by the narrow crescentic scar of the older tooth seen in *Enchodus pressidens.* The crown of the tooth was scarcely as large as that of the maxillaries, but is lost. Its basis is fluted, and the surface finely striate. Length of bone, $0^m.015$. This specimen was not found with the preceding. The latter was discovered on a bluff near Fort Wallace.

The surface of the bone where preserved is without special sculpture. The upper margin is grooved for articulation with a supernumerary maxillary. Teeth in $0^m.01$, two.

Measurements.

	M.
Length of the last maxillary tooth	0.008
Long diameter of the basis of the last maxillary tooth	0.004
Depth of the maxillary bone at the basis of the last maxillary tooth	0.012

TETHEODUS, Cope.

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

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

TETHEODUS PEPHREDO, Cope.

Both premaxillary and portions of the maxillary and dentary bones of one specimen represent this species. They show it to have been a powerful fish, of the size of the *Enchodus petrosus* below mentioned. The premaxillaries are excavated by the usual three oblique fossæ above on the inner side. The alveolar face is a ridge extending obliquely across from a tuberosity on the inner side, behind the apical tuberosity. There is no surface for the attachment of a tooth, and no scar or other trace of the former existence of one. The maxillary underlaps it by an oblique suture, and supports a large tooth similar to that at the end of the premaxillary in *Enchodus*, behind which are seen the crescentic scars of the previously shed teeth. The outer face of the basal cementum of this tooth is perfectly smooth. The distal portion of the *dentary bone* is toothless; its anterior tooth is a fang, with the base excavated in front; and an angle rising from the external side of it becomes a latero-exterior cutting-edge of the crown to the apex. The inner posterior, or more convex, face of the tooth is regularly and closely striate-grooved. On one dentary, there are three or four small denticles in front of it on the outer side. The smaller teeth have two cutting-edges, and the posterior face at the base is grooved striate. This regular grooving, as well as the large size of the first maxillary, distinguishes this fish from the *Phasganodus anceps*.

Measurements.

	M.
Length of the premaxillary bone above	0.075
Depth of the premaxillary bone above	0.033
Width of the basis at the first maxillary tooth	0.010

	M.
Depth of the dentary at the first tooth	0.020
Length of the dentary to the first tooth	0.020
Length of the first tooth	0.032
Interval between the maxillary teeth	0.008

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

ENCHODUS, Agassiz.

The massive premaxillary bones of this genus are well known. They support an elongate fang at the anterior extremity. The maxillaries underlap them, and support some elongate teeth near their anterior end. The anterior dentaries are also longer than the others. The teeth are all anchylosed by expanded bases; the posterior ones on an oblique alveolar surface. The long teeth are removed by an absorption set on foot at the posterior basis of each, which progresses until the crown readily breaks away. The successional teeth appear in front of the old ones, appearing successively as the animal increases in size, so that the scars of those of preceding stages are only indicated by successive curved lines, becoming more prominent from the back to the front of the bone.

The posterior part of the cranium of *E. petrosus* exhibits a supraoccipital crest with short basis; this element separates lateral pieces, which are epiotic or parietal. They are separated by a concavity from the bone that occupies the external posterior angle, which is epi- or opisthotic. On the inferior view, no muscular tube appears, nor any otic foramen, such as exists in the *Saurodontidæ*. The visible surfaces of the exoccipital, the pterotic, the postfrontal and proötic, are subequal, and the alisphenoid is well developed. A strong rounded ridge extends from the postfrontal angle to the anterior base of the proötic, which bounds a deep fossa which occupies the point of union of the postfrontal, pterotic, and proötic Cervical vertebræ are not coössified nor modified in any especial manner. Their centra are roughened with raised inosculating ridges.

This genus has long been known from the Cretaceous of Holland and England; two or three species have left their remains in the greensand of New Jersey, and others occur in the chalk of Kansas. Dr. Leidy described a species[1] from the Cretaceous formations of the Upper Missouri region, which he called *E shumardii*. Several premaxillaries of a rather larger species were

[1] *Enchodus shumardii*, Leidy, Proceedings of the Academy of Natural Sciences of Philadelphia, 1856, p. 257, is a smaller species than any of those here described.

obtained by my expedition; but the species is not determinable. The diameter of the basis of the tooth is $0^m.012$. The long tooth of a species of medium size was detected, the *Enchodus calliodon*, Cope (*Enchodus* sp., Cope, Hayden's Survey of Wyoming, etc., p. 424), in the matrix beneath the vertebræ of *Elasmosaurus platyurus.*

ENCHODUS PETROSUS, Cope.

Established on numerous portions of cranium and vertebræ of one individual, which had grown to the size of a twenty-five-pound muskallonge.

The upper surface of the cranium is smooth, excepting along the inner border of the pterotic, where a narrow ridge supports two rows of small enamel tubercles. Numerous similar tubercles ornament the external face of the postfrontal bone.

The premaxillary has the anterior margin truncate obliquely upward and backward; its lower margin passing into the base of the single large tooth. Alveolar surface elongate, posteriorly narrowed to an obtuse edge. The maxillary exhibits both borders obliquely truncate, with sutural face; the alveolar aspect supports two teeth, one larger than the other. (No. 2.)

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

Measurements.

	M.
Length (distal end lost)	0.067
Greatest width of the alveolar face	0.018
Depth of the outer face	0.030
Diameter of the basis of the tooth	0.009

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

ENCHODUS DOLICHUS, Cope.

Represented by the premaxillary and adjacent parts of the maxillary bone with teeth, of a specimen of one-tenth the size of the preceding, and differing from it in the more slender proportions and the peculiar positions of the teeth.

The premaxillary is long and narrow, and oval in section, supports one tooth (the large extremital one), and has two sublongitudinal fossæ on the inner side above. Behind these is a fossa divided by inosculating ridges, and a similar one on the outer side of the middle keel, which overlaps the two posterior ones. The maxillary underlaps farther than in some species, bringing the anterior teeth half-way between the large premaxillary and large maxillary teeth. In *E. petrosus* they are much nearer the large maxillary.

Measurements.

	M.
Length of the premaxillary	0.0270
Distance between the large maxillary and the premaxillary teeth	0.0180
Transverse diameter of the premaxillary	0.0070
Transverse diameter of the large maxillary tooth	0.0026

The type-specimen of this species was originally described as pertaining to the genus *Empo.*

ENCHODUS CALLIODON, Cope.

The tooth on which this species rests is especially elegant. It is quite slender, and gradually contracts to the acute apex. The cutting-edges, which extend to the base, are on one side, and are separated in one direction by a narrow, slightly convex, and perfectly smooth face. The inner face is strongly convex, being more than half a circle from the middle of the length downward. This is also smooth on its anterior and posterior aspects; but, on the inner, there are nine sharp delicate keels, which disappear as the tooth contracts, the last terminating with the third quarter of the length. Total length, $0^{m}.02$; longitudinal diameter at base, $0^{m}.0025$; transverse diameter at base, $0^{m}.0035$. The apex of the tooth is black.

From near Fossil Spring, Western Kansas.

ANOGMIUS, Cope.

Proceedings of the American Philosophical Society, 1871, p. 170.

This name was applied to a genus supposed to be allied to the *Saurodontidæ,* and represented by vertebræ only. One species was named *A. contractus,* Cope, *l. c.*, which was found by Professor Mudge. I have seen nothing resembling these vertebræ among either of the three families above described, and cannot ascertain their exact affinities without further investigation. It is clear that they are not referable to the known genera of *Saurodontidæ* nor of *Stratodontidæ.* They present a marked character in the crowding-together of those caudal vertebræ which precede those that support the caudal fin. The centra are shortened, and the prolonged neural and hæmal arches and spines lie one on the other, forming a fan-shaped body. The arches do not, at the same time, become anchylosed. This structure is seen in the *A. contractus* and in a second and smaller species. It finds a parallel in the caudal vertebræ of the genus *Ischyrhiza* of Leidy, from the greensand of the New Jersey Cretaceous, where all the elements of this fan-shaped body, centra, spines, etc., are coössified into a solid mass. This will define a family, and a species having the same structure is common in the Miocene of Maryland. In *Anogmius*, the sides of the centra, though lacking the large grooves of other genera, are striate-grooved and reticulate. So are those of *Ischyrhiza*, and both in this resemble the recent genus *Esox*. Add to this the fact that the teeth of *Ischyrhiza* are almost exactly like those of *Esox*, especially as to their large-fissured fangs, and half-pleurodont insertion, some relationship to the *Esocidæ* may be predicated. I brought forward this suggestion as to the affinities of *Ischyrhiza* in the preliminary monograph of the fossil fishes of Kansas already quoted.

Anogmius contractus was about the size of *Ichthyodectes prognathus*. The second *Anogmius* is not more than one-third the size; the caudal vertebræ are more aggregated; and the neural spines, after leaning backward, are turned upward. The specimen came from Lower Butte Creek; no parts of cranium nor fins were found. The vertebræ originally described by me as pertaining to *Ichthyodectes ctenodon* belong either here or to *Ischyrhiza;* they agree with the latter in most respects, having the neurapophyses coössified with the centrum. They are several times larger than those of *A. contractus*, and relatively shorter, being about equal to those of *Ischyrhiza mira*, Leidy.

I do not name these species, as they may belong to known genera, and will be, in any case, better identified from cranial and fin remains.

APSOPELIX, Cope.

Established on the remains of a fish preserved on a block of clay. It presents its ventral aspect, and displays pectoral, ventral, and anal fins, with the series of interneural spines to which the dorsal radii were articulated.

The scales are large and cycloid. They do not present a trace of radii, but are marked with fine and close concentric grooves. These assume a vertical direction on the exposed surface, and are there more irregular; the more marginal ones terminating above and below. But few, *i. e.*, the central, grooves are truly circular. No abdominal carina.

The two pelvic bones are together truncate heart-shaped, the acuminate apex presented forward. Their posterior portion is a strong transverse rib; anteriorly, each is a thin plate, with thickened outer edge, uniting with its fellow on the median line. The median portion is so thin as to be readily broken away. The ventral fins are short and wide, with numerous rays. The coracoid bone is a broad lamina, and the pectoral fin evidently had the support of rod-like humeral bones of no great length, after the type of most physostomous fishes; but their form cannot be made out. Pectorals not elongate. The anal fin originates but a short distance behind the ventrals, and was not armed with an anterior spine; its length cannot be made out. Immediately above it, a dorsal fin, with slender rays, is represented by the bases of these rays. From above the ventrals to above the distal portion of the pectorals, a line of projecting points appears in the specimen, which I am disposed to ascribe to the articular portions of the interneural spines and attached fin-rays of a first dorsal; but of this I cannot be entirely sure.

The vertebræ are longer than deep, and present the two deep lateral grooves frequently seen. The number of the cervico-abdominal series is twenty-six. The ribs are delicate, and supernumerary ribs are present.

In comparing this genus with forms already known, points of distinction from all of them may be detected. Thus, the lack of pectoral spine will distinguish it from the known genera of *Saurodontidæ* at least. The character of the dorsal fin distinguishes it from *Characinidæ*, *Salmonidæ*, etc., which, with the scales, point toward *Clupeidæ* and *Elopidæ*. From these, the form of the pelvic bones distinguishes it.

The end of both muzzle and caudal region are destroyed. The latter evidently contracts from the anal fin, and was not probably very elongate, but more as in *Elops* or *Saurus*.

APSOPELIX SAURIFORMIS, Cope.

Scales large; ten longitudinal series to be counted across the obliquely-depressed body. No lateral line visible. About seventeen transverse series between pectorals and ventrals. Ventral broad; when laid backward nearly reaching anal, but far behind the pectoral. Anal probably rather short; but this is not entirely certain. Radii, D. ?—12, P. 16, V. 12.

Measurements.

	M.
Length from the basis of Pectoral ray No. I. to Ventral ray 12	0. 083
Length from the basis of P. I. to A. I	0. 0985
Length of the ventral fin	0. 0178
Width of the ventral fin distally	0. 013
Length of the basis of D. 2	0. 0168
Width of the body	0. 047
Width of the pelvic bones together	0. 016
Length of the pelvic bones together	0. 016

The size of this species is about that of a one-pound brook-trout.

From the bed No. 2 of the Cretaceous of Meek and Hayden. Found in digging a well at Bunker Hill station on the Pacific Railroad of Kansas.

SELACHII.

Remains of sharks and rays are far less abundant in the Cretaceous of Western Kansas than in New Jersey, and are much exceeded in abundance by the physostomous *Actinopteri*, as the present account indicates. In the region near Fort Hays and Salina, sharks' teeth are more frequently found. The cestracionts are, on the other hand, more abundant, since five species of *Ptychodus* Ag. have been found in No. 3; in beds in various parts of Kansas and Colorado.

GALEOCERDO, Müll., Henl.

Galeocerdo crassidens, Cope.

Established on two teeth of the type of *G. aduncus*, Agass., *i. e.*, with one cutting-edge much more convex than the other. The processes of the fang are rather narrow; that beneath the convex cutting-edge the most so. The apex of the tooth is very short, entirely plane, and stands over the middle or inner edge of the wider process of the fang. The shorter cutting-edge is straight or convex to near the base, where a short divergent heel develops itself. The anterior edge is strongly convex, and all the edges are denticulate. One side is more convex than the other. No denticles. Cementum smooth.

Measurements.

	M.
Length of the basis	0. 014
Height of the crown	0. 01
Height of the root	0. 005
Width of the tooth at the contraction	0 01

GALEOCERDO HARTWELLII, Cope.

This species is of the *G. egertonii* group, *i. e.*, with the cutting-edges subequal and symmetrical. The basis is broad, and with convexities of the fang, instead of the processes of the last species. The external parts of the cutting-edge rise gradually from the base, and then more steeply at an obtuse angle. They are convex on each side above, and meet symmetrically, forming a little less than a right angle. No denticles. Cementum smooth. Edge everywhere denticulate. One side of crown plane; the other convex.

Measurements.

	M.
Length of the basis	0.0215
Length of the fang	0.0195
Elevation of the apex (from the concavity)	0.0145
Width of the crown at the contraction	0.012

This tooth is stouter and larger than that of *G. egertonii*, and was found beneath the bones of the *Protostega gigas*. It is named after Martin V. Hartwell, a member of my expedition, to whose acuteness and industry I owe many specimens.

PTYCHODUS, Agass.

PTYCHODUS JANEWAYII, Cope.

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

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

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

ACTINOCHIRI.

This order is established for fishes from the Upper Cretaceous of Kansas and England, of which nothing is certainly known excepting the scapular arch and pectoral fin. These are fully described under the head of the only family, the *Pelecopteridæ*, so that the characters distinguishing this from other orders only will be adverted to here.

As in no other order of actinopterous fishes, there are six single and one paired basilar bones supporting the pectoral fin, and all articulating with the scapula. In *Amia*, there are nine such bones; but only one of them articulates with the scapula. In *Batrachus*, there are five, but four of which articulate with the scapula, and the anterior one is single. In all other *Actinopteri*, there are four, three, or two basilar bones, and the anterior pectoral ray articulates immediately with the scapula.

The clavicle is osseous, and the coracoid, if rightly determined, is short, and attached to the clavicle.

Until other portions of the skeleton become known, it will be impossible to assign its place to this order, but it lessens, by its fin structure, the interruption between *Amia* and other *Physostomi*.

PELECOPTERIDÆ.

A well-marked type of pectoral arch is figured on Plates XLVIII, figs. 1–2, and LIV, fig. 8. Like that of *Portheus*, it supports a powerful spine, but of a very different character from that genus. These spines are very common in a fragmentary condition in the clay-chalk of Kansas, and in three instances I have obtained them in immediate connection with the scapula. In one of these, the clavicles also are present. These are elongate and thin, the posterior edge laminiform, the anterior obtusely rounded. The bone is strongly curved antero-posteriorly, showing that the clavicles and coracoids were projected forwards below. Both extremities are strongly marked with grooves, the upper for sutural union with the posttemporal, and perhaps epiclavicle. One end is wider than the other, and its posterior edge is like a convex knife-blade. The scapula is quite massive; the general form of its body being that of a very irregular three-sided pyramid (see fig. 9). Its superior angular border sends off a large fan-shaped osseous plate inward, upward, and forward. Its expanded distal end is doubtless in contact with the clavicle or epiclavicle; it rises from the scapula without sutural interruption. A shorter, fan-shaped process rises from the lower posterior border of the scapula, and unites by its broad extremity with the inner side of the clavicle, from which it is distinguished by a suture. It incloses a large foramen with the clavicle, and probably represents the coracoid, although I cannot detect any suture separating it from the scapula. It is much shorter than that of *Portheus.* The postero-external side of the scapula has three articular facets at the outer or thick extremity, from the base of which a wide, deep groove extends inwards to the apex of the bone. Two of the facets are on the plane

Fig. 10.

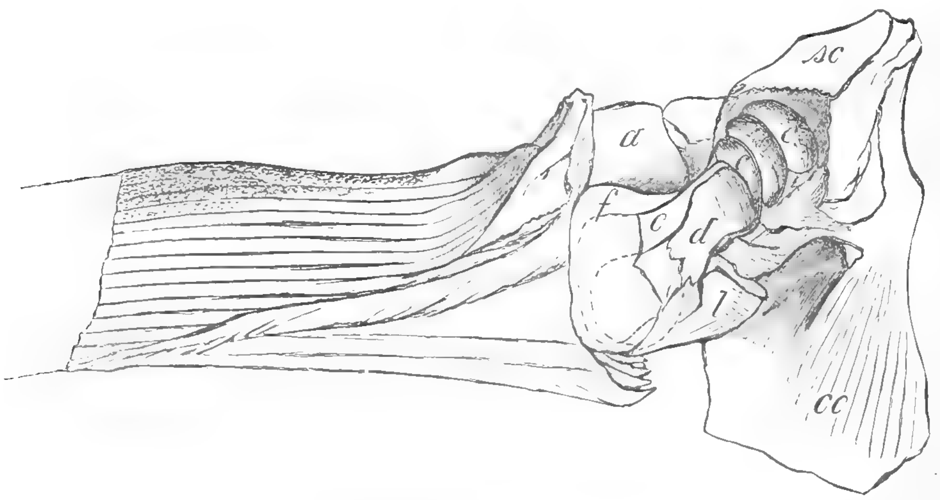


FIG. 10.—Left pectoral spine of *Pelecopterus chirurgus*, one-half natural size: *a* and *b*, the opposite anterior basilars; *c*, crescentic cotyli for the posterior median basilars; *d e f*, three median basilars; *sc*, scapula; *co*, coracoid.

of the posterior face, one above and one below. The third is between and exterior to them, and stands on an elevated tuberosity. The three together support the pectoral spine. Their surfaces were doubtless furnished with a thick cap of articular cartilage, as they are granular-rugose. The groove above mentioned is divided into five or six transverse subcrescentic fossæ, or cotyli, for the posterior basilar bones, whose fundus are also rugose.

The entire pectoral fin, so far as it is known, is devoted to the construction of a powerful spine. This follows from the fact that the spine is supported by all of the basilar bones. Six of the latter articulate in the fossæ of the groove of the scapula already described. They are flat, contracted at the middle, and expanded at the extremities. In front of these are two others, of a short, thick, cylindric form, one applied to the superior, the other to the inferior facets of the scapula above mentioned, while the tuberosity rises pedestal-like between them. This structure gives a slight hinge-movement, like the opening of the blades of a knife, and entirely unlike the rotary hinge-movement characteristic of the *Siluridæ*.

The spine is composed of parallel rods in close apposition. The anterior edge being oblique, the extremities of the rods terminate successively at the border, which is trenchant, constituting the offensive part of the spine. The edge is hardened and the adjacent parts of the spine thickened, and in some cases roughened by a deposit of a hard substance resembling enamel. It is either straight, or regularly undulate or serrate, with recurved, acute, tooth-like processes. The smaller species exhibit the serrate character; the larger, the regular border. In either case, a most formidable weapon is indicated, not less admirable than those already described from Paleozoic rocks. There is a considerable resemblance between the serrate type and the spines of the Carboniferous genus *Edestus*, where the teeth are more developed and denticulate.

Spines of this type were referred by Professor Agassiz to the cestraciont sharks of the genus *Ptychodus;* but the structure of the scapular arch, now first described, demonstrates the incorrectness of this association. The increased number of the basilar bones shows clearly that they belong to a peculiar family, which I call the *Pelecopteridæ*. The principal genus receives the name *Pelecopterus*, leaving the question of its relationship to *Erisichthe* an open one. The supposition that these spines belong to *Portheus* and its allies is, therefore, no longer entertained.

PELECOPTERUS, Cope.

The characters of this genus are only known from the bones of the scapular arch and the spine of the pectoral fin. As these have been already described under the head of the family, it remains to discriminate the species. Three of these have come under my observation, which are fishes of large size. They may be readily distinguished by the character of the cutting-edge and the relative size and direction of the component rods.

Smaller: rods larger and less oblique; edge undulate and serrate .... *P. perniciosus.*
Larger: rods smaller and more oblique; edge entire or irregular .... *P. gladius.*

PELECOPTERUS PERNICIOSUS, Cope.

Although the pectoral spines of this fish are abundant, they are rarely obtained unbroken; and I had long been familiar with their basal and distal portions before I was aware that they bore that relation to each other. The finest example was obtained by my friend Professor Merrill, on Spring Creek, in Rooks County. It includes spines and clavicles of both sides, with scapular and basilar bones of one side. Neither spine is complete, but the longest measures twenty-eight inches in length. The component rods make a small angle with the cutting-edge, and, commencing narrow at the base, widen out at the middle, and retain their width to the end at the cutting-border. The rods at the back of the spine are narrower than those at the middle and edge. The section is narrow, especially at the back, and it is thickest a little within the edge. There are thirty-four rods at the base, and fourteen at the middle of the spine.

At the base, the cutting-edge is almost straight, but it soon becomes undulate. Before the middle is reached, the convexities become low teeth, and from this point to the end the teeth are pronounced. They are acute in apex and edge, and have a long anterior and short posterior border. Each tooth marks the end of one of the oblique component rods. The apex of each tooth is the end of a transverse thickening or low ridge of the surface of the spine, so that the cutting-edge is equally acute at the bottoms of the concavities as at the rather obtuse apices of the teeth. The cement or enamel layer extends, on both sides of the spine, 0.75 inch from the cutting edge; it is composed of small, aggregated tubercles. In this specimen, the scapula is lighter than in the species next described, and has its outer anterior angle drawn out into a slender process, which does not exist in the latter. In this specimen, the fan-shaped inferior process of the scapula is present.

Measurements.

	M.
Length of the clavicle round its curve (proximal end broken)	0.215
Width of the clavicle near the lower end	0.043
Vertical diameter of the scapula	0.105

	M.
Vertical diameter of the scapula, body only	0.040
Transverse diameter of the scapula, body only	0.065
Width of the fan-process at the extremity	0.065
Width of the shaft of the fan-process (depressed)	0.025
Length of the spine (apex wanting)	0.705
Width at the base	0.067
Width at the middle	0.048
Thickness at the middle	0.008

In a second specimen (Plate XLVIII, fig. 2), the coracoid process is present, showing identity of character with the scapula of the *P. chirurgus*. This specimen also presents the anterior scapular hook. The dentation of the cutting-margin appears nearer the base in this than the preceding specimen.

In a third, which includes only the distal part of the spine (Plate LII, fig. 2), there are twenty teeth in $0^{m}.235$. From Prof. B. F. Mudge's collection.

PELECOPTERUS CHIRURGUS, Cope.

Represented by the basal part of a large spine attached to the scapula (Plate XLVIII, fig. 1), and by an isolated scapula (Plate LIV, fig. 8). These bones are more massive than those of the last species, which they resemble in various points. The most prominent of these is the wider and less oblique component rods than in *P. gladius.* The basal three inches of the anterior edge only is preserved, and this shows no trace of the undulation of that of the *P. perniciosus.* The enamel-deposit covers a width of three rods.

The scapula is, in this instance, attached to the clavicle, to a ledge on the inner posterior face of the latter, which joins the upper edge of the outer side or base of the former. This junction being rather narrow, it is strengthened by the solidly-coössified coracoid on the inner side of it. The spine contains fifteen rods in a width of $0^{m}.051$.

Measurements.

	M.
Vertical width of the scapular body in front	0.044
Width of the clavicle at the scapula	0.035
Length of the coracoid inside	0.041

This, as well as the second specimen, was found by Prof. B. F. Mudge.

PELECOPTERUS GLADIUS, Cope.

Distinguished from the preceding species by the superior size and mass of its spine, the small and more oblique rods, and non-dentate edge of the same.

It was originally established on a spine which, when complete, measured, according to Professor Mudge, forty-one inches in length; the portion now before me measures thirty-one inches. The margin is exceedingly acute, and is coated with an enamel-like layer, which conceals the extremities of the rods of which the spine is composed. Near the middle of its length, these rods number thirty; but whether the entire width of the spine is preserved is uncertain. The transverse section is a crescent from the base to beyond the middle; the surface being thus somewhat trough-like. The spine has been somewhat distorted by pressure; but I cannot discover that the form in question is entirely due to that cause. The edge is excavated and notched at irregular points, indicating the frequent use to which this formidable weapon was put during the life of its possessor (Plate LII, fig. 3).

Measurements.

	M.
Total length (*fide* Mudge)	1.040
Width near the middle	0.175
Thickness posteriorly near the middle	0.012

A second specimen, found by myself in the blue limestone-shale in Fossil Spring Cañon, is composed at the base of about twenty-six narrow double rods. A few appear between the others beyond the base, making thirty-one altogether. They are very oblique to the general base, but curve so as to become nearly straight, and enlarge distally. They terminate in a thickened portion, which bears an acute edge, which truncates them obliquely. This portion is enameled; the edge is slightly convex at the base, and slightly concave at a point probably beyond the middle (Plate XLIV, fig. 12).

Measurements.

	M.
Length of fragment (12 inches)	0.30
Width at the base	0.12
Thickness at the base	0.012
Thickness at the broken end an inch from the edge	0.007

This is a formidable weapon, and could be readily used to split wood in its fossilized condition.

PART III.

SYNOPSIS OF THE KNOWN CRETACEOUS VERTEBRATA OF NORTH AMERICA.

The following catalogue includes species which have been derived from all of the members of the Cretaceous formations excepting No. 1, which has not yet yielded vertebrate fossils.

No species has been introduced into the list which has not been described, and no genus has been adopted which has not been described. Reference is made to the place where such descriptions can be found in both cases; and, where such citation is omitted, it is understood that the name is provisional only, and that any name employed by the future describer of the genus will be substituted for it in future editions of this list.

AVES.

NATATORES.

HESPERORNIS, Marsh.

American Journal of Science and Arts, 1872, p. 360.

HESPERORNIS REGALIS, Marsh.

American Journal of Science and Arts, 1872, p. 56; *l. c.*, 1872, p. 360.

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

GRACULAVUS, Marsh.

GRACULAVUS ANCEPS, Marsh.

American Journal of Science and Arts, 1872 (III), p. 364.

Niobrara Cretaceous of the Smoky Hill.

LAORNIS, Marsh.

LAORNIS EDWARDSIANUS, Marsh.

American Journal of Science and Arts, March, 1870.

Cretaceous greensand; No 5, of New Jersey.

GRALLÆ.

PALÆOTRINGA, Marsh.

PALÆOTRINGA LITTORALIS, Marsh.

American Journal of Science and Arts, March, 1870.

Cretaceous greensand, No. 5, of New Jersey.

PALÆOTRINGA VETUS, Marsh.

American Journal of Science and Arts, March, 1870.

Cretaceous greensand, No. 4, of New Jersey.

TELMATORNIS, Marsh.

TELMATORNIS PRISCUS, Marsh.

American Journal of Science and Arts, March, 1870.

Cretaceous greensand, No. 5, of New Jersey.

TELMATORNIS AFFINIS, Marsh.

American Journal of Science and Arts, March, 1870.

Cretaceous greensand, No. 5, of New Jersey.

? SAURURA.

ICHTHYORNIS, Marsh.

ICHTHYORNIS DISPAR, Marsh.

American Journal of Science and Arts, 1872, p. 344 (IV); and 1873, p. 74 (V), February, 1873.

Niobrara Cretaceous of the Smoky Hill.

ICHTHYORNIS CELER, Marsh.

L. c., 1872, p. 406 (IV).—*Apatornis celer* (name only), *l. c.*, February, 1873.

Niobrara Cretaceous of the Smoky Hill.

REPTILIA.

DINOSAURIA.

CIONODON, Cope.

Bulletin of the United States Geological Survey of the Territories, No. 1, p. 10, Jan., 1874.
Ibidem, No. 2, p. 21, April, 1874.

CIONODON ARCTATUS, Cope. Figured on Plates I and II.

Bulletin of the United States Geological Survey of the Territories, No. 2, 1874, p. 21.

The Fort Union epoch of Colorado.

CIONODON STENOPSIS, Cope.

Supra, p. 63.

Fort Union epoch of the Saskatchewan district, British America.

HYPSIBEMA, Cope.

Transactions of the American Philosophical Society, 1870, 122 G.

HYPSIBEMA CRASSICAUDA, Cope.

Extinct Batrachia and Reptilia of North America, 1870, p. 122 G; Report of the Geology of North Carolina, by W. C. Kerr, p. 36 (Appendix B), Plates vi and vii.

Cretaceous of Southeastern North Carolina.

HADROSAURUS, Leidy.

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

HADROSAURUS FOULKEI, Leidy.

Proceedings of the Academy of Natural Sciences, Philadelphia, 1856, 218; Cretaceous Reptiles of North America, Smithsonian Contributions, 1865, p. 76, plates.

From the clays below the greensand of No. 4 of New Jersey, said to belong to No. 1.

HADROSAURUS TRIPOS, Cope.

Transactions of the American Philosophical Society, 1870, p. 122 I; Geological Survey of North Carolina, by Kerr, Appendix B, p. 40, Plate v.

From Cretaceous greensand of Southeastern North Carolina.

HADROSAURUS MINOR, Marsh, Cope.

Transactions of the American Philosophical Society, 1870, p. 122 J.

Cretaceous greensand, (No. 5,) of New Jersey.

HADROSAURUS AGILIS, Marsh.

American Journal of Science and Arts, 1872, p. 301.

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

HADROSAURUS MIRABILIS, Leidy.

Proceedings of the Academy of Philadelphia, 1868, 199; Cope, Extinct Batrachia, etc., 1868, 198.—*Trachodon mirabilis*, Leidy, Proceedings of the Academy of Philadelphia, 1856, 72; Transactions of the American Philosophical Society, 1860, 140.

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

HADROSAURUS OCCIDENTALIS, Leidy.

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

From the lowest member of the Lignite (Fort Union) formation at Grand River, Nebraska.

HADROSAURUS CAVATUS, Cope.

Proceedings of the American Philosophical Society, 1871, p. 50.

Cretaceous greensand, No. 5, of New Jersey.

ORNITHOTARSUS, Cope.

Transactions of the American Philosophical Society, 1870, p. 120.

ORNITHOTARSUS IMMANIS, Cope.

L. c., and Proceedings of the American Philosophical Society, 1869, p. 117.

Clays below the Cretaceous greensand, No. 4, of New Jersey, said to be No. 1.

AGATHAUMAS, Cope.

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

AGATHAUMAS SYLVESTRE, Cope. Figured on Plates IV, V, and VI.

L. c., and Bulletin of the United States Geological Survey, 1874, No. 2, p. 18.

Transition Cretaceous, No. (6 or) 7, of Bitter Creek, Wyoming

PALÆOSCINCUS, Leidy.

Proceedings of the Academy of Philadelphia, 1856, p. 72.

PALÆOSCINCUS COSTATUS, Leidy.

L. c.; and Transactions American Philosophical Society, 1860.

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

TROÖDON, Leidy.

L. c., 1856, p. 72; Transactions of the American Philosophical Society, 1860, 147.

TROÖDON FORMOSUS, Leidy, *l. c.*

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

AUBLYSODON, Leidy.

Proceedings of the Academy of Natural Sciences, Philadelphia, 1868, p. 198.—*Dinodon*, Leidy, *l. c.*, 1856, 72: not of Duméril.

AUBLYSODON HORRIDUS, Leidy.

Cope, Extinct Batrachia, etc., of North America, p. 120.—*Dinodon horridus*, Leidy, Proceedings of the Academy of Philadelphia, 1856, 72; Transactions of the American Philosophical Society, 1860, 140.—*Aublysodon mirandus*, Leidy, Proceedings of the Academy 1868, 198.

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

LÆLAPS, Cope.

Proceedings of the Academy of Natural Sciences, Philadelphia, 1866, p. 279; American Journal of Science and Arts, 1868, p. 415.

LÆLAPS AQUILUNGUIS, Cope.

L. c., p. 275; Extinct Batrachia and Reptilia of North America, 1869, p. 100.

Greensand, No. 5, of New Jersey.

LÆLAPS MACROPUS, Cope.

Extinct Batrachia and Reptilia of North America, 1870, p. 118; Leidy, Cretaceous Reptilia, p. 101 (without name).

Greensand of Monmouth County, New Jersey.

CŒLOSAURUS, Leidy.

Cope, Extinct Batrachia and Reptilia of North America, p. 119 (name only).

CŒLOSAURUS ANTIQUUS, Leidy.

Cretaceous Reptiles of North America, p. 100 (no name); p. 119, name, Table III, fig. 1.

Greensand of New Jersey.

PTEROSAURIA.

PTERODACTYLUS, Cuv.

PTERODACTYLUS UMBROSUS, Cope. Plate VII, figs. 1–4.

Proceedings of the American Philosophical Society, 1872, p. 471 (*Ornithochirus*). (Published March 9, 1872.)

Niobrara chalk of Kansas.

PTERODACTYLUS INGENS, Marsh.

American Journal of Science and Arts, 1872, April (published March 7, 1872).

Niobrara chalk of Kansas.

PTERODACTYLUS OCCIDENTALIS, Marsh. Plate VII, figs. 5, 6.

L. c., April, 1872 (published March 7th).—*Ornithochirus harpyia*, Cope, Proceedings of the American Philosophical Society, 1872, 471 (published March 9th).—*Pterodactylus owenii*, Marsh, *l. c.*, 1871, p. 472, not of Seeley.

Niobrara Cretaceous of Kansas.

PTERODACTYLUS VELOX, Marsh.

L. c., April, 1872.

Niobrara Cretaceous of Kansas.

CROCODILIA.

HYPOSAURUS, Owen.

Journal of the Geological Society of London, V, 383.

HYPOSAURUS VEBBII, Cope. Plate IX, fig. 8.

Proceedings of the American Philosophical Society, 1872, p. 310.

Benton, or No 2, Cretaceous of Kansas.

HYPOSAURUS ROGERSII, Owen.

Journal of the Geological Society of London, V, 383, plate; Leidy, Cretaceous Reptiles of North America, 1865, p. 18, Table III, figs. 4–21; Cope, Extinct Batrachia and Reptilia of North America, 1869, p. 80.

Greensand, No. 5, of New Jersey.

THORACOSAURUS, Leidy.

Cretaceous Reptiles of North America, 1865, p. 5.

THORACOSAURUS NEOCÆSARIENSIS, DeKay.

Gavial DeKay, Annals of Lyceum of New York, Table III, figs. 7–10.—*Gavialis neocæsariensis*, DeKay, Zoölogy of New York, 1842, part III, 1844, p. 82.—*Crocodilus s. Gavialis clavirostris*, Morton, Proceedings of the Academy of Natural Sciences, 1844, 82; Giebel Fauna der Vorwelt, 1847, 122.—*Crocodilus basifissus*, Owen, Journal of the Geological Society of London, 1849, p. 381, Table X, figs. 1–2.—*Crocodilus dekayi*, Leidy, Journal of the Academy of Natural Sciences, Philadelphia, II, p. 135.—*Thoracosaurus grandis*, Leidy, Proceedings of the Academy of Natural Sciences, Philadelphia, 1852, p. 35.—*Sphenosaurus*, Agassiz, *l. c.*, 1849, 160 (name only).

Greensand and limestone of No. 5, in New Jersey.

HOLOPS, Cope.

Extinct Batrachia and Reptilia, etc., of North America, 1869, p. 67.

HOLOPS PNEUMATICUS, Cope.

Proceedings of the Academy of Philadelphia, 1872, p. 11.

This gavial, as large as the *T. neocæsariensis*, is represented, so far as I know, by but one specimen; but this fortunately embraces a large proportion of the elements of the skeleton in a more or less fragmentary condition, as is usual with the fossils obtained from the greensand excavations.

The muzzle was very long and narrow; the mandible convex between the teeth; the palate flat. The surface of the muzzle is grooved, not very closely. The teeth are very much curved, and the section of most of the crowns is round; but a few posterior ones are flattened on the inner side, so that the section is an unsymmetrical oval. These teeth have acute but somewhat shortened crowns; the others are long and acuminate. A delicate angular ridge on the front and posterior aspects divides an inner from an outer face, of which the outer is more convex. The enamel is marked by a number of shallow, obscure sulci on the middle portions of the crown on both faces; while the surface is thrown into fine wrinkles, so as to resemble silk, which disappear from the used portions of old crowns. Twenty-one teeth are preserved, but the entire number is unknown. The crowns are composed of four, sometimes three, concentric cones.

The vertebræ are remarkable for the strong posterior shoulder of the centrum, so that the protuberant ball presents a more than usually contracted base. The ball is strongly impressed by a ligamentous pit in the center. The cervicals are relatively very large, exceeding the dorsals and lumbars. In the only one which is nearly complete, the centrum is depressed, and hence the articular faces are transverse ovals. The shoulder is oblique to the vertical plane. Surfaces smooth. The cup of the first dorsal is nearly round; its hypapophysis is long, directed forward, and squarely truncate at the end and in front. The parapophysis is below the middle of the centrum, and longitudinal. There are some faint ridges extending to the shoulder, and a fossa above each parapophysis. The neural arch is coössified. A more posterior dorsal has a hypapophysis with a very large base. The cup is as wide vertically as transversely, but is, like the centrum, contracted in outline below the middle. The lumbars differ from those of other species of the genus in the shortness of the centrum as compared with its other dimensions. They are compressed; the vertical diameter exceeding the transverse. Of course, the transverse width is the greater near the sacrum. In the caudal vertebræ, the balls and cups gradually disappear, until a narrow transverse fossa is all that indicates either. One of the terminal caudals is thus truncate at both ends; has the sides of the centrum replaced by a deep longitudinal fossa, the base only having some transverse diameter. The neural canal is a tube, one-half of which is roofed by a saddle-shaped body, and the opposite end supports the vertical spine, which is connected with the former by a lamina.

The femur is large and has the form usual in the order, and has a hollow shaft. Like all the long bones, the dense layer of bone is thin, and the tissue light; surface near articulations always striate-ridged. The tibia has a head subtriangular in outline, obtuse in front, with a rudimental cnemial spine turned outward, and an open emargination behind. It is penetrated near the anterior angle by a large pneumatic foramen, and the shaft is hollow.

The dermal scuta have free, thin margins, and they are coarsely and deeply pitted.

Measurements.

	M.
Length of the space containing three teeth	0.036
Width of the under jaw at the same point	0.035
Length of a tooth on the curve	0 075
Length of the crown of the same	0.033
Diameter of the crown of the same	0.011
Length of a cervical vertebra	0.094
Vertical diameter of the centrum	0.053
Transverse diameter of the centrum	0.068
Length of the first dorsal	0.075
Vertical diameter of the cup of the centrum	0.055
Transverse diameter of the cup of the centrum	0.057
Length of the posterior dorsal	0.080
Vertical diameter of the cup	0.050
Transverse diameter of the cup	0.052
Length of the centrum of a lumbar	0.075
Vertical diameter of the cup of the same	0.052
Transverse diameter of the cup of the same	0.049
Greatest diameter of the head of the femur	0.078
Least diameter of the head of the femur	0.047
Diameter of the shaft of the femur	0.048
Diameter of the head of the tibia, longitudinal	0.057
Diameter of the head of the tibia, transverse	0.060

This species, in its transverse cervical articular cups, resembles the *Thoracosaurus neocæsariensis;* but the diameters of the dorsal vertebræ referred to that species by Leidy exceed those of the cervicals, while the latter exceed the former in *H. pneumaticus.* This gavial also differs in the more acute and cylindric crowns of the teeth, as is the case with other *Holopes;* while in the *T. neocæsariensis* they are more compressed and obtuse. I am not able to determine the presence or absence of the lachrymal fossa.

The greensand bed No. 5, near Harrisonville, New Jersey. Discovered by my friend Barclay Edwards.

HOLOPS BREVISPINIS, Cope.

Proceedings of the Academy of Philadelphia, 1867, p. 39 (*Thoracosaurus*); Extinct Batrachia and Reptilia of North America, 1869, p. 69, Plate I, fig. 13, and IV, 4–6.

Greensand of New Jersey, No. 5.

HOLOPS GLYPTODON, Cope.

Extinct Batrachia and Reptilia of North America, 1869, pp. 74, 231.

Greensand of New Jersey, No. 5.

HOLOPS OBSCURUS, Leidy.

Crocodilus obscurus, Leidy, Smithsonian Contributions, Cretaceous Reptiles of North America, 1865, p. 115, Plate II, fig. 4.—*Thoracosaurus obscurus*, Cope, Geological Survey of New Jersey by Cook, Appendix C.—*Holops obscurus*, Cope, Extinct Batrachia and Reptilia of North America, 1869, p. 75, Plate IV, figs. 1–3.

Greensand of New Jersey, No. 5.

HOLOPS CORDATUS, Cope.

Extinct Batrachia and Reptilia of North America, 1869, p. 73.

Greensand of New Jersey, No. 5.

HOLOPS BASITRUNCATUS, Owen.

Crocodilus basitruncatus, Owen, Journal of the Geological Society of London, V, 1849, 380.—*Crocodilus tenebrosus*, Leidy, Cretaceous Reptiles of North America, 1865, p. 115, Plate III, figs. 12–15.—*Holops tenebrosus*, Cope, Extinct Batrachia and Reptilia of North America, 1869, p. 78.—*H. basitruncatus*, Cope, *l. c.*, p. 231; fig. 19, p. 77.

Greensand of New Jersey, No. 5.

BOTTOSAURUS, Agassiz.

Cope, Proceedings of the American Philosophical Society, 1871, p. 48.

BOTTOSAURUS MACRORHYNCHUS, Harlan.

Crocodilus macrorhynchus, Harlan, Journal of the Academy of Natural Sciences, Philadelphia, 1824, p. 15.—*Crocodilus harlani*, Meyer, Palæologica, 1832, 108.—*Bottosaurus harlani*, Agassiz, Leidy, Cretaceous Reptiles of North America, 1865, 12–14. Plate IV, figs. 19–23.—*Bottosaurus macrorhynchus*, Cope, Proceedings of the American Philosophical Society, 1871, p. 48 (general osteology).

Greensand of New Jersey, No. 5.

BOTTOSAURUS TUBERCULATUS, Cope.

Extinct Batrachia and Reptilia of North America, 1870, p. 230; Proceedings of the American Philosophical Society, 1871, p. 49.

Greensand of New Jersey, No. 5.

BOTTOSAURUS PERRUGOSUS, Cope. Plate VI, figs. 5–8.

Hayden's Bulletin of the United States Geological Survey of the Territories, No. 2, 1874, p. 26.

Fort Union epoch of Colorado.

Bottosaurus(?) humilis, Leidy.

Crocodilus humilis, Leidy, Proceedings of the Academy of Natural Sciences, Philadelphia, 1856, p. 73 (teeth only). Transactions of the American Philosophical Society, XII, p. 146. Plate XI, figs. 9–19.

Bad lands of Montana (Judith River).

GAVIALIS, Merrem.

Gray, Catalogue of the Tortoises, Crocodiles, etc., British Museum, 1844, p. 57.

Gavialis fraterculus, Cope.

Hyposaurus fraterculus, Cope, Extinct Batrachia and Reptilia of North America, 1869, p. 82.

This species was established on a portion of the mandible. Since the date of description, parts of two other individuals have come into my possession, one of which includes considerable portions of the mandible, with teeth, numerous vertebræ from all parts of the column, humerus, ischium, pubis etc. These remains indicate that this species is a procœlian crocodile allied to *Holops*, but having the long, produced hypapophyses of the cervical vertebræ of *Gavialis*. From the Tertiary genus *Thecachampsa*, it differs in the simplicity of the dental crowns.

The mandibular ramus exhibits a large foramen on the outer side, bounding the angular bone above, and a large dental foramen on the inner side. The outer faces of the dentary exhibit rather distant narrow grooves; the outer face of the angular is coarsely articulate or pitted. The cup of an anterior cervical is round; of a posterior, slightly depressed. The hypapophysis is acute, prominent, and directed well forward. The caudal vertebræ are large, indicating a large tail. The humerus is much like that of *Holops brevispinis*.

This gavial is the least of the *Crocodilia* of the Cretaceous. The specimen described is adult, and considerably less than the smallest of the *Holops brevispinis*, the next larger.

Greensand, No. 5, from Birmingham and Hornerstown, New Jersey.

SAUROPTERYGIA.

PIRATOSAURUS, Leidy.

Piratosaurus plicatus, Leidy.

Cretaceous Reptiles of North America, p. 29. Table XIX. fig. 8.

Cretaceous of the Red River, Minnesota.

POLYCOTYLUS, Cope.

Extinct Batrachia and Reptilia of North America, 1869, p. 36.

POLYCOTYLUS LATIPINNIS, Cope. Plate VII, fig. 7.

Extinct Batrachia and Reptilia of North America, 1869, p. 36, Plate I, figs. 1-13; Hayden's Geological Survey of Wyoming, 1870, p. 388.

From the Niobrara chalk of Kansas.

CIMOLIASAURUS, Leidy.

Discosaurus et Brimosaurus, Leidy, Cope, Extinct Batrachia and Reptilia of North America, 1869, p. 40.

CIMOLIASAURUS GRANDIS, Leidy.

Cope, *L. c.*, p. 43.—*Brimosaurus grandis*, Leidy, Proceedings of the Academy of Natural Sciences, 1854, p. 72, Plate I; figs. 1-3.

Cretaceous of Arkansas.

CIMOLIASAURUS MAGNUS, Leidy.

Proceedings of the Academy of Natural Sciences, 1851, p. 325; *ibid.*, 1854, 72, Plate II, figs. 4-6; Cretaceous Reptiles of North America, 1865, p. 25, Plates V, figs. 13-19, and VI; Cope, Synopsis of the Extinct Batrachia and Reptilia of North America, 1869, p. 42, 43.

Greensand of No. 5, New Jersey.

CIMOLIASAURUS VETUSTUS, Leidy.

Cope, Extinct Batrachia and Reptilia of North America, 1869, p. 42.—*Discosaurus vetustus*, Leidy, Proceedings of the Academy of Natural Sciences, Philadelphia, 1851, 326; Cretaceous Reptiles of the United States, 1865, p. 22.

Alabama, No. ?.

CIMOLIASAURUS PLANIOR, Leidy.

Proceedings of the Academy of Philadelphia, 1870, p. 22.—*Discosaurus vetustus*, pars, Leidy, Cretaceous Reptiles of the United States, p. 23, Plate V, figs. 10-12.

Cretaceous, No. ?, Mississippi.

ELASMOSAURUS, Cope.

Leconte's Notes on the Geology of the Smoky Hill Route of the Union Pacific Railroad, 1868, p. 68; Synopsis of the Extinct Batrachia and Reptilia of North America, 1869, p. 44; American Journal of Science and Arts, 1870, pp. 141, 268.

ELASMOSAURUS ORIENTALIS, Cope.

Synopsis of the Extinct Batrachia and Reptilia of North America, 1869, p. 55.—*Discosaurus orientalis*, Leidy, Proceedings of the Academy of Natural Sciences, Philadelphia, 1870, p. 22.

Greensand, No. 4, New Jersey.

Elasmosaurus platyurus, Cope.

Notes on the Geology of the Southern Division of the Pacific Railroad, by J. Leconte, 1868, p. 68; Extinct Batrachia and Reptilia of North America, etc., 1869, p. 44; Hayden, Geological Survey of the Territories, 1870, Wyoming, p. 393.—*Discosaurus carinatus*, Cope, Leconte's Notes, *l. c.*

Niobrara Cretaceous of Kansas.

PLESIOSAURUS, Conybeare.

Plesiosaurus lockwoodii, Cope.

Extinct Batrachia and Reptilia of North America, 1869, p. 40.

Cretaceous clays, No. 1, New Jersey.

Plesiosaurus brevifemur, Cope, *sp. nov.*

Cimoliasaurus magnus, Leidy, Cope, part; Extinct Batrachia and Reptilia of North America, 1869, p. 43; figs. 13–15, p. 41.

Greensand of No. 5, New Jersey.

Plesiosaurus gulo, Cope.

Proceedings of the Academy of Philadelphia, 1872, 128.

Niobrara Cretaceous of Kansas.

Plesiosaurus occiduus, Leidy.

Nothosaurus occiduus, Leidy, Proceedings of the Academy of Philadelphia, 1870, p. 74; Report of the Geological Survey of the Territories (4to), 1873, I, p. 345, Table XV, figs. 11–13.

Lignite Cretaceous of Moreau River, Dakota.

ISCHYROSAURUS, Cope.

Extinct Batrachia and Reptilia of North America, 1869, p. 38.—*Ischyrotherium*, Leidy, Proceedings of the Academy of Philadelphia, 1856, p. 89; Transactions of the American Philosophical Society, 1860, p. 150.

Ischyrosaurus antiquus, Cope, *l. c.*

Ischyrotherium antiquum, Leidy, *l. c.*; Transactions of the American Philosophical Society, 1860, Table X, figs. 8–17.

Lignite period between Moreau and Grand Rivers, Nebraska.

TESTUDINATA.

PROTOSTEGA, Cope.

Proceedings of the American Philosophical Society, 1871, p. 175; *l. c.*, 1872, p. 422.

Protostega gigas, Cope, *l. c.* Plates X, XI, XII, XIII.

From the Niobrara Cretaceous of Kansas.

PROTOSTEGA TUBEROSA, Cope.

Proceedings of the American Philosophical Society, 1872, 433 (where *Platecarpus* is written (*lapsu calami*); and Hayden's Annual Report of the United States Geological Survey, 1872, 330, 334.—*Atlantochelys tuberosus*, Leidy, Report to the United States Geological Survey of the Territories, 4to, vol. I, 1873, p. 342.

Cretaceous of Mississippi.

PROTOSTEGA NEPTUNIA, Cope.

Proceedings of the American Philosophical Society, 1872, p. 433.—*Atlantochelys mortonii*, Leidy, Report of the United States Geological Survey of the Territories, I, 1873, p. 342; *Mosasaurus mitchilii*, Leidy (pars), Cretaceous Reptiles of the United States, 1865, p. 43, 116, Plate VIII, figs. 3–4.

Greensand, No. ?, of New Jersey.

LYTOLOMA, Cope.

Extinct Batrachia and Reptilia of North America, 1870, p. 144.

LYTOLOMA JEANESII, Cope.

L. c., p. 145.

Greensand of No. 5, New Jersey.

LYTOLOMA ANGUSTA, Cope.

L. c., p. 145; *Chelone sopita* (part), Leidy, Cretaceous Reptiles of the United States, p. 105, Plate XIX, fig. 2.

Greensand of No. 5, New Jersey.

OSTEOPYGIS, Cope.

Proceedings of the Academy of Philadelphia, 1868, p. 147; Extinct Batrachia and Reptilia of North America, 1870, p. 132.

In this genus, the alveolar surfaces are horizontal, very wide, and entirely flat. The alveolar edge is not generally reflexed, even at the broadly-rounded apex, but is acute. As already described, there are eleven marginal bones, which, with the pygal, make twenty-three in all. The first and last are without corresponding costal bone, so that the number of the latter is nine. I formerly suspected that the eleventh marginal of the *O. sopitus* is connected with a special costal, the entire number in this species being thus ten; but subsequent investigation does not establish the view, though it is not yet disproven. For the present, therefore, I place this species in *Osteopygis*. I now add another species to the genus, making the entire number four; and the following table points out the distinctive characters:

A. The costal pits of the lateral margins narrow; posterior marginals deeply notched above for the ribs:
Surface smooth . . . . *O. platylomus.*

AA. Lateral costal pits round; the posterior marginals deeply notched above for the ribs:
Surface smooth; lateral marginals low, depressed . . . . *O. sopitus.*
Surface coarsely pitted; lateral marginals elevated . . . . *O. erosus.*

AAA. Lateral costal pits round; the posterior marginals with upper face produced above the rib-pits, concealing them:
External border openly notched . . . . *O. emarginatus.*

OSTEOPYGIS PLATYLOMUS, Cope.

Extinct Batrachia and Reptilia of North America, 1870, pp. 135, 235.

Greensand, No. 5, of New Jersey.

OSTEOPYGIS SOPITUS, Leidy.

Chelone sopita, Leidy, Cretaceous Reptiles of North America, 1865, p. 104; *Propleura sopita*, Cope, Extinct Batrachia and Reptilia of North America, 1870, 140, Plate VII, fig. 4.

Greensand, No. 4, of New Jersey.

OSTEOPYGIS EROSUS, Cope, *sp. nov.*

The largest species of the genus is represented by many specimens from the upper bed of greensand of New Jersey. Although exceeding the *O. emarginatus* in size, the posterior marginals do not present as high a degree of ossification of the interior border. These bones are thin and flat, while the laterals are very massive, and have an elevated outer lamina, much exceeding the corresponding ones of *O. sopitus* in this respect and in transverse diameter below, although they equal them in length. The pit for the first costal is at the posterior end of the second marginal. This, with the first marginal, is coössified to the carapace, as are the pygal and eleventh marginals. The vertebral bones are more than twice as long as wide; are slightly notched before, and obtusely rounded at the narrowed posterior end. The grooves of the dermal scuta are everywhere deeply impressed in this species, and the surface of all the bones marked by numerous pits resembling raindrop marking, which are somewhat irregular in their depths, and not as sharply defined as in most of the fossil *Trionyches*.

Five vertebræ exhibit the character of supporting the neural arch at only one end by a short basal articulation. In three of these, with neural arches remaining, the latter inclose a vertically oval canal. They have a small narrow area above for contact with the carapace, and, although their centra are plane, they are doubtless sacral in position. They display large facets for the diapophyses. The centrum of the last one is shorter, and has a posterior ball.

Abundant in different localities in No 5 of New Jersey.

OSTEOPYGIS EMARGINATUS, Cope.

Extinct Batrachia and Reptilia of North America, 1870, p. 136, Plate VII, fig. 3.

Greensand, No. 5, New Jersey.

EUCLASTES, Cope.

Proceedings of the Academy of Philadelphia, 1867, 39; possibly identical with *Osteopygis*.

EUCLASTES PLATYOPS, Cope.

L. c., and Extinct Batrachia and Reptilia of North America, 1870, p. 147, Plate VI.

Limestone of No. 5, New Jersey.

CATAPLEURA, Cope.

Extinct Batrachia and Reptilia of North America, 1870, p. 143.

CATAPLEURA REPANDA, Cope.

L. c., 1870, 143, Plate VII, fig. 2.

Greensand, No. 5, New Jersey.

CATAPLEURA PONDEROSA, Cope.

Proceedings of the American Philosophical Society, 1871, p. 46.

Greensand of No. 5, New-Jersey.

CATAPLEURA CHELYDRINA, Cope.

Osteopygis chelydrinus, Cope, Extinct Batrachia and Reptilia of North America, 1870, p. 138, Plate VII, fig. 8.

The reference of the last two species to this genus is not final, as the essential parts of the skeleton,—the anterior costal and marginal bones,—are not known. The type-species differs from the *Osteopygis* (in all of which the corresponding marginal bones are known) in the absence of any costal gomphosis with the second marginal.

PERITRESIUS, Cope.

Extinct Batrachia and Reptilia of North America, 1870, p. 150.

PERITRESIUS ORNATUS, Leidy, Cope.

L. c., Leidy, Cretaceous Reptiles of the United States, p. 303, Plate XVIII, fig. 10.

Greensand No. ? of New Jersey.

PNEUMATARTHRUS, Cope.

Proceedings of the American Philosophical Society, 1870, p. 446.

PNEUMATARTHRUS PELOREUS, Cope, *l. c.*

Young ?*Hadrosaurus*, Leidy, Cretaceous Reptiles of the United States, p. 100, Plate XIII, figs. 27–28.

Greensand ?No. 4, Monmouth County, New Jersey.

TOXOCHELYS, Cope.

Proceedings of the Academy of Natural Sciences, Philadelphia, 1873, p. 10.

TOXOCHELYS LATIREMIS, Cope, *l. c.* Plate VIII, figs. 1, 2.

?*Cynocercus incisus*, Cope, *l. c.*, 1872, p. 129; Leidy, Report of the United States Geological Survey of the Territories, I, p. 279, Table XXXVI, figs. 17–21.

Niobrara Cretaceous of Kansas.

CYNOCERCUS, Cope.

Proceedings of the American Philosophical Society, 1872, 308.

CYNOCERCUS INCISUS, Cope, *l. c.* Plate VIII, figs. 3–5.

Niobrara Cretaceous of Kansas.

TRIONYX, Geoffr.

TRIONYX FOVEATUS, Leidy.

Proceedings of the Academy of Philadelphia, 1856, 73; Transactions of the American Philosophical Society, 1860, 148, Table XI, figs. 1–2.

Fort Union epoch of Judith River, Montana.

TRIONYX VAGANS, Cope. Plate VI, figs. 13, 14.

Hayden's Bulletin of the United States Geological Survey, No. 2, p. 29, 1874.

Fort Union epoch of Colorado, Montana, and Nebraska.

TRIONYX PRISCUS, Leidy.

Proceedings of the Academy of Natural Sciences, 1851, p. 329; Cretaceous Reptiles of the United States, 1865, 113, Plate XVIII, fig. 9.

Greensand, No. 4, of New Jersey.

TRIONYX HALOPHILUS, Cope.

Proceedings of the Academy of Natural Sciences, 1869, p. 12; Extinct Batrachia and Reptilia of North America, 1870, p. 151, Plate VII, fig. 15.

Greensand, No. 4, of Delaware and New Jersey.

PLASTOMENUS, Cope.

Annual Report of the United States Geological Survey of Montana, Wyoming, etc., 1872, p. 617.

PLASTOMENUS COALESCENS, Cope. Plate VIII, figs. 6, 7.

Supra, p. 93.

Fort Union epoch of Milk River, Saskatchewan, British North America.

PLASTOMENUS COSTATUS, Cope. Plate VIII, fig. 8.

Supra, p. 94.

Fort Union epoch of Milk River, Saskatchewan, British North America.

PLASTOMENUS INSIGNIS, Cope. Plate VI, fig. 10.

Hayden's Bulletin of the United States Geological Survey, No. 2, 1874, p. 29.

Fort Union epoch of Colorado.

PLASTOMENUS PUNCTULATUS, Cope. Plate VI, fig. 9.

Hayden's Bulletin of the United States Geological Survey, 1874, p. 29.

Fort Union epoch of Colorado and Nebraska.

COMPSEMYS, Leidy, Cope.

Supra, p. 91.

COMPSEMYS OGMIUS, Cope.

Supra, p. 91.

Fort Union epoch of Milk River, British North America.

COMPSEMYS VICTUS, Leidy. Plate VI, figs. 15, 16.

Proceedings of the Academy of Natural Sciences, Philadelphia, 1856, p. 312; Transactions of the American Philosophical Society, 1869, p. 152, Plate XI, fig. 557.

Fort Union epoch of Nebraska, Colorado, and ? Milk River, British North America.

COMPSEMYS OBSCURUS, Leidy.

Emys obscurus, Leidy, Proceedings of the Academy of Philadelphia, 1856, 312.—*Compsemys obscurus*, Cope, Extinct Batrachia and Reptilia of North America, 1870, 124.

Fort Union epoch of Long Lake, Nebraska.

AGOMPHUS, Cope.

Proceedings of the American Philosophical Society, 1871, p. 46; Hayden's Annual Report of the United States Geological Survey of the Territories, 1872, p. 625.

AGOMPHUS TURGIDUS, Cope.

Emys turgidus, Extinct Batrachia and Reptilia of North America, 1870, p. 127.

Greensand, No. 5, of New Jersey.

AGOMPHUS PETROSUS, Cope.

Emys petrosus, Cope, Proceedings of the Academy of Philadelphia, 1868, 236; Extinct Batrachia and Reptilia of North America, 1870, 126.

Greensand, No. 5, of New Jersey.

AGOMPHUS FIRMUS, Leidy.

Emys firmus, Leidy, Cretaceous Reptiles of the United States, 1865, p. 106, Plate XIX, fig. 3.

Greensand of New Jersey, No. 5.

ADOCUS, Cope.

Proceedings of the Academy of Natural Sciences, Philadelphia, 1868, 235; Extinct Batrachia and Reptilia of North America, 1870, p. 232; Proceedings of the American Philosophical Society, 1870, p. 547.

ADOCUS PECTORALIS, Cope.

Extinct Batrachia and Reptilia of North America, 1870, p. 233, Plate VII, fig. 1.—*Pleurosternum pectorale*, Cope, *l. c.*, p. 130.

Greensand, No. 5, of New Jersey.

ADOCUS PRAVUS, Leidy.

Cope, *l. c.*, p. 234.—*Emys pravus*, Leidy, Cretaceous Reptiles of the United States, 1865, 108, Plate XIX, fig. 1; Proceedings of the Academy of Philadelphia, 1856, 303.

Greensand of New Jersey, No. 5.

ADOCUS BEATUS, Leidy.

Cope, *l. c.*, p. 233.—*Emys beatus*, Leidy, Extinct Batrachia and Reptilia of North America, 1865, p. 107, Plate XVIII, figs. 1–3.

Greensand, No. 5, of New Jersey.

ADOCUS SYNTHETICUS, Cope.

Proceedings of the American Philosophical Society, 1870, p. 548.

Greensand, No. 5, New Jersey.

ADOCUS AGILIS, Cope.

Extinct Batrachia and Reptilia of North America, 1870, p. 108.

Greensand of New Jersey, No. 5.

ADOCUS LINEOLATUS, Cope. Plate VI, figs. 11, 12.

Hayden's Bulletin of the United States Geological Survey of the Territories, No. 2, 1874, p. 30

Fort Union epoch of Montana, Colorado, and ? Saskatchewan.

ZYGORAMMA, Cope.

Proceedings of the American Philosophical Society, 1870, 550.

ZYGORAMMA STRIATULA, Cope, *l. c.*

Greensand, No. 5, New Jersey.

ZYGORAMMA MICROGLYPHA, Cope.

L. c., 1871, p. 44.

Greensand, No. 5, of New Jersey.

HOMOROPHUS, Cope.

Proceedings of the American Philosophical Society, 1870, p. 551.

HOMOROPHUS INSUETUS, Cope.

L. c., 552.

Greensand, No. 5, of New Jersey.

BOTHREMYS, Leidy.

Cretaceous Reptiles of the United States, 1865, p. 110.

BOTHREMYS COOKII, Leidy.

L. c., Plate XVIII, figs. 4–8.

Greensand, No. 4, New Jersey.

TAPHROSPHYS, Cope.

Extinct Batrachia and Reptilia of North America, 1870, p. 157; American Naturalist, 1869, p. 90.

TAPHROSPHYS MOLOPS, Cope.

Extinct Batrachia and Reptilia of North America, 1870, p. 159, Plate VII, fig. 16.

Common in greensand of No. 5, New Jersey.

TAPHROSPHYS LONGINUCHUS, Cope.

L. c., 162.

Greensand of No. 5, New Jersey.

Taphrosphys sulcatus, Leidy.

Cope, *l. c.*, p. 164.—*Platemys sulcatus*, Leidy, Proceedings of the Academy of Philadelphia, 1856, 303; Cretaceous Reptiles of the United States, 1865, 109, Plate XIX, fig. 4.

Greensand of No. 5, New Jersey.

Taphrosphys leslianus, Cope.

Extinct Batrachia and Reptilia of North America, 1870, p. 166.

Greensand of No. 5, New Jersey.

Taphrosphys strenuus, Cope.

Extinct Batrachia and Reptilia of North America, 166 B, 1870.

Greensand, No. 5, of New Jersey.

Taphrosphys nodosus, Cope.

L. c., p. 166 C, Plate I, fig. 16.

Greensand below No. 5, New Jersey.

PYTHONOMORPHA.

The quadrate bones of the species of this order are represented in Plate XXXVII In completion of the description of this portion of the skeleton, I would point out the coincidence between the forms of the quadrate bone and other characters employed in the preceding pages, as indicative of generic divisions. To the ridges already described, I would add that the "meatal knob" of *Mōsasaurus* is represented by a ridge or crest in *Liodon*, and by one less marked in *Clidastes;* and hence the term "knob-ridge" may be added. The lower part of the great anterior ala turns backward, and is generally continued upward on the outer and anterior side of the knob-ridge; this may be called the "posterior alar" ridge. We then have: *proximally*, the alar process: the internal angle; and the internal longitudinal ridge; *distally*, beginning in front, the posterior alar ridge; the knob or knob-ridge; median posterior ridge; and the distal longitudinal ridge.

Mosasaurus differs from all the other genera in the absence of the internal longitudinal ridge. No other genus is known to possess the median posterior ridge, nor is the knob of the same form in any other. *M. fulciatus* is the only species of the order in which all four of the distal ridges are present. In *M. maximus*, the knob is wanting; and in *M. giganteus*, the median posterior ridge is not found.

In *Platecarpus* and *Clidastes*, the knob-ridge is low and ends obtusely not far above the distal condyle, and the posterior alar is very prominent. In *Liodon*, the knob-ridge is much more prominent, and forms a protuberant angle below the position of the "knob" in *Mosasaurus*, which is continued by a decreasing crest to the distal condyle. This ridge, with the equally prominent posterior alar, causes a protuberance on the posterior part of the quadrate, between the meatus and the distal condyle, which is especially marked in the *Liodon validus*. In the three genera mentioned, the position of the median posterior ridge is occupied by a concave surface. *Clidastes planifrons*, Cope, is intermediate in the form of its quadrate bone, between such forms as *C. tortor* and the *Platecarpi*. Its internal angle and ridge are less prominent than in *C. tortor*, and a part of it extends so near to the stapedial pit as to have led me to call it the median posterior ridge in my original description, an error I now correct. *Platecarpus tympaniticus* is closely similar to the Kansas species of the genus in the form of this element.

In the following list are included a number of names of species which I have not seen. Those described by Dr. Leidy and myself I believe to be distinct from each other and from those described by the older authors.

CLIDASTES, Cope.

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

I. *Frontal bones without median keel; dorsal vertebræ depressed:*

CLIDASTES PLANIFRONS, Cope. Plate XXII and XXIII, figs. 1–14.

Hayden's Bulletin of the United States Geological Survey, No. 2, 1874, p. 31.

Niobrara epoch, Kansas.

II. *Frontal bones with median keel; dorsal vertebræ depressed:*

CLIDASTES PROPYTHON, Cope.

Proceedings of the Boston Society of Natural History, 1869, p. 258; Extinct Batrachia and Reptilia of North America, 1870, p. 221, Plate XII, figs. 1–21.

Rotten limestone, "No. 4," of Alabama.

CLIDASTES TORTOR, Cope. Plates XIV, fig. 1; XVI, figs. 1, 2; XVII, fig. 1; XIX, figs. 1–10; XXXVI, fig. 3; and XXXVII, fig. 2.

Edestosaurus tortor, Cope, Proceedings of the American Philosophical Society, December, 1871.

Niobrara Cretaceous of the Smoky Hill River.

CLIDASTES STENOPS, Cope. Plates XIV, figs. 4, 5; XVII, figs. 7, 8; XVIII, figs. 1–5; XXXVI, fig. 4; XXXVII, fig. 3; XXXVIII, fig. 3.

Edestosaurus stenops, l. c., Hayden's Annual Report of the United States Geological Survey, 1871, p. 330.

Niobrara Cretaceous of the Smoky Hill River.

CLIDASTES REX, Marsh.

American Journal of Science and Arts, 1872, June.

Niobrara Cretaceous of Smoky Hill River.

CLIDASTES AFFINIS, Leidy.

Report of the United States Geological Survey of the Territories, I, p. 281, Table XXXIV, figs. 6–9 and 11.

Niobrara Cretaceous of Smoky Hill River.

III. *Dorsal vertebræ, with depressed centra; frontal bones unknown:*

CLIDASTES DISPAR, Marsh.

Edestosaurus dispar, Marsh, American Journal of Science and Arts, 1871, June.

Niobrara Cretaceous of the Smoky Hill River.

CLIDASTES VELOX, Marsh.

L. c. (*Edestosaurus*).

Niobrara Cretaceous of the Smoky Hill River.

CLIDASTES VYMANII, Marsh, *l. c.*

Niobrara Cretaceous of the Smoky Hill River, Western Kansas.

CLIDASTES PUMILUS, Marsh, *l. c.*

Niobrara Cretaceous of the Smoky Hill River.

CLIDASTES IGUANAVUS, Cope.

Proceedings of the Academy of Philadelphia, 1868, p. 223; Extinct Batrachia and Reptilia of North America, 1870, p. 220, Plate V, fig. 3.

Greensand, No. 4, of New Jersey.

IV. *Centra of dorsal vertebræ compressed:*

CLIDASTES CINERIARUM, Cope. Plate XXI, figs. 14–17.

Proceedings of the American Philosophical Society, 1870, 583.

Niobrara Cretaceous of the Smoky Hill River.

V. *Dorsal vertebræ and frontals unkown; bases of some dental crowns swollen:*

CLIDASTES INTERMEDIUS, Leidy.

Proceedings of the Academy of Philadelphia, 1870 (January); Report on the United States Geological Survey of the Territories, 1873, I, p. 281, Plate XXXIV, figs. 1–5.

Rotten limestone, Pickens County, Alabama, "No. 4."

SIRONECTES, Cope.

Bulletin of the United States Geological Survey of the Territories, 1874, No. 2, p. 34.

SIRONECTES ANGULIFERUS, Cope. Plates XXIII, figs. 16–18; XXIV, figs. 1–14.

L. c., p. 34.

Niobrara Cretaceous of Kansas.

PLATECARPUS, Cope.

Extinct Batrachia and Reptilia of North America, 1870, pp. 185, 199; Proceedings of the Academy of Philadelphia, 1872, p. 141.—*Holcodus*, Cope, *nec* Gibbsii, Proceedings of the American Philosophical Society, 1871, December.—*Lestosaurus*, Marsh, American Journal of Science and Arts, 1872 (June); (*separata*, p. 9).

α. The stapedial pit inclosed between ridges:

PLATECARPUS ICTERICUS, Cope. Plates XIV, fig. 6; XV, fig. 2; XXII, figs. 3, 4; XVIII, fig. 6; XIX, fig. 9; XX. fig. 1; XXV; XXXVI, fig. 7; XXXVII, fig. 8.

Holcodus ictericus, Cope, Proceedings of the American Philosophical Society, 1870, 577, and 1871, December.—*Lestosaurus ictericus*, Marsh, American Journal of Science and Arts, 1872, June.

Niobrara chalk of the Smoky Hill River.

PLATECARPUS CORYPHÆUS, Cope. Plates XIV, fig. 3; XV, fig. 1; XVI, fig. 4; XVII, fig. 6; XX, fig. 4; XXI, figs. 1, 2; XXXVI, fig. 6; XXXVII, fig. 9.

Holcodus coryphæus, Cope, Proceedings of the American Philosophical Society, 1871, December.—*Lestosaurus coryphæus*, Marsh, *l. c.*

Niobrara chalk of the Smoky Hill River.

PLATECARPUS TYMPANITICUS, Cope. Plate XXXVII, fig. 11.

Proceedings of the Boston Society of Natural History, 1869, p. 265; Extinct Batrachia and Reptilia of North America, 1870, p. 200.—*Holcodus acutidens*, "Gibbes," Leidy, in part, Cretaceous Reptiles of the United States, p. 118, Plate VII, 4-7; VIII, fig. 1–2–7; XI, 14.

Cretaceous, No. ?, of Mississippi.

PLATECARPUS FELIX, Marsh.

Lestosaurus felix, Marsh, American Journal of Science and Arts, 1872, June, Table XIII, fig. 4.

Niobrara chalk of the Smoky Hill River, Kansas.

PLATECARPUS CURTIROSTRIS, Cope. Plates XIV, fig. 2; XV, fig. 3; XVI, figs. 5, 6; XVII, fig. 2; XVIII, figs. 7, 8; XXI, fig. 8; XXXVI, fig. 5; XXXVII, fig. 10; XXXVIII, fig. 1.

Liodon curtirostris, Cope, Proceedings of the American Philosophical Society, 1871, December.—*Lestosaurus curtirostris*, Marsh, *l. c.*

Niobrara chalk of the Smoky Hill River, Kansas.

αα. Relations of stapedial pit unknown:

PLATECARPUS CRASSARTUS, Cope. Plate XXVI, figs. 4–12.

Liodon crassartus, Cope, Proceedings of the American Philosophical Society, 1871, 168, and December

Niobrara chalk of Eagle Tail, Colorado.

PLATECARPUS SIMUS, Marsh.

Lestosaurus simus, Marsh, *l. c.*, 1872, June.

Niobrara chalk of the Smoky Hill River.

PLATECARPUS LATIFRONS, Marsh.

Lestosaurus latifrons, Marsh, *l. c.*, 1872, June.

Niobrara chalk of the Smoky Hill River, Kansas.

PLATECARPUS GRACILIS, Marsh.

Lestosaurus gracilis, Marsh, *l. c.*, 1872, June.

Niobrara chalk of the Smoky Hill River, Kansas.

PLATECARPUS? LATISPINIS, Cope. Plate XXVI, fig. 1–6.

Liodon latispinis, Cope, Proceedings of the American Philosophical Society 1871, p. 169; 1871, December.

PLATECARPUS? GLANDIFERUS, Cope. Plate XXVI, figs. 13, 14.

Liodon glandiferus, Cope, Proceedings of the American Philosophical Society, 1871, December.

Niobrara beds of the Smoky Hill River, Kansas.

ααα. Stapedial pit excavated in a plane surface:

PLATECARPUS MUDGEI, Cope. Plates XVI, fig. 3; XVII, fig. 5; XXVI, fig. 3; XXXVII, fig. 7.

Liodon mudgei, Cope, Proceedings of the American Philosophical Society, 1870, p. 581.—*Holcodus mudgei*, Cope, *l. c.*, 1871, December.—*Rhinosaurus mudgei*, Marsh, American Journal of Science and Arts, 1872, June.

Niobrara chalk of the Smoky Hill River.

PLATECARPUS TECTULUS, Cope. Plates XXI, fig. 3–6; XXVII, figs. 5–10.

Holcodus tectulus, Proceedings of the American Philosophical Society, 1871, December.

Niobrara chalk of the Smoky Hill River.

MOSASAURUS, Conyb.

Cuvier, Ossemens fossiles, X, p. 119.

α. Species with articular faces of dorsal vertebræ subround:

MOSASAURUS MAXIMUS, Cope. Plate XXXVII, fig. 15.

Extinct Batrachia and Reptilia of North America, 1870, p. 189, Plate XI, fig. 7.

Greensand of No. 4 of New Jersey.

MOSASAURUS DEKAYI, Bronn. Plate XXXVII, fig. 16.

Lethæa Geognostica, 1838, from DeKay, in Annals of the New York Lyceum, III, p. 135.—*Mosasaurus major*, DeKay, Geological Survey of New York, 1841.—? *M. carolinensis* and ? *M. couperii*, Gibbes, Smithsonian Contributions to Knowledge, vol. II, p. 6, plate.—*Mosasaurus mitchillii*, Leidy, Cretaceous Reptiles of the United States, 1865, p. 118, plates pro parte; Proceedings of the Academy of Natural Sciences, Philadelphia, 1859, p. 90.—*Bascodon reversus*, Leidy, Cretaceous Reptiles of the United States, p. 118, Plate X, figs. 14–15.—? *Mosasaurus princeps*, Marsh, American Journal of Science and Arts, 1869, 392; Cope, Extinct Batrachia and Reptilia of North America, 1870, 192, 235.

Greensand of New Jersey, No. 4 and ? No. 5; South Carolina? (Gibbes).

MOSASAURUS FULCIATUS, Cope. Plate XXXVII, fig. 13.

Extinct Batrachia and Reptilia of North America, 1870, p. 194.

Greensand of ? No. 4, New Jersey.

αα. Species with articular faces of dorsal vertebræ transversely oval:

MOSASAURUS OARTHRUS, Cope. Plate XXXVII, fig. 17.

Extinct Batrachia and Reptilia of North America, 1870, p. 196.

Greensand of No. 5, New Jersey.

MOSASAURUS MISSURIENSIS, Harlan.

Ichthyosaurus missuriensis, Harlan, Transactions of the American Philosophical Society, 1834, vol. IV, p. 405, Plate XX, figs. 3–8.—*Mosasaurus neovidii*, Goldfuss, Deutsche Naturforscher Versammlung zu Mainz, 1848, I, 141.—*Mosasaurus maximiliani*, Goldfuss, Nova Acta Acad., K. L. C. Nat. Cur., XXI, p. 179, Plates VI, VII, VIII, IX.—*Mosasaurus missuriensis*, Leidy, Proceedings of the Academy of Philadelphia, 1857, 90; Cope, Extinct Batrachia and Reptilia, of North America 1870, p. 195, exclusive of specimen from Kansas.

Cretaceous, ? No. 4, of the Missouri River.

MOSASAURUS DEPRESSUS, Cope. Plate XXXVII, fig. 12.

Extinct Batrachia and Reptilia of North America, 1870, 196.

Greensand, No. 4 or 5 ?, New Jersey.

ααα. Species known only from teeth and parts of crania:

MOSASAURUS ACUTIDENS, Gibbes.

Holcodus acutidens, Gibbes, pro parte, Smithsonian Contributions, II, p. 9, Plate III, figs. 6-9.—? *Mosasaurus minor*, Gibbes, *l. c.*, p. 7, Plate I, figs. 3-5, 1851.

Cretaceous of Alabama.

MOSASAURUS COPEANUS, Marsh.

American Journal of Science and Arts, 1869, 398; Cope, Extinct Batrachia and Reptilia of North America, 1870, p. 198.

Greensand, No. 4, New Jersey.

MOSASAURUS CRASSIDENS, Marsh.

American Journal of Science and Arts, 1870, February and March; Cope, Extinct Batrachia and Reptilia of North America, 1870, 198.

Greensand of North Carolina.

αααα. Species of uncertain reference:

MOSASAURUS MIERSII, Marsh.

American Journal of Science and Arts, 1869, 395.

Greensand below No. 5, New Jersey.

MOSASAURUS BRUMBYI, Gibbes.

Cope, Extinct Batrachia and Reptilia of North America, 1870, p. 198.—*Amphorosteus Brumbyi*, Gibbes, Smithsonian Contributions, II, 1851, p. 9, Plate III, figs. 10-16.

Cretaceous of Alabama.

LIODON, Owen.

Proceedings of the British Association for the Advancement of Science, 1841, p. 144; Cope, Transactions of the American Philosophical Society, Extinct Batrachia, etc., 1870, p. 200; Proceedings of the American Philosophical Society, 1871, December.

α. Species with the dorsal vertebral centra compressed; Macrosaurus, Owen:

LIODON LÆVIS, Owen.

Macrosaurus lævis, Owen, Journal of the Geological Society of London, 1849, 380, plate.—*Liodon lævis*, Cope, Extinct Batrachia and Reptilia of North America, 1870, 205 (exclusive of Lockwood's specimen).

Greensand, No. ?, New Jersey.

LIODON MITCHILLII, DeKay.

Geosaurus mitchillii, DeKay, Annals of the Lyceum of New York, III, p. 140.—*Mosasaurus mitchillii*, pro parte, Leidy, Cretaceous Reptiles of the United States, p. 65, Plate XI, figs. 1-4; Cope, Proceedings of the Boston Society of Natural History, 1869.—*Drepanodon impar*, Leidy, Proceedings of the Academy of Philadelphia, 1856, 255 —*Lesticodus impar*, Leidy, Geological Survey of North Carolina, p. 224, figs. 45-46, *fide* Leidy.

This species is at least twice as large as the *L. lævis*, equaling the largest of the order. Much of the cranium remains unknown, but isolated teeth are rather common. The large specimens noted by me as above, under *L. lævis*, probably belong here.

Greensand, No. 4, of New Jersey.

αα. Species with the dorsal centra depressed; Nectoportheus, Cope:

LIODON VALIDUS, Cope. Plate XXXVII, fig. 4.

Extinct Batrachia and Reptilia of North America, 1870, p. 207.—*Nectoportheus validus*, Cope, Proceedings of the Academy of Natural Sciences, Philadelphia, 1868, 181.—*Mosasaurus*, Leidy, pro parte, Cretaceous Reptiles of the United States, 1865, p. 74-75, Plate VII, 19-20, III, 1-2.

Greensand, No. 5, New Jersey.

LIODON MICROMUS, Marsh.

Rhinosaurus micromus, Marsh, American Journal of Science and Arts, 1872, June, Table XIII, figs. 1-2.

Niobrara chalk of the Smoky Hill.

LIODON NEPÆOLICUS, Cope. Plate XXXV, figs. 11-13.

Hayden's Bulletin of the United Sta es Geological Survey of the Territories, 1874, p. 37.

Niobrara epoch of Kansas.

LIODON PRORIGER, Cope. Plates XXVIII, figs. 8, 9; XXX, figs. 10-14; XXXVI, fig. 2; XXXVII, fig. 6.

Transactions of the American Philosophical Society, Extinct Batrachia, etc., 1870, p. 202.—*Macrosaurus proriger*, *l. c.*, on Table XII, figs. 22-24.—*Rhinosaurus proriger*, Marsh, American Journal of Science and Arts, 1872, June.—*Rhamphosaurus*, Cope, Proceedings of the Academy of Natural Sciences, 1872, p. 141.

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

LIODON DYSPELOR, Cope. Plates XXVIII, figs. 1-7; XXIX-XXXIII.

Proceedings of the American Philosophical Society, 1870, 574; *l. c.*, 1871, December.—*Rhinosaurus dyspelor*, Marsh, American Journal of Science and Arts, 1872, June.—*Tylosaurus dyspelor*, Leidy, Report of the Geological Survey of the Territories, I, p. 271, Table XXXV, figs. 1-11.

Niobrara chalk of Fort McRae, New Mexico, and of Smoky Hill, Kansas.

LIODON SECTORIUS, Cope.

Proceedings of the American Philosophical Society, 1871, p. 41.

Greensand, No. 5, of New Jersey.

ααα. Species of uncertain reference:

LIODON PERLATUS, Cope.

Proceedings of the American Philosophical Society, 1870, p. 497.—*Mosasaurus brumbyi*, "Gibbes," pro parte, Cope, Extinct Batrachia and Reptilia of North America, 1870, p. 198.

White limestone of Alabama.

Liodon congrops, Cope.

Extinct Batrachia and Reptilia of North America, 1870, p. 206.

Perhaps a *Clidastes.*

Rotten limestone of Alabama.

DIPLOTOMODON, Leidy.

Proceedings of the Academy of Natural Sciences, 1868, p. 202.—*Tomodon*, Leidy, Cretaceous Reptiles of the United States, 1865, 102, not of Duméril, 1853.—? —— ——, Cope, American Journal of Science and Arts, 1868, p. 417.

Diplotomodon horrificus, Leidy.

L. c., *Tomodon horrificus*, Cretaceous Reptiles of the United States, 102, Plate XX, figs. 7–9.

Greensand, No. ?, of New Jersey.

BAPTOSAURUS, Marsh.

Proceedings of the Academy of Philadelphia, 1870.—*Halisaurus*, Marsh, American Journal of Science and Arts, 1869, 395, *nec Johnsonii.*—*Baptosaurus*, Cope, Extinct Batrachia and Reptilia of North America, 1870, 208.

Baptosaurus platyspondylus, Marsh.

Cope, *l. c.*, 209.—*Macrosaurus platyspondylus*, Marsh, Proceedings of the American Association for the Advancement of Science, 1869.—*Halisaurus platyspondylus*, Marsh, American Journal of Science and Arts, 1869, 395.

Greensand, No. 5, of New Jersey.

Baptosaurus fraternus, Marsh.

L. c., 307; Cope, *l. c.*, 210.

Greensand, No. 5, of New Jersey.

PISCES.

PERCOMORPHI.

BERYX, Cuv.

Règne animal, 1817; Agassiz, Poissons fossiles.

Beryx insculptus, Cope. Plate LII, fig. 4.

Proceedings of the American Philosophical Society, 1869, p. 240.

Greensand of No. 5, New Jersey.

PERCESOCES.

SYLLÆMUS, Cope.

Report on the Fishes collected by the United States Geographical and Geological Survey of the One Hundredth Meridian, 1875. MSS.

SYLLÆMUS LATIFRONS, Cope.

L. c. supra, p. 180.

Cretaceous No. 3 or 4, of Colorado.

PELECORAPIS, Cope.

Hayden's Bulletin of the United States Geological Survey of the Territories, 1874, No. 2, p. 39.

PELECORAPIS VARIUS, Cope, *l. c.*

Benton group, near Sibley, Kansas.

ACTINOCHIRI.

PELECOPTERUS, Cope.

Supra, p. 244 A.

PELECOPTERUS PERNICIOSUS, Cope, Plate XLVIII, fig. 2; LII, fig. 2.

Supra, p. 244 D.

Ichthyodectes perniciosus, Cope, Bulletin of the United States Geological Survey of the Territories, No. 2, 1874, p. 41; ditto, *infra*, p. 275 (*lapsu calami*).

Niobrara beds of the Solomon.

PELECOPTERUS CHIRURGUS, Cope. Plate XLVIII, fig. 1; LIV, fig. 8.

Supra, p. 244 E.

Niobrara beds of the Solomon.

PELECOPTERUS GLADIUS, Cope. Plate LII, fig. 3; XLIV, fig. 12.

Supra, p. 244 E.

Portheus gladius, Cope, Bulletin of the United States Geological Survey, No. 2, 1874, p. 40; Proceedings of the Academy of Philadelphia, 1873, p. 338; *infra*, p. 274 (*lapsu calami*).

Niobrara beds of the Smoky Hill and Solomon Rivers.

ISOSPONDYLI.

PORTHEUS, Cope.

Proceedings of the American Philosophical Society, 1871, p. 173; *l. c.*, 1872, p. 333.

PORTHEUS MOLOSSUS, Cope.

Proceedings of the American Philosophical Society, 1871, p. 173; 1872, p. 333.

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

PORTHEUS THAUMAS, Cope.

Saurocephalus thaumas, Cope, Proceedings of the American Philosophical Society, 1870, November; *l. c.*, 1872, p. 335.

Same locality as the last.

PORTHEUS LESTRIO, Cope. Plates XLII, figs. 1–3; XLVII, figs. 1–5.

Proceedings of the Academy of Natural Sciences, Philadelphia, 1873, p. 337.

Niobrara Cretaceous of Kansas, near the Solomon River; abundant.

PORTHEUS MUDGEI, Cope.

Hayden's Bulletin of the United States Geological Survey of the Territories, No. 2, 1874, p. 40.

Niobrara group of Kansas.

PORTHEUS ARCUATUS, Cope. Plate XLVII, fig. 7–9.

Supra, p. 204.

Niobrara group of Kansas.

PORTHEUS GLADIUS, Cope. Plate LII, fig. 3.

Proceedings of the Academy of Natural Sciences, Philadelphia, 1873, 338.

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

Niobrara Cretaceous of the Solomon River, Kansas.

ICHTHYODECTES, Cope.

Proceedings of the American Philosophical Society, 1870, November; *l. c.*, 1872, p. 338.

ICHTHYODECTES ANAIDES, Cope. Plates XLIV, figs. 14, 15; XLV, figs. 1–8.

L. c., 1872, 339.

Niobrara Cretaceous of the Smoky Hill.

ICHTHYODECTES CTENODON, Cope. Plate XLVI, figs. 1–4.

L. c., 1870, November; *l. c.*, 1872, 340.

Niobrara Cretaceous of the Smoky Hill.

ICHTHYODECTES HAMATUS, Cope. Plate XLVI, fig. 5.

L. c., 1872, 340.

Niobrara Cretaceous of the Smoky Hill.

ICHTHYODECTES PROGNATHUS, Cope. Plate XLVI, figs. 6–10.

L. c., 1872, 341.—*Saurocephalus prognathus*, Proceedings of the American Philosophical Society, 1870, November.

Cretaceous (Niobrara) of the Smoky Hill.

ICHTHYODECTES MULTIDENTATUS, Cope. Plate L, figs. 6, 7.

L. c., 1872, p. 342.

Cretaceous (Niobrara) of the Smoky Hill.

ICHTHYODECTES PERNICIOSUS, Cope. Plate LII, fig. 2.

Bulletin of the United States Geological Survey of the Territories, No. 2, 1874, p. 41.

Niobrara group of Kansas.

DAPTINUS. Cope.

Proceedings of the Academy of Philadelphia, 1873, p. 339.

DAPTINUS PHLEBOTOMUS, Cope. Plates XLVII, fig. 6; XLIX, figs. 1–4.

Saurocephalus phlebotomus, Cope, Proceedings of the American Philosophical Society, 1870, November; Hayden's Annual Report of the United States Geological Survey, 1871, p. 416.

Niobrara epoch, Rooks and Phillips Counties, Kansas.

SAUROCEPHALUS, Harlan.

SAUROCEPHALUS LANCIFORMIS, Harlan.

Journal of the Academy of Natural Sciences, I, vol. III, 331; Leidy, Transactions of the American Philosophical Society, 1860, p. —.

Cretaceous on the Missouri River.

SAUROCEPHALUS ARAPAHOVIUS, Cope. Plate XLIX, fig. 5.

Proceedings of the American Philosophical Society, 1872, p. 343.

Niobrara epoch of the Smoky Hill, Kansas.

SAURODON, Hays.

Transactions of the American Philosophical Society, 1830, p. 476.

SAURODON LEANUS, Hays.

L. c., Plate XVI.—*Saurocephalus leanus*, Leidy, *l. c.*, 1856.

Greensand of No. 5, New Jersey.

ERISICHTHE, Cope.

Proceedings of the Academy of Philadelphia, 1872, 2-0.

ERISICHTHE NITIDA, Cope. Plate XLVIII, figs. 3–8.

L. c., and Hayden's Bulletin of the United States Geological Survey of the Territories, No. 2, p. 41, 1874.

Niobrara group of Kansas.

ERISICHTHE ANGULATA, Cope.

Portheus angulatus, Cope, Proceedings of the American Philosophical Society, 1872, p. 337; Geological Survey of North Carolina, Appendix B, p. 32.

Cretaceous, No. ?, of North Carolina.

XIPHACTINUS, Leidy.

XIPHACTINUS AUDAX, Leidy.

Proceedings of the Academy of Philadelphia, 1870, 12; Report on the Geological Survey of the Territories, 1873, I, p. 290, Plate XVII, figs. 9–10.

Niobrara epoch of Kansas.

PACHYRHIZODUS, Agassiz.

Dixon's Geology of Sussex, 1850, p. 374; Cope, Proceedings of the American Philosophical Society, 1872, p. 344.

PACHYRHIZODUS CANINUS, Cope. Plate L, figs. 1–4.

L. c., 344.

Niobrara epoch of the Smoky Hill River.

PACHYRHIZODUS KINGII, Cope. Plate XLVI, fig. 11.

L. c., 346.

Niobrara epoch of the Smoky Hill River.

PACHYRHIZODUS LATIMENTUM, Cope. Plates L, fig. 5; LI, figs. 1–7.

L. c., 346.

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

PACHYRHIZODUS SHEARERI, Cope.

Proceedings of the American Philosophical Society, 1872, p. 347.

Niobrara epoch of the Smoky Hill River.

PACHYRHIZODUS LEPTOPSIS, Cope. Plate LI, fig. 8.

Hayden's Bulletin of the United States Geological Survey of the Territories, No. 2, 1874, p. 42.

Niobrara epoch of Kansas.

CONOSAURUS, Gibbes.

Smithsonian Contributions, 1851, vol. II, p. 10.—*Conosaurops*, Leidy, Proceedings of the Academy of Philadelphia, 1868, p. 202.

CONOSAURUS BOWMANII, Gibbes, Leidy, *l. c.*

Greensand, No. ?, Burlington County, New Jersey.

PHASGANODUS, Leidy.

Report of the United States Geological Survey of the Territories, I, 1873, 289.

PHASGANODUS DIRUS, Leidy.

Proceedings of the Academy of Natural Sciences, Philadelphia, 1857, p. 167; Report of the Geological Survey of the Territories, 1873, I, p. 289, Table XVII, figs. 23, 24.

From Cannonball River, Dakota.

PHASGANODUS GLADIOLUS, Cope. Plate XLII, fig. 11.

Cimolichthys gladiolus, Cope, Proceedings of the American Philosophical Society, 1872, p. 353.

Niobrara epoch of the Smoky Hill River.

PHASGANODUS ANCEPS, Cope. Plate XLII, fig. 2.

Cimolichthys anceps, Cope, Proceedings of the American Philosophical Society, 1872, p. 352.

Niobrara epoch of the Smoky Hill River.

PHASGANODUS CARINATUS, Cope.

Sphyræna carinata, Cope, Hayden's Annual Report, 1870, p. 424.

Niobrara epoch of Kansas.

PHASGANODUS SEMISTRIATUS, Marsh.

Enchodus semistriatus, Marsh, Proceedings of the American Association for the Advancement of Science, 1870, 230.

Greensand of No. 4, New Jersey.

TETHEODUS, Cope.

Hayden's Bulletin of the United States Geological Survey of the Territories, No. 2, 1874, p. 43.

TETHEODUS PEPHREDO, Cope, *l. c.* Plate LIV, figs. 1–3.

Niobrara group of Kansas.

ENCHODUS, Agassiz.

Poissons fossiles, V.

ENCHODUS FEROX, Morton, Leidy.

Proceedings of the Academy of Philadelphia, 1855, p. 397.

Below greensand, No. 5, New Jersey.

ENCHODUS PRESSIDENS, Cope.

Proceedings of the American Philosophical Society, 1869, p. 241.

Greensand, No. ?, of New Jersey.

ENCHODUS PETROSUS, Cope. Plate LIV, figs. 4, 5.

Hayden's Bulletin of the United States Geological Survey of the Territories, No. 2, p. 44.

Niobrara group of Kansas.

ENCHODUS DOLICHUS, Cope. Plate LIV, fig. 7.

Supra, p. 240.

Niobrara Cretaceous of Kansas

ENCHODUS OXYTOMUS, Cope, *sp. nov.*

Represented by one of the long teeth from the anterior extremity of the premaxillary or dentary bones. It differs from other species of the genus in the extent to which the posterior cutting-edge is prolonged downward toward the base of the tooth, nearly equaling in this respect the anterior edge. As in all other *Enchodi*, the cutting-edges are not opposite, and a section of the base is unsymmetrical. Cementum mostly smooth. Crown rather broad for its length, which is below the average of the Cretaceous species.

Clays below Cretaceous, No. 4, New Jersey.

ENCHODUS TETRÆCUS, Cope, *sp. nov.*

Established on various teeth from the greensand of Delaware and New Jersey. The elongate anterior teeth are narrow and slender; the greatest diameter at the base being at right angles to that of the upper part of the crown. The posterior side is, as usual, much more convex than the anterior, and the two faces are separated by cutting-edges, both of which extend to the base of the crown. A shallow groove runs just behind each cutting-edge to the base, giving the latter an unsymmetrical figure-8-form of section. The anterior face is but little convex, and is perfectly smooth; the posterior is very convex, and is marked with sharply defined grooves, about half-way to the apex from the base, between the lateral shallow grooves. Fifteen may be counted from side to side. Length of crown, $0^{m}.030$; median diameter, $0^{m}.005$; basal diameter, $0^{m}.007$.

Cretaceous, No. 4, Delaware and New Jersey.

ENCHODUS CALLIODON, Cope.

L. c., p. 354.

Niobrara epoch of the Smoky Hill River.

ENCHODUS SHUMARDII, Leidy.

Proceedings of the Academy of Natural Sciences, Philadelphia, 1856, 257; Report of the United States Geological Survey of the Territories, I, 1873, 289, Table XVII, fig. 20.

Sage Creek, Dakota.

EMPO, Cope.

Proceedings of the American Philosophical Society, 1872, p. 347.—*Cimolichthys*, Cope, *l. c.*, p. 348 (attributed to Leidy, but not his genus).

EMPO NEPÆOLICA, Cope. Plates XLIX, fig. 9; L, fig. 8; LII, fig. 1; LIII, figs. 3–5.

Proceedings of the American Philosophical Society, 1872, p. 347.—*Empo sulcata*, Cope, Hayden's Bulletin of the United States Geological Survey, No. 2, p. 46.—*Cimolichthys sulcatus*, Cope, *l. c.*, p. 351.

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

EMPO SEMIANCEPS, Cope. Plate LIII, figs. 1, 2, and 6–9.

Cimolichthys semianceps, Cope, *l. c.*, p. 351.

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

EMPO CONTRACTA, Cope. Plate LIII, figs. 14–17.

Hayden's Bulletin of the United States Geological Survey of the Territories, No. 2, 1874, p. 46.

Niobrara Cretaceous of Kansas.

EMPO MERRILLII, Cope. Plate LIII, figs. 10–13.

Ibid., p. 46.

Niobrara Cretaceous of Kansas.

STRATODUS, Cope.

Proceedings of the American Philosophical Society, 1872, p. 348.

STRATODUS APICALIS, Cope. Plate XLIX, figs. 6–8.

L. c., p. 349.

Niobrara epoch of the Smoky Hill River.

APSOPELIX, Cope.

Hayden's Annual Report, 1870, p. 423.

APSOPELIX SAURIFORMIS, Cope. Plate XLII, fig. 4.

L. c., 1870, 424.

Benton epoch at Bunker Hill, Kansas.

HAPLOMI.

ISCHYRHIZA, Leidy.

Proceedings of the Academy of Philadelphia, 1856, 221; Cope, Proceedings of the American Philosophical Society, 1872, 354.

One species of this genus is not rare in the New Jersey greensand; and a second one has been described from North Carolina, which may be of Miocene age, or be Cretaceous, but intrusive in Miocene beds. In any case, this or an allied genus is abundant in the Miocene of Maryland; but the teeth of the species have not yet been obtained. The form, as I have already pointed out, is allied to the living *Esox*, but is referable to a distinct family (the *Ischyrhizidæ*), based on the coössification of many of the terminal caudal vertebral centra and spines into a fan-shaped body of considerable strength.

Ischyrhiza mira, Leidy.

L. c., p. 221.

Greensand, No. 5, New Jersey, near Harrisonville.

Ischyrhiza antiqua, Leidy.

L. c., 1856, p. 256; Emmons, Geological Survey of North Carolina, 1856, figs. 47–48.

? Cretaceous of Neuse River. North Carolina.

PYCNODONTES.

PYCNODUS, Agassiz.

Poissons fossiles, 1833, I, p. 16; II, p. 183.

Pycnodus faba, Leidy.

Report of the United States Geological Survey of the Territories, 4to, I, p. 292, Plate XIX, fig. 16.

Greensand, No. ?, of New Jersey.

Incertæ sedis.

POLYGONODON, Leidy.

Polygonodon vetus, Leidy.

Proceedings of the Academy of Philadelphia, 1856, 221; Cretaceous Reptiles of the United States, 118, Plate IX, figs. 12–13.

Greensand of Burlington County, New Jersey.

HOLOCEPHALI.

LEPTOMYLUS, Cope.

Proceedings of the Boston Society of Natural History, 1869, p. 313.

Three species of this genus are known to the writer, which may be distinguished as follows:

I. Mandible without apical dentinal cylinder:

Large, massive, and not compressed .... *L. densus.*

II. A terminal or apical cylinder:

Outer margin much elevated; inner much depressed; large.. *L. forfex*

Outer margin less elevated; the inner equally so; smaller... *L. cookii.*

LEPTOMYLUS DENSUS, Cope.

Proceedings of the Boston Society of Natural History, 1869, p. 313.

Greensand of New Jersey, No. 5; Birmingham, Judson Gaskill.

LEPTOMYLUS FORFEX, Cope, *sp. nov.*

This chimæroid is represented by two mandibles from distant localities, and probably by a maxillary bone. The form of these elements is highly characteristic. The mandible is much elevated; but the elevation is confined to the outer side, which rises as a lamina, causing the masticating face to be nearly vertical for much of its length; but a short extent is level to the apex. There is a slight marginal swelling where the anterior outer dentinal area should be, and an abrupt rise in the margin to the position occupied in *Ischyodus* by the posterior outer area. The inner border of the masticating surface is parallel to the inferior border of the jaw, except where the two converge to the apex; here the entire face included between them is occupied by the large symphyseal facet. The inner dentinal area is represented by a narrow acuminate patch on the inner angle of the masticatory face, opposite the tuberosity which represents the anterior outer. The apical area is very narrow, and extends for some distance along the exterior angle of the superior face.

Measurements.

	M.
Length of a fragment	0.135
Length to the posterior outer tuberosity	0.066
Depth behind	0.102
Depth at the anterior outer tuberosity	0.055
Depth of the inner face behind	0.031
Length of the inner dentinal area	0.014
Width at the inner angle (behind)	0.023
Width near the superior border	0.013

The maxillary was found in connection with mandibles of *Ischyodus mirificus*, but does not pertain to them, and is only inferentially referred to this species. The resemblance to the mandibles is very great. Its oblique superior and outer face is greatly extended, while the inner is narrow and vertical. The usual superior groove is present, and close to the edge of the latter. The inferior border is quite thin. There are only two dentinal areas present, and these are exceedingly small, representing the outer and anterior inner of the species of *Ischyodus*. Length, $0^{m}.140$; width, $0^{m}.024$; depth (oblique), $0^{m}.070$.

This species is readily distinguished from its congeners.

From the greensand of New Jersey, No. 5; a mandible from Hornerstown, from John C. Miers, and mandible and maxillary from near Barnesborough, from I. C. Voorhees.

LEPTOMYLUS COOKII, Cope.

Proceedings of the American Philosophical Society, 1870, p. 384.

Greensand of New Jersey, No, 5, near Mount Holly, Burlington County.

EUMYLODUS, Leidy.

EUMYLODUS LAQUEATUS, Leidy.

Report of the United States Geological Survey, by F. V. Hayden, vol. I, p. 309, Plates XIX and XXXVII.

Cretaceous, near Columbus, Northern Mississippi.

BRYACTINUS, Cope, *genus novum.*

Represented by a bone of the jaws, either mandibular or premaxillary. It resembles, in several respects, the *Eumylodus laqueatus*, Leidy; but differs in having several dentinal areas exposed along the outer margin, and in having the apical tube exposed at both extremities. From *Ischyodus*, it differs in the same respects and the excavation of the posterior half of the inner face.

BRYACTINUS AMORPHUS, Cope.

The section of the jaw is triangular; the base representing the grinding-face, and not level, but, like both the others, slightly convex. The opposite angular ridge only extends half the length of the jaw, and then sinks, and exposes the posterior end of the apical column of dentine. Three other columns issue on the grinding-face along the outer border, and are not parallel in their courses, but divergent from nearer origins. The inner face behind the posterior exit of the apical column is excavated as if for the application of another bone; hence, I have suspected that the piece described might be premaxillary. The grinding-face is convex at the middle, but divided into two planes posteriorly: the outer narrow and elevated; the inner oblique, and separated by an obtuse angle from the excavation of the inner side.

Measurements.

	M.
Length of the fragment	0.042
Length of the fragment to the posterior exposure of the apical column	0.020
Depth at the end of the apical angular ridge	0.018
Width opposite the end of the apical angular ridge	0.016
Width of the fragment behind	0.009

This species is associated in my collection with specimens of *Ischyodus smockii*, but cannot be the premaxillary of that species, since that element occurs in the same series, and is similar to that observed in other species of the genus.

DIPHRISSA, Cope, *genus novum.*

Established on peculiarities exhibited by the mandibular dentition There is a large inner area of dentinal tubules, and a terminal one issuing near the apex. There is but a single small external area In *Ischyodus*, there are two such areas; but, in other respects, the mandibles of the two genera are similar.

DIPHRISSA SOLIDULA.

Ischyodus solidulus, Cope, Proceedings of the American Philosophical Society, 1869, p. 244.

Greensand of New Jersey, No. 5, at Hornerstown; from John G. Miers.

DIPHRISSA LATIDENS, Cope.

Indicated by a mandibular ramus, derived from the same locality and donor as the last species. Anterior portion or beak narrowed; the apical area flat, or crescent-like. Inner area very wide, leaving but a narrow border on the outer side of it. This band is but little oblique, the edge being slightly elevated, and does not exhibit any dentinal area. The single outer column issues near the border; its posterior edge in transverse line with the anterior edge of the inner area, its anterior extremity extending a short distance beyond. The anterior border of the inner area is broad and obtuse.

Measurements.

	M.
Length of the fragment	0.094
Length to the outer area	0.031
Length to the inner area	0.041
Width of the inner area	0.029
Width at the inner area	0.038
Width of the outer area	0.004

Greensand of New Jersey, No. 5.

ISCHYODUS, Egerton.

The species of this genus are numerous in the greensand of New Jersey, but have not yet been met with elsewhere in North America. One occurs in the Eocene formation of the same State, which is nearly allied to the Cretaceous forms. The species may be distinguished as follows:

I. Dentinal areas very small; the inner represented by two columns, widely separated from each other:
   Form compressed; grinding-face vertical behind .... *I. stenobryus.*

II. Dentinal areas moderate; the inner represented by three adjacent areas:
   Inner area inside of margin; outer margin with tuberosities .... *I. tripartitus.*

III. Inner dentinal area undivided:
   A Inner area contracted, and separated by a plane from the inner margin:
      Anterior outer on a prominent ledge .... *I. longirostris.*
   AA. Inner area extending to inner margin of superior face of mandible:
      B. The anterior outer area produced anterior to the inner area:
         External areas on laminar crests of the border; posterior area very small; anterior crest produced .... *I. laterigerus.*
         Each of the outer areas produced, and standing on a horizontal step of the thin outer margin .... *I. smockii.*

Anterior outer within the border, oval, on a high tuberosity; beak long, narrow; maxillary areas large .... *I. eocænus.*

Anterior outer oval, standing on a high tuberosity; maxillary areas small; beak narrow .... *I. monolophus.*

Anterior outer oval, much within the border, on a low tuberosity; beak thick, long.... *I. incrassatus.*

Anterior outer oval, not on a tuberosity; posterior outer minute .... *I. gaskillii.*

BB. Anterior outer area not produced anterior to the border of the inner area:

Anterior outer moderate, on a prominent angle of outer margin; inner margin abruptly excavated from inner area, which is wide. *I. fecundus.*

Anterior outer area not standing on an angle; inner border not abruptly excavated; inner area narrowed, not produced beyond anterior outer .... *I. mirificus.*

Anterior outer area not on a projection, not extending as far as inner, which is narrow; beak long, straight.................... *I. miersii.*

Exterior areas very small, the anterior not on an elevation; beak not excavated, but turned outward; inner area very wide .... *I. divaricatus.*

Ischyodus stenobryus, Cope.

Indicated by both rami of the mandibular arch. The characters are striking. The outer border rises rapidly from a little behind the apex, first to a shoulder, which supports the first exterior dentinal area, and then steeply to an oblique border, which bears the posterior area. The inner masticatory margin remains parallel with the inferior border of the jaw, marking one-third the total depth. The external areas are very narrow, and behind the anterior a smaller one appears in the position of the inner one of *I. tripartitus*, thus representing the outer part of the large inner area. The inner part of this area appears on the inner edge, far removed from the former, is narrow, and extends a little anterior to the anterior border of the anterior outer. The apex of the jaw is obtuse, and the terminal area is on its superior aspect, is oval, and continues as the edge of a lamina along the outer margin of the beak. There is no symphyseal plane, and the whole jaw is much compressed and narrowed. It has much the form of that of *Leptomylus forfex*, and approaches the *I. laterigerus*.

Measurements.

	M.
Length of the fragment (total)	0.070
Depth behind	0.080
Depth at the posterior outer area	0.064
Depth at the anterior outer area	0.041
Depth at the inner area	0.024
Depth of the inner face behind	0.027
Width at the inner area	0.018
Width behind at the inner angle	0.021
Width behind near the summit	0.015

Hornerstown, New Jersey. Greensand of No. 5.

ISCHYODUS TRIPARTITUS, Cope.

I. mirificus, "Leidy," Cope, Proceedings of the Boston Society of Natural History, 1869, p. 314, not of Leidy.

This species was embraced in the specimens mentioned by Professor Leidy as having furnished the type of his *I. mirificus;* and, as his first description does not specify to which of them he referred, I had supposed that those belonging to the present species were the ones described. As Dr. Leidy has subsequently selected a different one as his type (in Report of Hayden's United States Geological Survey), it remains to give the present Chimæroid a new appellation.

The *I. tripartitus* is the largest of the American species of the genus, and is not uncommon in the greensand of No. 5. The tripartite division of the inner area is a prominent feature: the three columns are united at their adjacent borders; and the outer is more than twice as large as either of the two interior ones. The latter are separated from the inner angle of the jaw by an oblique plane of some width, a character which is only seen in the *I. longirostris* among the other species of this genus known to me. The external areas are narrow; the posterior quite small. The anterior is elongate, and extends far in advance of the inner areas along the summit of a horizontal ridge, which is produced as a strong step of the outer margin. The outer narrow border rises abruptly opposite the middle of the anterior area, causing the masticatory face to be very oblique at that point. The outer face of the jaw exhibits two longitudinal convexities, and the inner is nearly vertical, and with a short symphyseal plane. The beak is narrow and produced. The maxillary bones which accompanied the type-specimens are of usual character. The dentinal areas are large, and the anterior border not much produced. Superior groove wide; outer face not produced.

Measurements.

	M.
Total length	0.175
Depth behind	0.090
Depth at the posterior outer area	0.080
Depth at the anterior outer area	0.055
Length to the anterior outer area	0.075
Width at the anterior outer area	0.038
Width at the in- er angle behind	0.033
Width at the middle of the beak	0.020

The type-specimens of this species came from the upper bed of green-sand at Hurffville, New Jersey. It includes both mandibles and the left maxillary bone. Specimens agreeing with these in all respects are not uncommon.

ISCHYODUS LONGIROSTRIS, Cope.

With this species, we enter the more typical group of the genus. The form of the *I longirostris* is much that of the *I. fecundus*, but is characterized by a considerably greater anterior prolongation, and by the narrowing of the inner area, so as to leave a wide oblique plane between it and the inner angle of the jaw. The outer posterior area is lost from the specimen, but the outer anterior opens in front of the interior on a horizontal step, which forms a strong angle of the outer border. This border is, therefore, abruptly excavated from that point forward, while the inner border descends gradually from the inner angle. The terminal area is quite large and oblique. The symphyseal face is large, and the inferior border of the jaw obtuse, while the end of the jaw is narrowly compressed.

Measurements.

	M.
Total length	0.112
Depth at the anterior outer area	0.053
Depth at the middle of the beak	0.020
Width at the middle of the beak	0.017
Width at the angle behind	0.033
Width of the inner area	0.015

A maxillary bone accompanying the mandible is characterized by the small size and posterior position of the anterior area, so that the bone appears to be more produced. The posterior areas are large.

Greensand of No. 5; from Birmingham, New Jersey; discovered by Judson C. Gaskill, of that place.

ISCHYODUS LATERIGERUS, Cope.

Proceedings of the American Philosophical Society, 1869, 243.

Greensand of No. 5, from Hornerstown, New Jersey; John C. Miers.

A very distinct species, not obtained since the discovery of the type.

ISCHYODUS SMOCKII, Cope.

Proceedings of the Boston Society of Natural History, 1869, p. 316.

A well-marked species from the same horizon as the preceding. Several individuals have been obtained from Mr. Miers's marl-pits at Hornerstown, New Jersey.

ISCHYODUS EOCÆNUS, Cope.

Represented by parts of three individuals from the Eocene greensand of Farmingdale, Monmouth County, New Jersey. One of these includes the premaxillary and maxillary; another, the mandible. Their size is similar, and they were taken from the same excavations, but at different times. It is, therefore, uncertain whether they all belong to the same species, but it is probable.

The mandible may be selected as the type. The inner and posterior outer areas are unfortunately broken away. The outer border of the beak rises abruptly to a considerable elevation, which supports the anterior outer area. The latter is oval, and well within the border; it is cut off at its posterior portion, but in advance of the position of the inner area. The terminal column is laminar, and extends well back on the outer edge of the beak. The outer face of the jaw is uniformly convex to the anterior outer area, and the apex is transverse, not compressed. The symphyseal face is not well marked.

Measurements.

	M.
Length to the anterior outer area	0.050
Depth at the anterior outer area	0.040
Width at the anterior outer area	0.028
Width at the middle of the beak	0.018

The areas of the maxillary are large and elongate, but not on elevated bases, as in *I. smockii*. The external face of the premaxillary is smooth; the lower border very oblique to the interior, which is longitudinally grooved. The portion preserved includes five dentinal columns, the inner borders more or less exposed. The median or interior column is the largest. This piece is similar in generic characters to that of *I. mirificus.*

This species is quite near to the *I. monolophus*, differing in the uniform convexity of the outer face, which is in the latter partially concave. A maxillary bone from the locality from which the latter was derived differs from that of the *I. eocænus* in the small size of its areas; its reference is not certain.

From the Eocene greensand of New Jersey.

ISCHYODUS MONOLOPHUS, Cope.

Proceedings of the Boston Society of Natural History, 1869, p. 314.

Greensand, No. 5, of New Jersey, near Barnesborough; I. C. Voorhees, discoverer.

ISCHYODUS INCRASSATUS, Cope.

This large species has a general resemblance to the *I. mirificus*, differing in important details. Thus, the apex of the inner dentinal area marks only the middle of the anterior outer instead of the anterior extremity. The latter is horizontal, standing on a considerable tuberosity, which is removed within the outer border of the jaw, so that the latter is not angulated there as in some similar species, as *I. fecundus*. The convexity of the lower half of the outer face of the jaw is very strong, so that the lower border is thicker than in any other species here enumerated. The inner area is undivided, and slopes to the inner edge of the jaw; it is of medium extent. The symphyseal face is a narrow border along the inner edge of the beak; the inner face of the jaw is plane, and is longitudinally striate with low ridges. The beak is but little curved outward.

Measurements.

	M.
Length of the fragment	0.125
Length to the anterior outer area	0.060
Depth at the anterior outer area	0.045
Width at the anterior outer area	0.030
Width at the middle of the beak	0.021
Depth at the middle of the beak	0.022
Width of the inner area obliquely	0.028

But one specimen of this species has come under my observation, and it was found at Hornerstown, New Jersey, by John G. Miers, in the greensand of Cretaceous No. 5.

ISCHYODUS GASKILLII, Cope.

This Chimæroid makes a nearer approach to the species of *Diphrissa* than any other member of this genus. This is seen in the very small size of the external dentinal columns; especially of the posterior, which is not only small but shallow. The anterior is oval, within the outer border, and not on a tuberosity; its anterior border is considerably beyond that of the inner area. The latter is rather narrow and oblique, extending to the inner border of the jaw, and leaving a wide band between it and the outer. The inner and outer borders of the beak are continuous, and not abruptly excavated; but the outer rises considerably higher posteriorly, carrying the solid upper surface as a narrow plane horizontal in transverse section. The inner face is gently concave, with very slight symphyseal bevel; the outer mostly concave, so that the lower border is quite narrow. The long axis is regularly curved outward. The terminal area is less narrowed than usual, the column being a cylinder, with a narrow superior lamina.

Measurements.

	M.
Total length	0.077
Depth at the posterior outer area	0.040
Depth at the anterior outer area	0.025
Depth at the middle of the beak	0.013
Width at the middle of the beak	0.010
Width at the posterior outer area	0.020
Width of the inner area	0.015

Greensand of New Jersey, No. 5. From the marl-pits of Judson Gaskill, at Birmingham, a locality which, through the interested care of the proprietor, has yielded many important additions to paleontology.

ISCHYODUS FECUNDUS, Cope.

A large species, second in the genus to the *I. tripartitus.* Both the inner and anterior outer dentinal areas are narrowed anteriorly, and they terminate on the same transverse line. The anterior outer is rather small and wide, and is horizontal, so that the apex is elevated abruptly above the outer border of the beak; but not to the same extent as is seen in *I. smockii,* nor are the outer areas elongate, as in that species. The present fish is also twice as large. The inner border of the beak has the same abrupt descent as the outer. This form distinguishes it from *I. mirificus.* The posterior outer area is rather small, while the inner is large. The long axis is strongly curved, and the outer side concave in vertical as well as transverse section. The inner face is also concave, with narrow symphyseal plane along inner border. The apical column is an oblique lamina. The maxillaries are narrowed and truncate in front; the areas are large, especially the posterior. The superior groove is deep, and the outer face extensive and longitudinally ridged.

A specimen from Medford, New Jersey, resembles the others, but is only half the size.

Measurements.

	M.
Total length	0.135
Depth at the posterior outer area	0.058
Depth at the anterior outer area	0.040
Depth at the middle of the beak	0.023
Width behind at the inner angle	0.030
Width at the anterior outer area	0.030
Width at the middle of the beak	0.020
Length of the maxillary	0.110
Width at the apex	0.017
Width at the posterior edge of the posterior area	0.042
Depth of the outer face of the maxillary	0.042

Eight lower jaws of this Chimæroid are before me, several of them accompanied by maxillary bones. The eighth is, as before mentioned, from Medford, New Jersey. The others are from the same horizon, greensand of Cretaceous, No. 5, from Birmingham and Hornerstown.

ISCHYODUS MIRIFICUS, Leidy.

Edaphodon mirificus, Leidy, Proceedings of the Academy of Philadelphia, 1856, p. 221; Report of the United States Geological Survey, Hayden, I, p. 306, Plate XXXVII, figs. 1–6.

Six lower jaws of this species, several of them accompanied by maxillaries, resemble closely the one described and figured by Leidy, as above. As Leidy represents, the inner, and especially the outer, borders of the beak are not abruptly excavated from the extremities of the dentinal area, but form a line generally uninterrupted. The anterior outer area is not supported on a tuberosity or angle, and is situated well inside the outer border. One specimen includes all the pieces of the jaws. The premaxillaries are entire. The median and outer borders are thickened, the latter most so; while the inner concave face is excavated to a horizontal border of a basal thickening that extends from one edge to the other. The marginal dentinal areas are eight in number, the inner and outer larger than the intervening ones.

The specimens in my possession are from near Barnesborough and Hornerstown, New Jersey; greensand, No. 5.

ISCHYODUS MIERSII.

? *Dipristis miersii*, Marsh, Proceedings of the American Association for the Advancement of Science, 1870, p. 230.

The mandible of this species is peculiar in several respects. The beak is long and straight, and the outer face is concave to the base of the anterior outer dentinal area. The anterior outer dentinal area is not elevated above the grinding-face in front of it, and is near the edge of the jaw. The inner area is acuminate, and produced beyond it, and extends to the inner border. The inner face is slightly concave, with a broad symphyseal bevel along the inner margin. The apical area is the end of a curved laminar column. The long axis of the jaw is straight, as is the inferior border, differing from allied species, which are more or less curved. Lower border transversely thickened.

Measurements.

	M.
Length of the fragment	0.100
Length to the anterior outer area	0.055
Depth at the anterior outer area	0.030
Width at the anterior outer area	0.022
Width of the middle of the beak	0.015
Depth at the middle of the beak	0.015
Diameter of the lower border at the middle of the beak	0.017

A broken maxillary and a dorsal spine accompany this mandible. The latter is identical with the ichthyodorulite described by Marsh, as above, as *Dipristis miersii.* My specimens are from the locality from which the latter was derived, viz, the excavations on the property of John G. Miers, at Hornerstown, Monmouth County, New Jersey.

ISCHYODUS DIVARICATUS, Cope.

Proceedings of the Boston Society of Natural History, 1869, p. 315.

Besides the typical specimen, three others have come into my hands. They exhibit the general peculiarities, as the uninterrupted masticatory surface, the small external areæ, the anterior subround, and opposite or behind the apex of the very large inner; the narrowed beak making an angle with the posterior part of the jaw, and penetrated by a laminar column of little width. Size rather less than that of *I. fecundus.*

New Jersey greensand, No. 5, from near Hornerstown.

MYLOGNATHUS, Leidy

Proceedings of the Academy of Philadelphia, 1856, 312.

MYLOGNATHUS PRISCUS, Leidy.

Proceedings of the Academy of Philadelphia, 1856, 312; Transactions of the American Philosophical Society, 1860, Plate.

Fort Union Cretaceous of Long Lake, Nebraska.

ISOTÆNIA, Cope.

Established on a maxillary bone, which differs from that of *Ischyodus* in wanting the superior groove. Two dentinal columns are exposed, which represent the anterior two of that genus; but they differ in being on the same plane, and hence issuing on the masticatory face together, being only separated by a narrow partition. Whether the other column is present is not ascertainable, as the lower part of the bone is removed.

ISOTÆNIA NEOCÆSARIENSIS, Cope.

The solid planes of the maxillary bone of this species are three; the widest is opposite to the dentinal columns and parallel with them; it is nearly as wide as they. The lateral planes are not parallel with each other: the wider forms an acute angle with the last described; the narrower, a very obtuse angle, so as to be nearly continuous with the same, running out into it posteriorly. The more vertical side retains the same depth throughout. One end of the bone is rounded and truncate; the other is excavated directly at right angles to the dentinal areæ, and then continued as an edentulous plate, which is soon broken off in the specimen.

Measurements.

	M.
Total length	0.093
Length of the dentinal columns	0.096
Width of the dentinal columns	0.030
Depth on the vertical side	0.020

Greensand of New Jersey, No. 5, at Hornerstown; John G. Miers.

SPHAGEPŒA, Cope.

Proceedings of the American Philosophical Society, 1869, p. 241.

SPHAGEPŒA ACICULATA, Cope, *l. c.*

Greensand of No. 5, Birmingham, New Jersey.

ELASMOBRANCHII.

PTYCHODUS, Agassiz.

Poissons fossiles, 1833, III, 150.

PTYCHODUS POLYGYRUS, Agassiz.

Poissons fossiles, III, p. 156; Gibbes, Journal of the Academy of Philadelphia, 1849, 299, Plate XLII, figs. 5–6; Leidy, Proceedings of the Academy of Philadelphia, 1868, p. 208.

Rotten limestone of Alabama, and Niobrara epoch of Kansas.

PTYCHODUS JANEVAII, Cope.

Sporetodus janevaii, Cope, Hayden's Bulletin of the United States Geological Survey of the Territories, No. 2, 1874, p. 47.

Niobrara Cretaceous of Kansas.

PTYCHODUS OCCIDENTALIS, Leidy.

Proceedings of the Academy of Philadelphia, 1868, p. 207; Report of the United States Geological Survey of the Territories, 1873, p. 398, Table XVII, 7–8, XVIII, 15–18.

Niobrara epoch of the Smoky Hill.

PTYCHODUS MORTONII, Agassiz.

Poissons fossiles, III, p. 158, Plate 25, figs. 1–3.

Niobrara Cretaceous of the Smoky Hill River, Professor Mudge; Alabama; Mississippi.

PTYCHODUS WHIPPLEYI, Marcou.

Geology of North America, 1858, p. 33; Leidy, Report, etc., 1873, 300, Table XVIII, 19–20.

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

PTYCHODUS MAMMILLARIS, Agassiz.

Poissons fossiles, III, p. 151.

Cretaceous greensand, No. 4, of Delaware.

PTYCHODUS PAPILLOSUS, Cope.

The grinders of this species possess the elevated form of those of *P. whippleyi*, and are of about the same size. The surface is characterized by the absence of folds or ridges, but is uniformly covered with subequal areolæ or papillæ of small size, giving the cementum a shagreened appearance.

Cretaceous, No. 3, of Colorado, east of the Rocky Mountains.

GALEOCERDO, M. & H.

Agassiz, Poissons fossiles.

GALEOCERDO CRASSIDENS, Cope.

Proceedings of the American Philosophical Society, 1872, p. 355.

Niobrara epoch of the Smoky Hill.

GALEOCERDO HARTVELLII, Cope.

L. c., 1872, 356.

Niobrara epoch of the Smoky Hill.

GALEOCERDO FALCATUS, Agassiz.

Leidy, Report of the United States Geological Survey of the Territories, I, p. 301, Table XVIII, 29–43.

Niobrara epoch of the Smoky Hill; greensand of New Jersey.

GALEOCERDO PRISTODONTUS, Agass.

Greensand of New Jersey; buff sandstone of Gallinas, New Mexico.

CARCHARODON, Agassiz.

Poissons fossiles, III.

CARCHARODON ANGUSTIDENS, Agassiz.

Gibbes, Journal of the Academy of Philadelphia, 1849.

Greensand of No. 5, New Jersey.

OTODUS, Agassiz.

Poissons fossiles, 1833, vol. III

OTODUS DIVARICATUS, Leidy.

Report, I, p. 305, Table XVIII, figs. 26–28.

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

Jewell County, Kansas, Professor Mudge; also Mississippi.

OTODUS APPENDICULATUS, Agassiz.

Poissons fossiles, III.

Greensand, No. 5, of New Jersey.

OXYRHINA, Agassiz.

OXYRHINA EXTENTA, Leidy.

L. c., p. 302, Table XVIII, figs. 23–25.

Niobrara epoch of the Smoky Hill.

OXYRHINA?

A species with flat but narrower crown than the last, and with perfectly smooth cementum; the base of the latter being serrulate on the convex side of the crown. No denticles. Crown with a lateral curvature.

Common in the greensand, No. 4, New Jersey.

OXYRHINA?

With crown flatter and broader than the last; frequently oblique, but not curved, and not unfrequently with lateral denticles. Cementum smooth, except a short distance from the base on the convex side striate-grooved.

Common in the greensand, No. 4, New Jersey.

OXYRHINA?

A species with much narrower crown than the preceding species, and at the same time flat, and with transversely-extended and shallow roots. Crown oblique, but not curved; cementum perfectly smooth. Lateral denticles large, flat.

Niobrara epoch of Ellis County, Kansas. Professor Mudge.

LAMNA, Cuvier.

LAMNA TEXANA, Roemer.

Kreidebildungen von Texas, 29, Plate I, fig. 7; Leidy, Report of the United States Geological Survey of the Territories, I, pp. 304–305, Plate XVIII, figs. 46–50.

With numerous specimens of this species before me, I can substantiate the observations of Dr. Leidy that its teeth are generally without lateral denticles, but must add that it occasionally possesses them. They are seen on three individuals, undoubtedly from the greensand No. 4 of New Jersey, which are associated with many others from the same locality without denticles.

Greensand, No. 4, of New Jersey; also, Alabama, Mississippi, and No. 2 of Kansas; (I have not seen it from No. 3).

LAMNA ?CUSPIDATA, Agassiz.

Leidy, Report of the United States Geological Survey, I, p. 304, Plate XVIII, 44–45.

Cretaceous No. 3 or Niobrara epoch, of Kansas.

LAMNA MACRORHIZA, Cope, *sp. nov.* Plate XLII, figs. 5–7.

Established on four teeth from Kansas, which are distinguished by a number of peculiarities. The crown is of the slender type, with the diameters of the basis subequal, and the axis of the crown nearly straight. The base is very oblique; the plane face descending far below the convex; the roots rising on the latter to a point more than one-third the length from the basis of the cementum, and forming a strong protuberance. There is a denticle on each side, standing on a protuberance of the root, vertically below the flat face of the crown at the inferior apex of the cementum; standing thus interior as well as lateral to the principal crown. The roots are continued some distance below these. The enamel is smooth, except at the base of the flat face, where it and the denticles as well are strongly striate-ridged. This striation occupies the opposite side of the tooth from that observed in several other species. Length (total), $0^{m}.027$; of crown in front, $0^{m}.012$; behind, $0^{m}.020$; of root behind, $0^{m}.010$; diameter of crown at base, longitudinal, $0^{m}.006$; transverse, $0^{m}.006$.

Ellis County, Kansas, Niobrara epoch.

LAMNA MUDGEI, Cope, *sp. nov.* Plate XLII, fig. 8.

Indicated by three teeth from the Niobrara epoch of Kansas, and one from greensand, No. 4, of New Jersey. These teeth are rather stout, especially at the base, and the crown not very elongate. The root is excessively protuberant, projecting horizontally beyond the convex side, and flat or truncate below the protuberance. The enamel is entirely smooth. Measurements of the New Jersey specimen: length of crown, $0^{m}.014$; diameter of base, longitudinal, $0^{m}.004$; transverse, $0^{m}.007$; long diameter of roots at basis of crown, $0^{m}.008$.

Dedicated to Professor Mudge, of Kansas.

ADDENDA.

Some new material from the Niobrara beds of Kansas having come into my possession since the preceding text was printed, I add some further contributions to the knowledge of the fauna of that horizon.

TESTUDINATA.

TOXOCHELYS SERRIFER, Cope, *sp. nov.*

This turtle is represented by bones of the cranium and of the carapace; the former including mandibular, maxillary, frontal, sphenoid, and quadrate bones; the latter, two lateral marginals.

The dentary bone is stouter, but not so large as in *T. latiremis*, Cope, and is flattened concave on its superior alveolar face, whose outer border, though sharp, is not elevated above the level of the inner border. The symphysis is short, and there is no beak. The inner face of the dentary is a broad, shallow groove. The head has evidently been short and wide. The posterior part of the maxillaries only are preserved. The alveolar face is flat, and the outer border is produced vertically to a sharp edge. There is a suture for a malar bone, and the orbit was evidently large. The frontal bones have an open median groove below. The interorbital space is nearly flat, and the orbital borders subparallel for a short distance. The prefrontals are stout, extend to the middle of the superciliary border, and are united on the median line in front. The free border of the parietal on one side, though not well preserved, indicates that the temporal fossa is partially roofed, as in *Chelydra*. The quadrate is remarkably solid, and is distinguished by the open or fissure-like form of the *meatus auditorius*, which is a consequence of the shortness of the posterior hook, which is not produced into contact with the lower part of the body of the bone. The concavity of the upper part of it is very shallow; its outline is subtriangular, with a flat superior border; there is no trace of the bulla-like superior chamber of *Chelydra*. The body of the bone is wide and slightly concave above, the anterior face separated from the superior by an overhanging angle, and also concave. The condyle of it is quite small and flat; a larger, apparently articular, face is adjacent to it on the posterior face. The sphenoid bone is wide and flat.

The two marginal bones are longer than wide and quite thin. The proximal margin is obtuse, rugose, and but little thickened, and exhibits near the end in each bone a small oval fossa for the extremity of the rib. The external margin is thin and sharp, and is produced into a prominent angle near the middle in each bone. This presents a right angle partially backward, and is thin-edged. The bone is dense, and there are no indications of scutal sutures.

Measurements.

	M.
Length of the dentary bone	0.048
Width above	0.009
Depth on the inner side at the middle	0.007
Width of the maxillary	0.013
Depth of the maxillary on the outer side	0.008
Interorbital width	0.016
Width of the sphenoid at the middle	0.016
Antero-posterior width of the quadrate above	0.016
Depth of the quadrate externally	0.021
Length of a marginal	0.048
Width of a marginal	0.033
Depth of a marginal proximally	0.006

The characters displayed by this species ally it to the genera of the New Jersey greensand, as *Osteopygis*, etc., which, as I have pointed out, possess characters of both the *Chelydridæ* and the *Cheloniidæ*. The superciliary border of the frontal, with the extent of the prefrontals, with the indications of a short temporal roof, are characters of *Chelydra*. The absence of dermal scutal sutures distinguishes the genus from *Catapleura*, *Osteopygis*, etc. The stouter and deeper dentary bone strongly distinguishes the species from *Toxochelys latiremis*, Cope (see p. 98).

PISCES.

ENCHODUS DOLICHUS, Cope, *supra*, p. 239.

Several additional specimens of this fish exhibit the following characters: No. 1 shows that the long premaxillary tooth has a cutting-edge on the posterior side of the apex extending one-fourth the length, and directly opposite the anterior edge. The surface of this and of the maxillary teeth is not sulcate, but striate, and with a silky luster. The maxillary teeth, as in other species, diminish in size posteriorly, and display two cutting-edges nearly to the base. In No. 2, the dentary bones of both sides are preserved. These display a series of small, acute teeth on the outer alveolar margin, which passes round the outer side of the larger anterior fangs to the end of the symphysis. There are coarser striæ mingled with the finer ones on the posterior faces of the mandibular teeth. Rami slender.

This specimen exhibits the mode of succession of the teeth, which is quite peculiar and different from what I have described in the other genera. The first teeth appear on the alveolar surface at a considerable distance apart. The second teeth appear immediately in front of these, and by their presence create the irritation which results in the absorption of the root and shedding of the crown of the first. The teeth of the third series appear in advance of the second, occupying the space between them and the empty space previously occupied by No. 1. These may co-exist for some time with teeth No. 2, as the specimen indicates, but the result is as before, the shedding of the adjacent older teeth. In the case of the anterior long tooth of each side, the movement is reversed. Here the successional tooth appears behind the position of the functional, which is consequently shed, and in the old fish this tooth occupies a position behind a concave symphyseal portion, which is concave and edentulous, or only provided with the small teeth of the marginal row.

The skull of this species is flat, and the frontal bones are very thin. They are strengthened by a longitudinal striate rib on each side, which passes from the posterior part of the cranium to the prefrontal region. There are apparently no exoccipital condyles, and the basis cranii is simple and with a short keel on the basioccipital.

A comparison of this species with a new specimen of the *Enchodus gladiolus*, Cope (*Phasganodus* m.), better than that previously described (see p. 235), exhibits the following specific differences. (The latter species was founded on a long anterior maxillary tooth.) The teeth all differ in possessing on the posterior face a sculpture of parallel grooves. The known specimens are larger. In the *E. calliodon*, the grooves are fewer and stronger, and the cutting-edges of the fangs are not opposite.

The specimens above described indicate that the genus *Phasganodus*, Leidy, as defined in the present work, is untenable, and that the species must be united with *Enchodus;* the greater or less convexity of the sides of the fangs offering specific characters only. The *Enchodus anceps* (*Phasganodus*, l. c.) differs from the two species above described in the shorter and much stouter teeth. Its long fangs are not certainly known.

RECAPITULATION.

	Species.	
AVES:		
Natatores	3	
Grallæ	4	
Saururæ	2	
		9
REPTILIA:		
Dinosauria	18	
Pterosauria	4	
Crocodilia	14	
Sauropterygia	13	
Testudinata	48	
Pythonomorpha	50	
		147
PISCES:		
Percomorphi	1	
Percesoces	2	
Isospondyli	43	
Haplomi	2	
Pycnodontes	1	
Actinochiri	3	
Holocephali	23	
Elasmobranchii	22	
		97
Total vertebrata		253

INDEX.

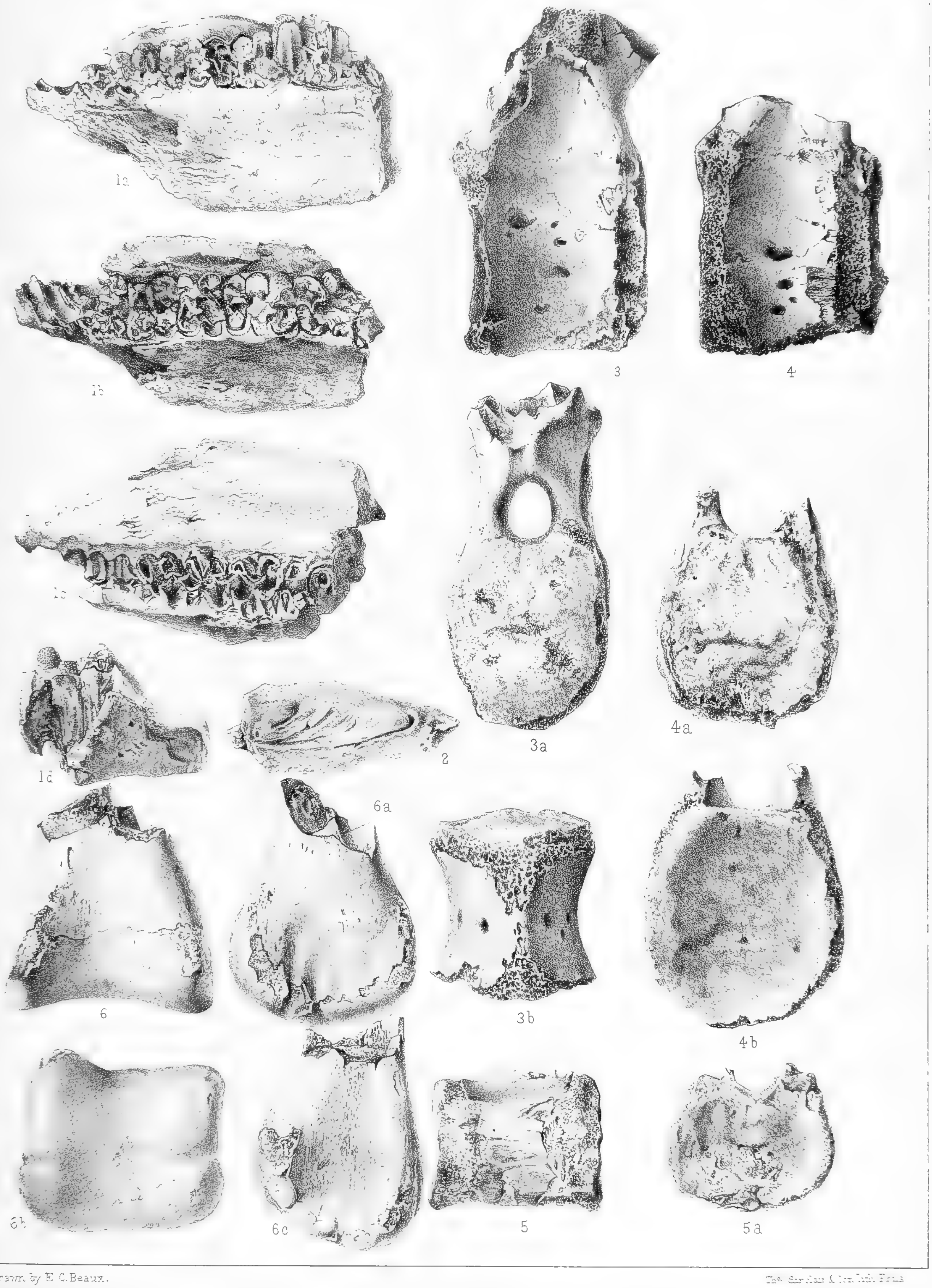
EXPLANATIONS OF PLATES.

EXPLANATION OF PLATE I.

Bones of *Cionodon arctatus*, one-half natural size.

FIG. 1. Right maxillary bone with teeth: *a*, viewed from the inner side; *b*, from below; *c*, from above; *d*, from the proximal end.

2. Fragment of a cranial bone.
3. Dorsal vertebra, lateral view: *a*, same from before; *b*, from below.
4. Dorsal vertebra, lateral view: *a*, from before; *b*, from behind.
5. Caudal vertebra, from the side: *a*, from the end.
6. Femur, distal end, antero-posterior view: *a* and *c*, lateral views; *b*. end view.



Drawn by E. C. Beaux.

Thos. Sinclair & Son, Lith. Phila.

CIONODON ARCTATUS.

EXPLANATION OF PLATE II.

FIGS. 1–2. *Cionodon arctatus*, one-half natural size.

FIG. 1. Proximal end of tibia from front: *a*, from outside; *b*, from inside; *c*, from above.

2. Distal end of the tibia from the side: *a*, from below.

FIGS. 3–5. Vertebræ of *Polyonax mortuarius*, one-half natural size.

FIG. 3. Anterior dorsal, articular face of centrum: *a*, side view of centrum.

4. Anterior dorsal, articular face of centrum: *a*, side, and *b*, lower face of the same.

5. Posterior dorsal or lumbar vertebra, side view of centrum: *a*, inferior view; *b*, articular face.

1-2. CIONODON ARCTATUS. 3-5. POLYONAX MORTUARIUS.

EXPLANATION OF PLATE III.

FIGS. 1–4. *Polyonax mortuarius*, one-half natural size.

FIG. 1. Fragment of femur from side: *a*, same from below; *b*, from above.

2. Fragment of ? ischium from side; *a*, narrower extremity; *b*, stouter extremity.

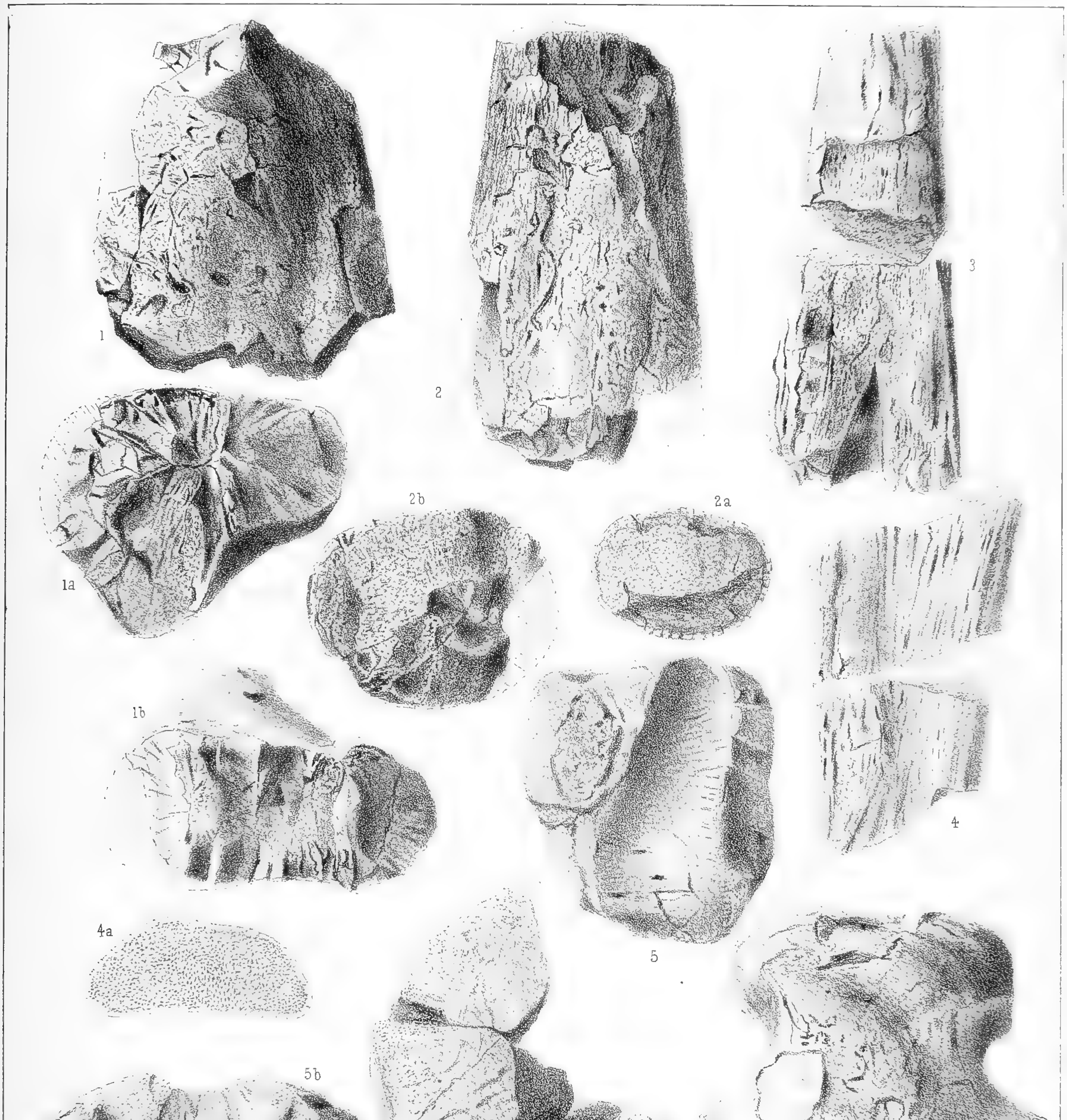
3. Broken fragment of the other ? ischium, edge view, showing internal cavity.

4. Inside view of part of fibula: *a*, superior end view of the same.

FIGS. 5–6. Bones of *Hadrosaurus ? occidentalis*, from Colorado.

FIG. 5. Fourth sacral vertebra from the side, one-half natural size: *a*, same from below; *b*, from front.

6. Fragment of head of tibia seen from above, four-tenths natural size.

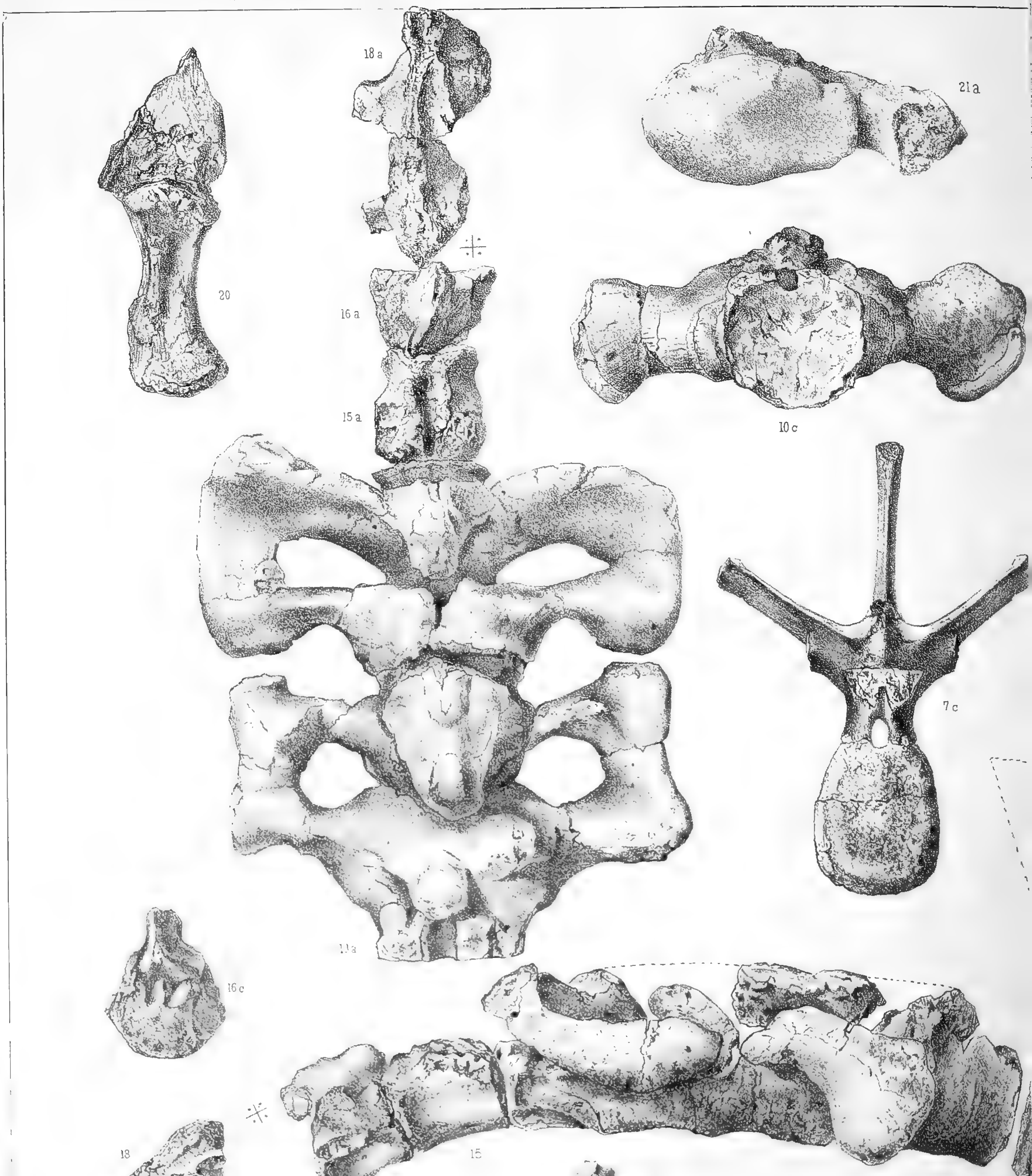


1-4. POLYONAX MORTUARIUS. 5-6. HADROSAURUS.

EXPLANATION OF PLATE IV.

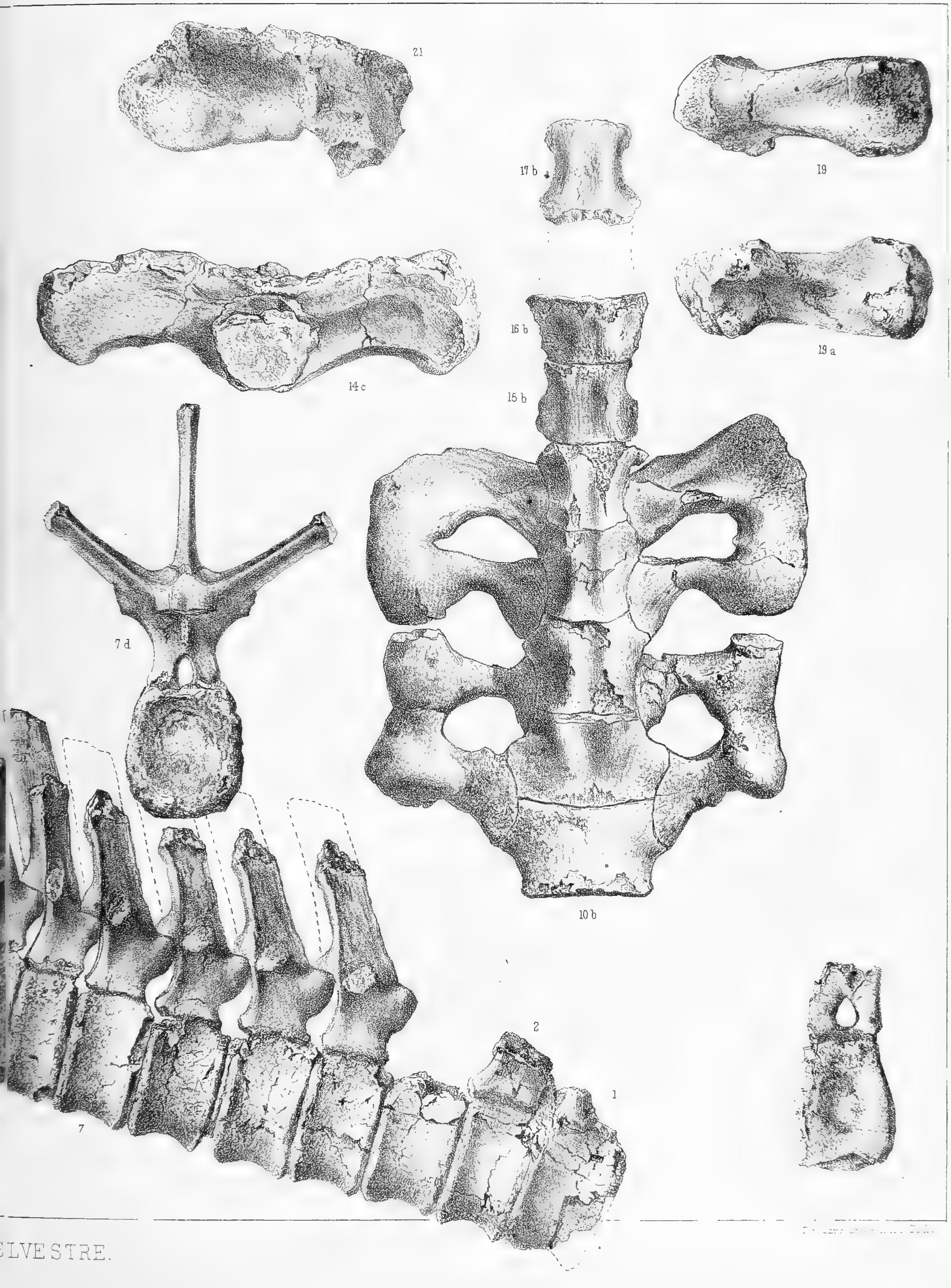
Agathaumas sylvestre, one-sixth natural size, except 19-20, which are one-fourth the same.

FIGS. 1–16. A continuous series of dorsal, lumbar, and sacral vertebræ, viewed from the right side; one only of the neural arches found in place.
FIG. 2. Second vertebra of the series: *a*, viewed from behind.
FIG. 7. Antepenultimate lumbar vertebra: *c*, viewed from before; *d*, viewed from behind.
FIGS. 10–16, *a*. The sacral series viewed from above.
10–16, *b*. The same viewed from below.
FIG. 10, *c*. Proximal end of sacrum.
14, *c*. Dis al end of the fifth vertebra of the same.
16. Seventh sacral vertebra: *c*, anterior view; *d*, posterior view, both exhibiting the inferior position of the articular surface for the diapophysis.
17. A more distal sacral vertebra: *b*, from below.
18. The neural arches of two consecutive ? sacral vertebræ, coösified, and with diapophyses free from the centrum: *a*, from above.
FIGS. 19–20. Undetermined bones.
FIG. 21. Lateral view of the acetabular portion of the ilium, with the base of the ischium continuous with it; *a*, the same, viewed from below.

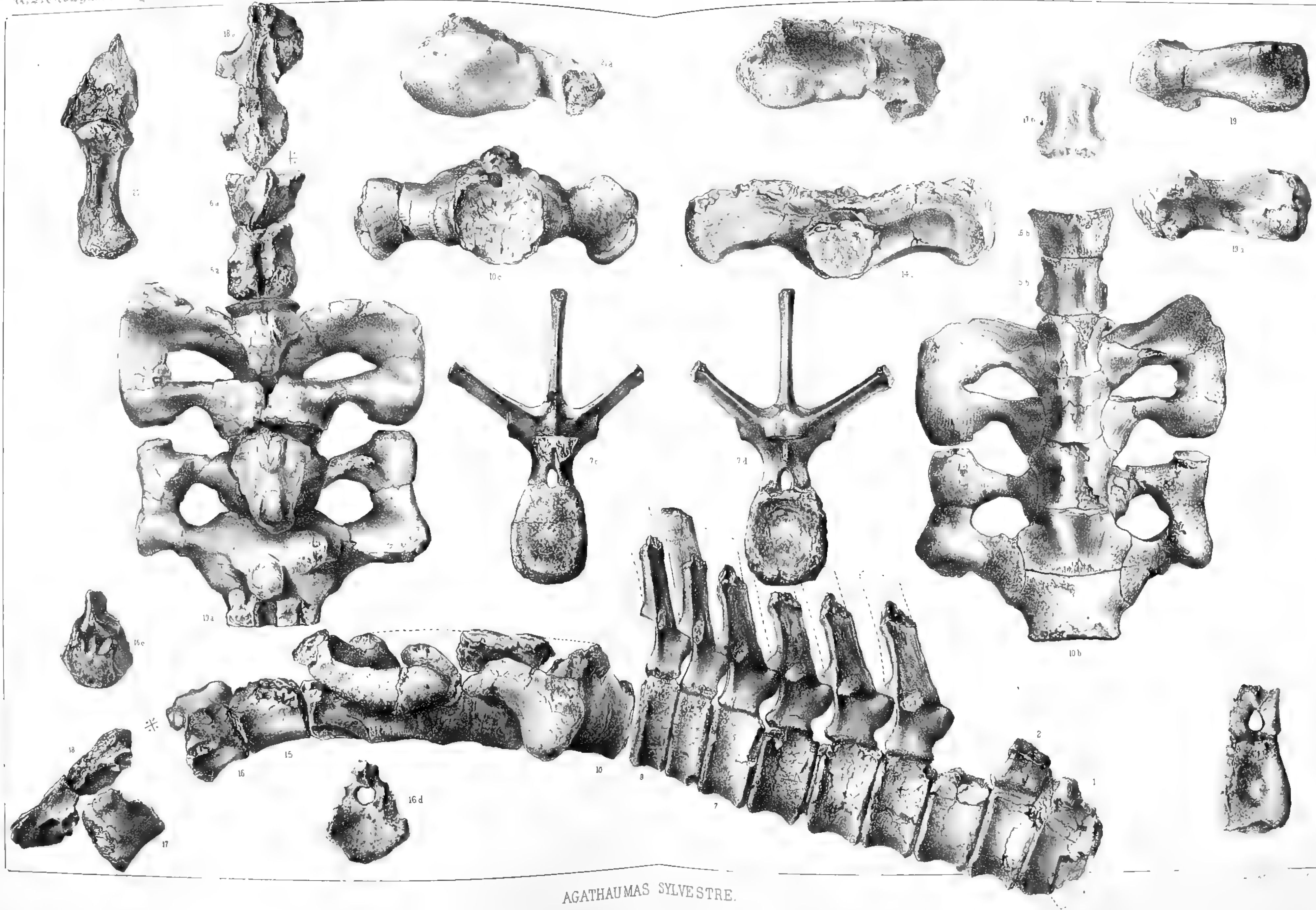


AGATHAUMA

Plate IV.



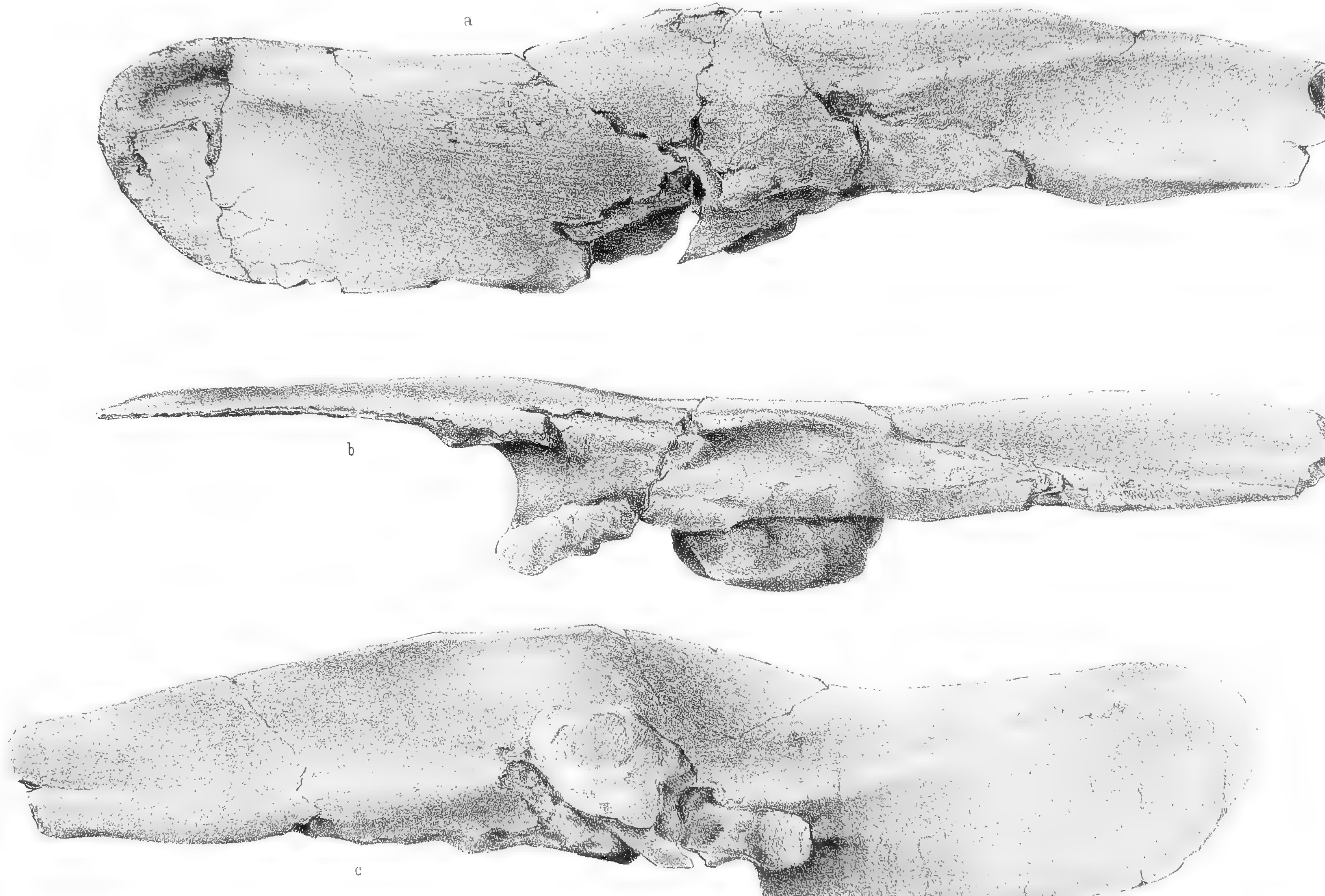
LVESTRE.



AGATHAUMAS SYLVESTRE.

EXPLANATION OF PLATE V.

Figs. 1–3. *Agathaumas sylvestre*, three views of ilium, one-sixth natural size: *a*, the outer side; *b*, the inferior edge; *c*, the inner side; the iliac acetabular face retains some of the matrix; see Pl. IV.

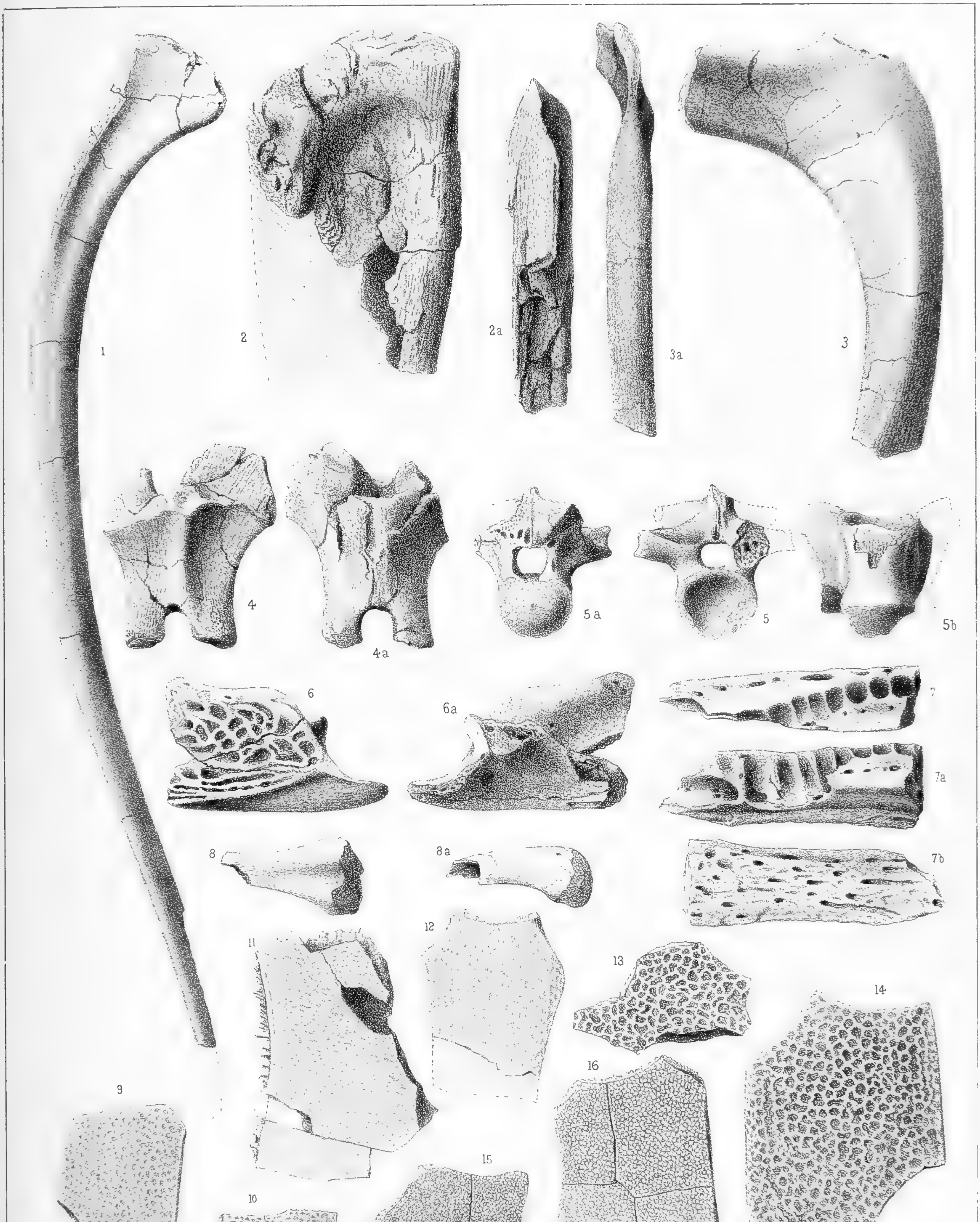


Thos. Sinclair & Son lith. Phila.

ACATHAUMUS SYLVESTRE COPE. $\frac{1}{6}$.

EXPLANATION OF PLATE VI.

FIGS. 1–4. *Agathaumas sylvestre,* one-fourth natural size.
FIG. 1. A ? rib.
FIGS. 2–3. Undetermined bones.
FIG. 4. Neural arch of a dorsal vertebra minus the processes.
FIGS. 5–8. *Bottosaurus perrugosus,* one-half natural size.
FIG. 5. A posterior dorsal vertebra from front: *a,* from behind, and, *b,* from below.
6. Posterior part of mandibular ramus from outer side; *b,* from inner side.
7. Portion of dentary bone with alveoli: *a,* from inner side; *b,* from outer side.
8. Distal end of femur found with the preceding; *a,* lateral view.
FIGS. 9–16. Fragments of tortoises from the Cretaceous of Colorado, natural size.
FIG. 9. *Plastomenus punctulatus,* costal bone.
10. *P. insignis,* hyposternal bone.
FIGS. 11–12. *Adocus lineolatus:* 11, from plastron; 12, vertebral bone.
13–14. *Trionyx vagans,* portions of costal bones.
15–16. Marginal bones of *Compsemys victus.*

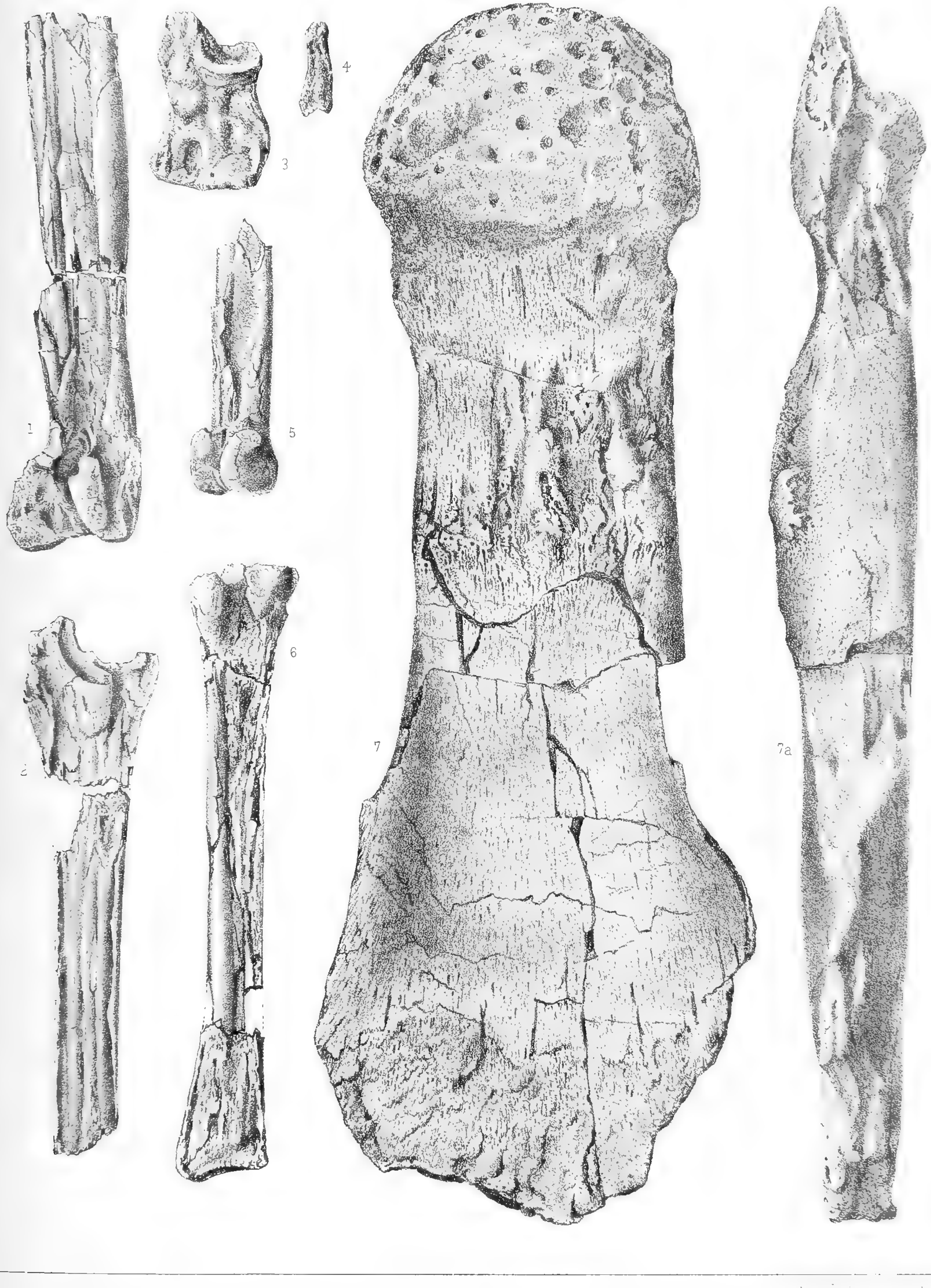


1-4. AGATHAUMAS SYLVESTRE. 5-8. BOTTOSAURUS PERRUGOSUS.
9-10. PLASTOMENUS. 11-12. ADOCUS. 13-14. TRIONYX. 15-16. COMPSEMYS.

EXPLANATION OF PLATE VII.

Bones of *Ornithosaurians* and *Sauropterygians*, one-half natural size, excepting Figs. 3–4, which are natural size.

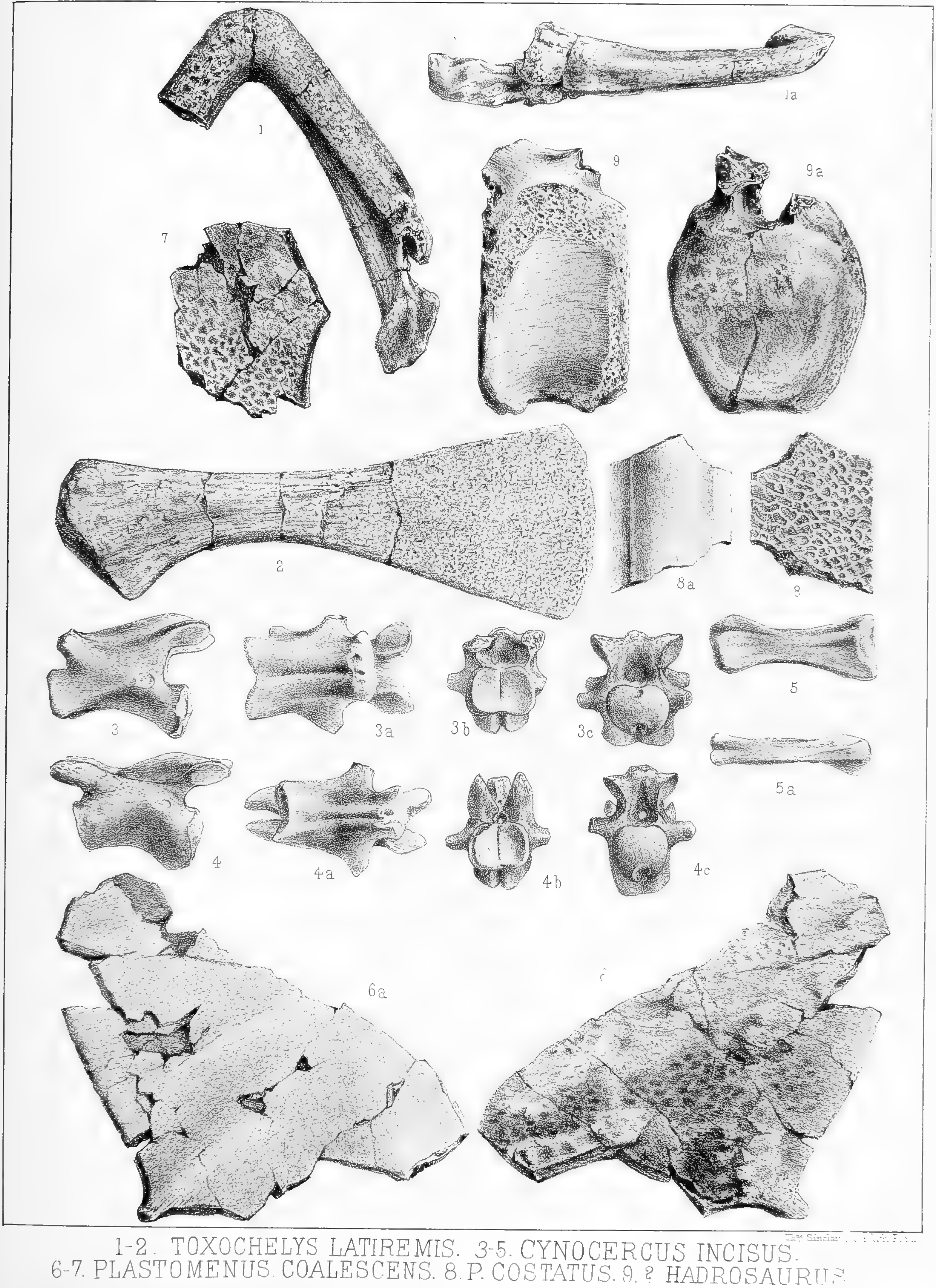
FIG. 1. Wing-metacarpal of *Pterodactylus umbrosus*, Cope, from below.
2. Phalange of first rank of the same digit.
3. Lateral carpal of the same, natural size.
4. Phalange of clawed digit of same individual.
5. Wing-metacarpal of *Pterodactylus occidentalis*, from below.
6. First phalange of wing-finger of same, but doubtfully of the same individual.
7. *Polycotylus latipinnis*, humerus from inner side; 7 *a*, from edge.



1-4. PTERODACTYLUS UMBROSUS. 5-6. P. OCCIDENTALIS.
7. POLYCOTYLUS LATIPINNIS.

EXPLANATION OF PLATE VIII.

FIGS. 1–2. *Toxochelys latiremis*, one-half natural size.
FIG. 1. Mandible from above; 1 *a*, from outer side.
2. Coracoid bone.
FIGS. 3–5. *Cynocercus incisus*, natural size.
FIG. 3. A caudal vertebra, lateral view: *a*, inferior; *b*, anterior; and, *c*, posterior views.
4. Caudal vertebra, lateral view: *a*, view from below; *b*, from front; *c*, from behind.
FIGS. 6–7. *Plastomenus coalescens*, one-half natural size: 6, portion of carapace from above; 6 *a*, same from below.
FIG. 7. Portion of plastron with lateral free border, from below.
8. *Plastomenus costatus*, costal bone, external surface; *a*, same from below.
9. Caudal vertebra of a *Hadrosaurus* from Milk River, British America, one-half natural size; *a*, front view.



Thos Sinclair ... Lith. Phila.

1-2. TOXOCHELYS LATIREMIS. 3-5. CYNOCERCUS INCISUS.
6-7. PLASTOMENUS COALESCENS. 8. P. COSTATUS. 9. ? HADROSAURUS.

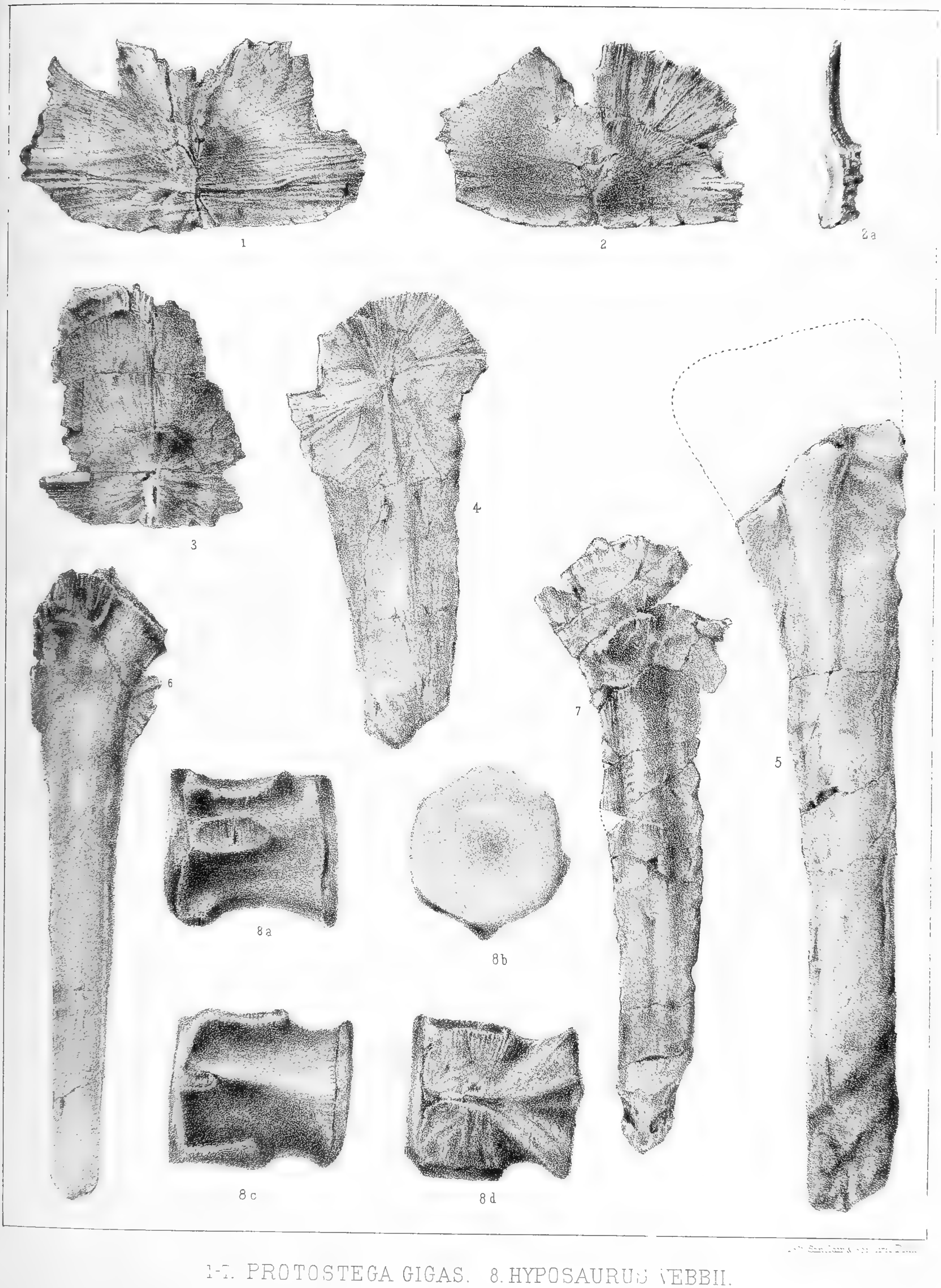
EXPLANATION OF PLATE IX.

Bones of *Protostega gigas*, one-third natural size.

FIGS. 1–3. Marginal bones: 1 *a*, lateral from above; 2, another lateral from below; 2 *a*, the same from one end; 3, ? caudal marginal.

4–7. Ribs; 7, posterior.

FIG. 8. Cervical vertebra of *Hyposaurus vebbianus*, two-thirds the natural size: *a*, from the side; *b*, from the front; *c*, from below; *d*, from above.

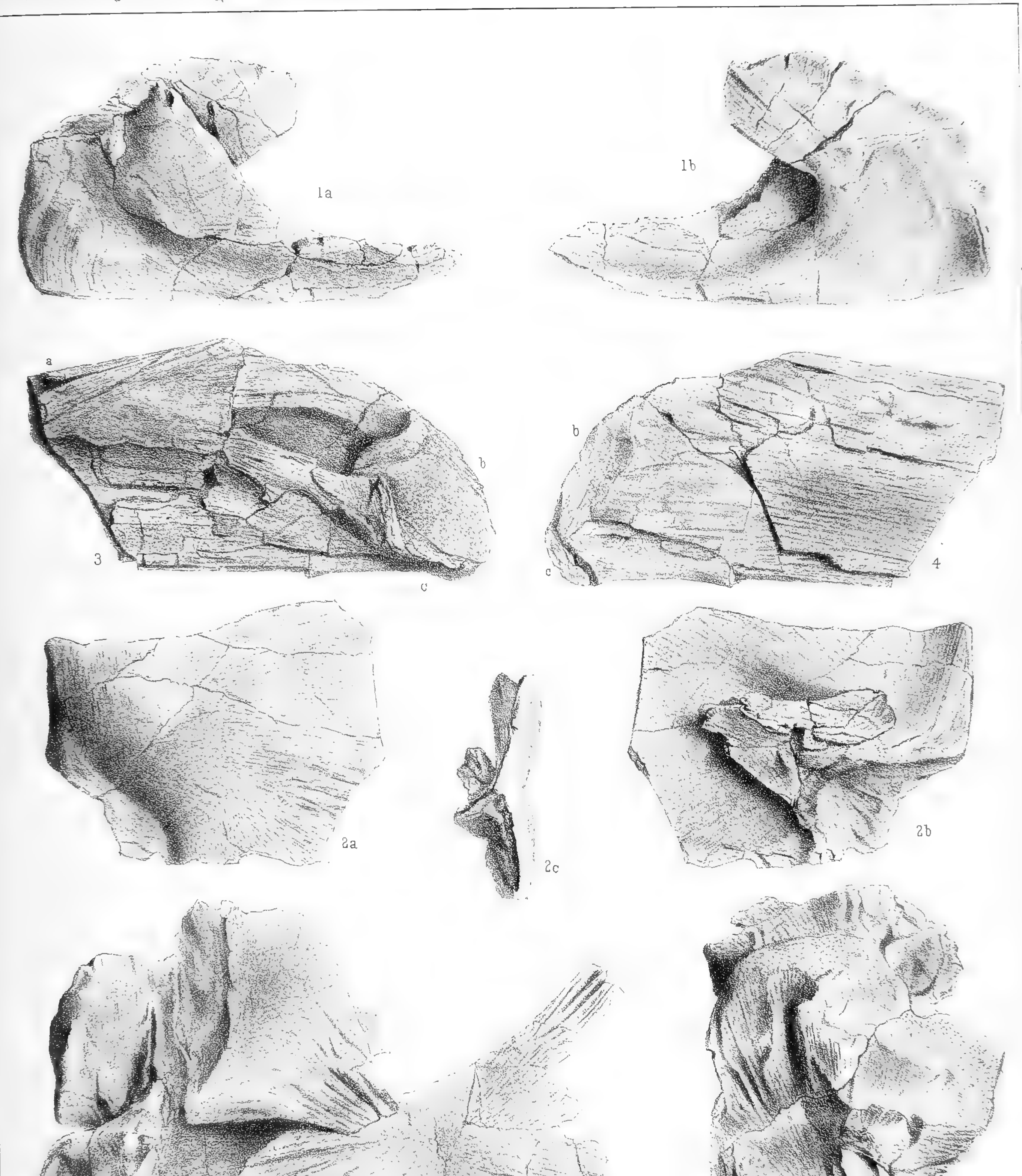


1-7. PROTOSTEGA GIGAS. 8. HYPOSAURUS WEBBII.

EXPLANATION OF PLATE X.

Cranial bones of *Protostega gigas*, Cope, one-half natural size.

FIG. 1. Maxillary bone: *a*, from without; *b*, from within.
2. Dentary bone: *a*, from without; *b*, from within; *c*, anterior view.
3. Posterior portion of mandibular ramus from within: *a*, dentary; *b*, articular; *c*, angular bones.
4. Posterior portion of mandibular ramus from the outside; letters the same.
5. Quadrate and pterygoid bones of the right side from within.
6. Quadrate bone of the same side from without.

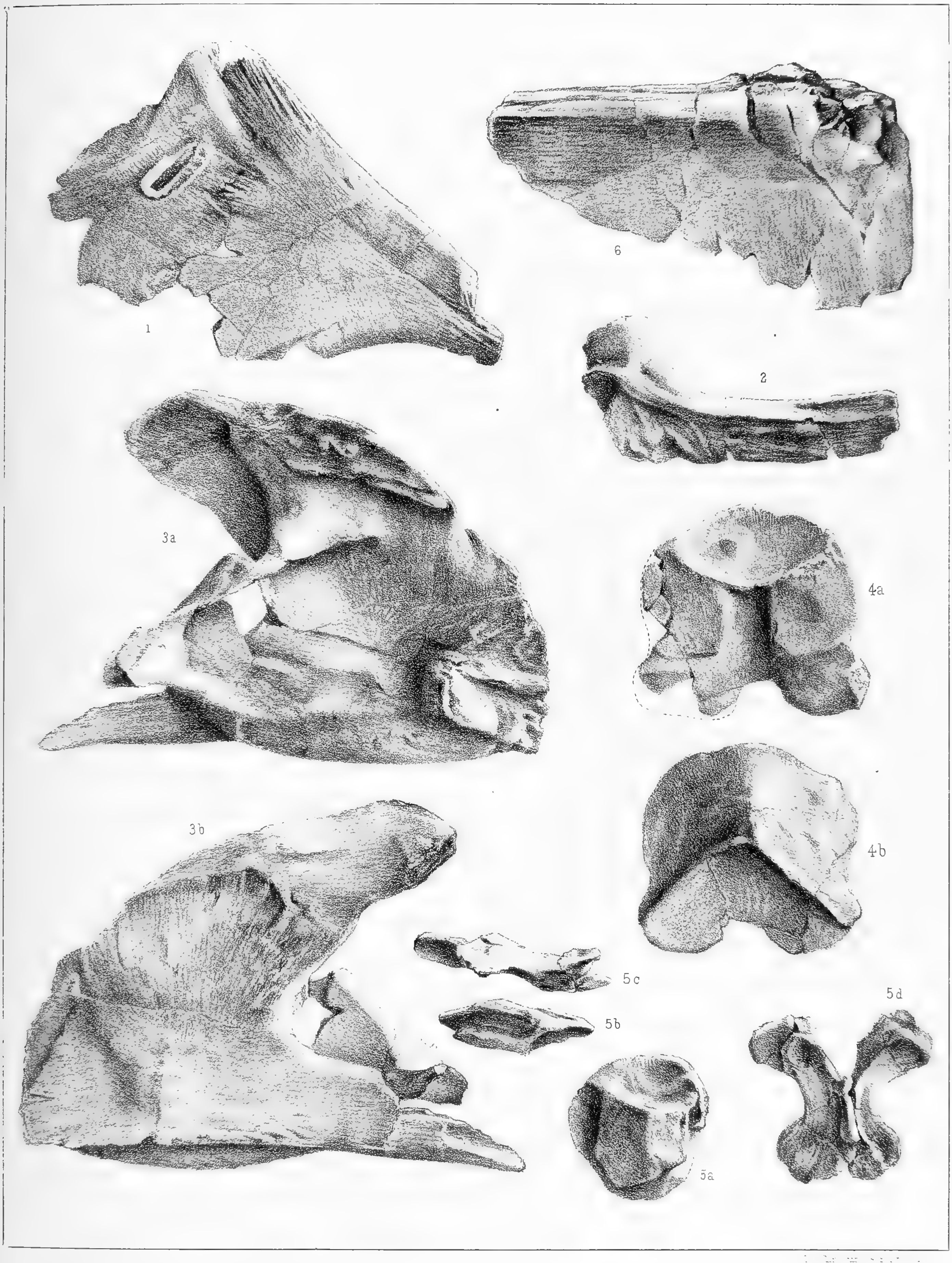


PROTOSTEGA GIGAS.

EXPLANATION OF PLATE XI.

Bones of the same specimen of *Protostega gigas*.

FIG. 1. Pterygoid and columellar plate of left side.
2. ? Anterior part of pterygoid.
3. Postfrontal bone: *a*, from inside; *b*, from outside.
4. Vertebral centrum flattened by pressure: *a*, from above; *b*, from below.
5. ? Cervical vertebra: *a*, centrum (flattened) from below; *b*, from side; *c*, neural arch from side; *d*, from above.

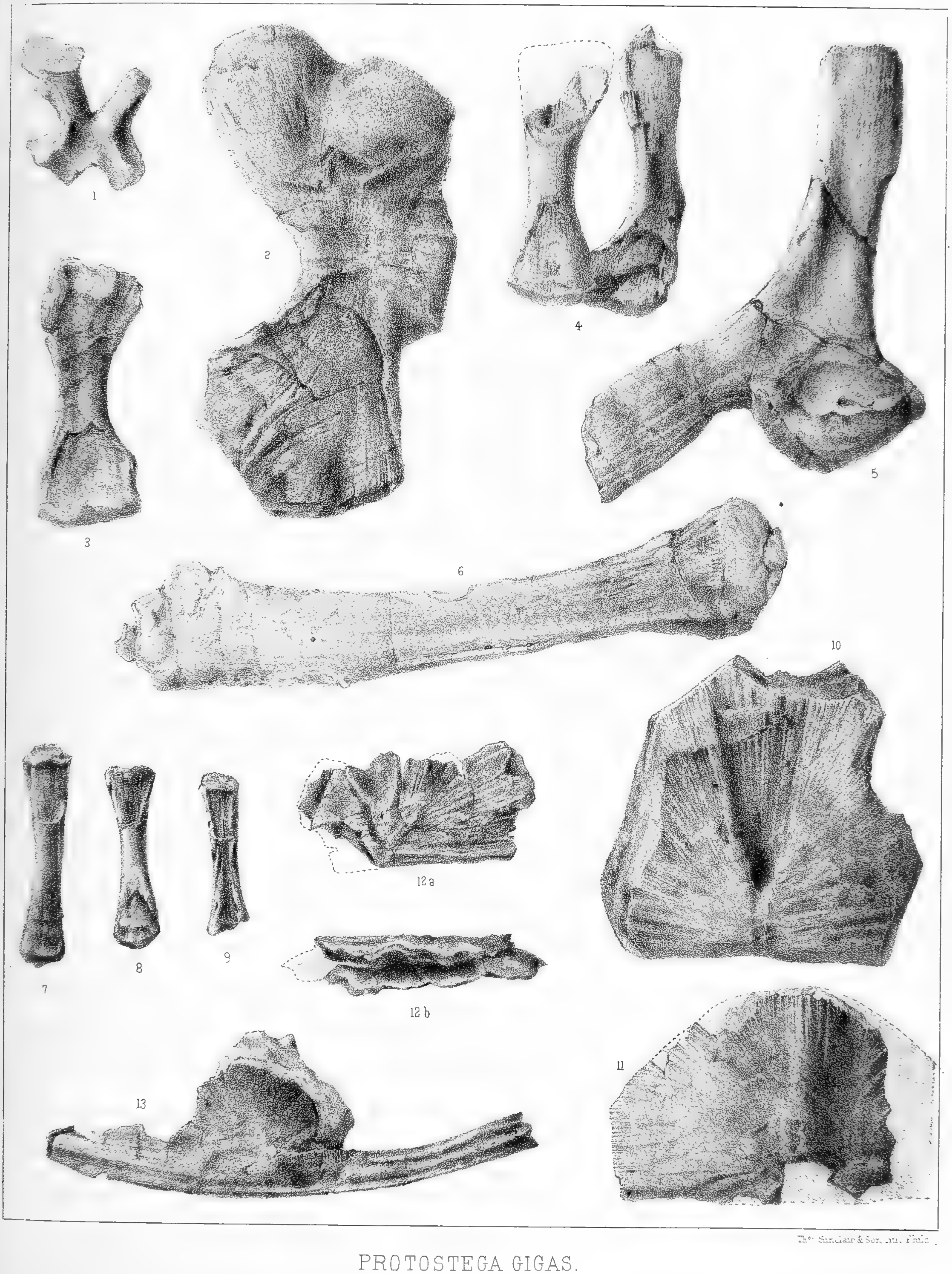


PROTOSTEGA GIGAS.

EXPLANATION OF PLATE XII.

Bones of *Protostega gigas,* one-third natural size, except Fig. 1, which is one-half nature.

FIG. 1. Neural arch of ? cervical vertebra, from above.
2. Left humerus.
FIGS. 3–4. Metapodial bones.
FIG. 5. Scapulo-procoracoid of the right side.
6. Coracoid of the right side.
FIGS. 7–9. Phalanges.
FIG. 10. Normal lateral marginal bone, from below.
11. Vertebral ? nuchal bone, from above.
12. Marginal bone with two laminæ: *a,* from without; *b,* from the proximal or inner margin.
13. Long anterior marginal bone.



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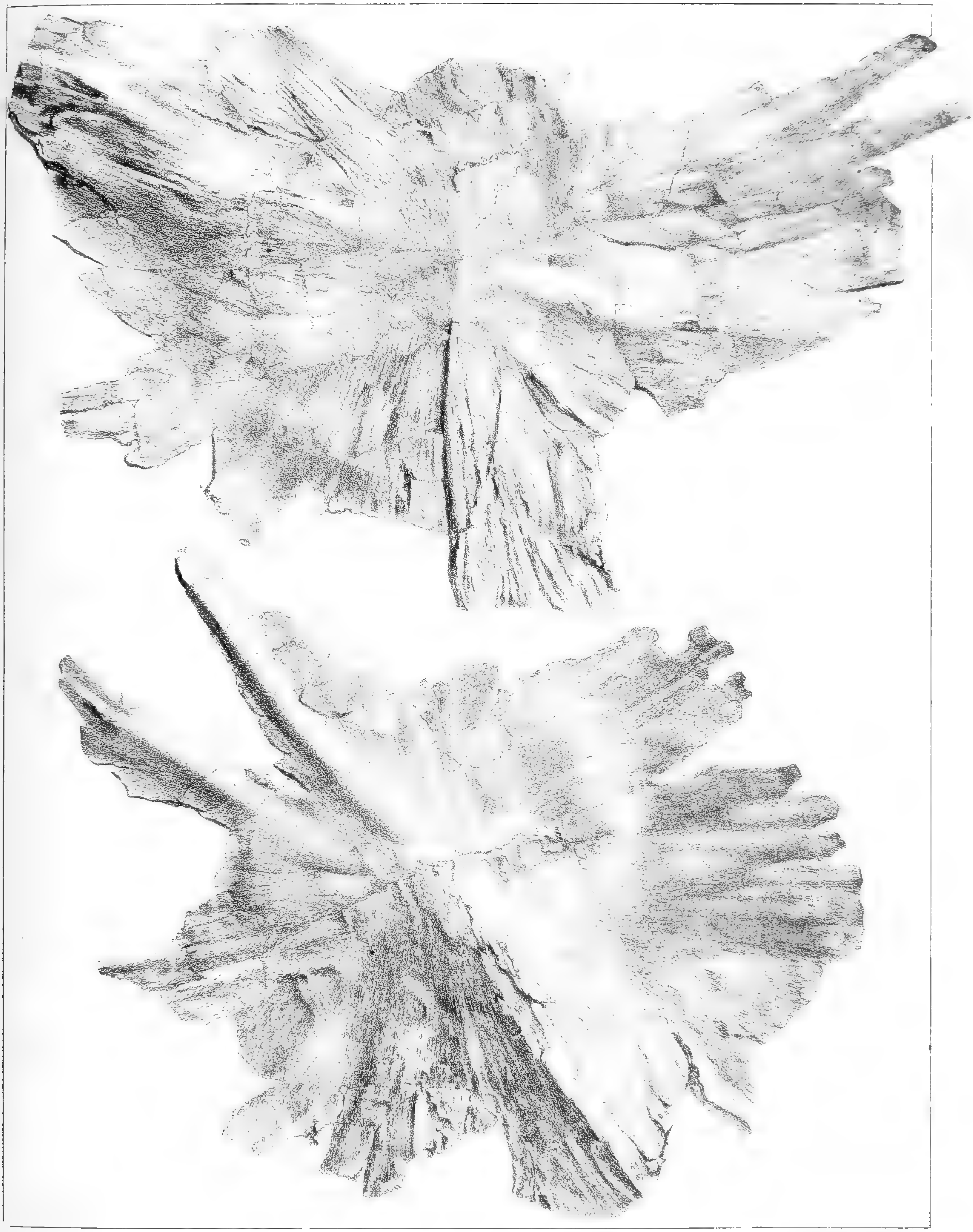
PROTOSTEGA GIGAS.

EXPLANATION OF PLATE XIII.

Two dermal bones of *Protostega gigas*, one-third natural size.



PROTOSTEGA GIGAS.

EXPLANATION OF PLATE XIV.

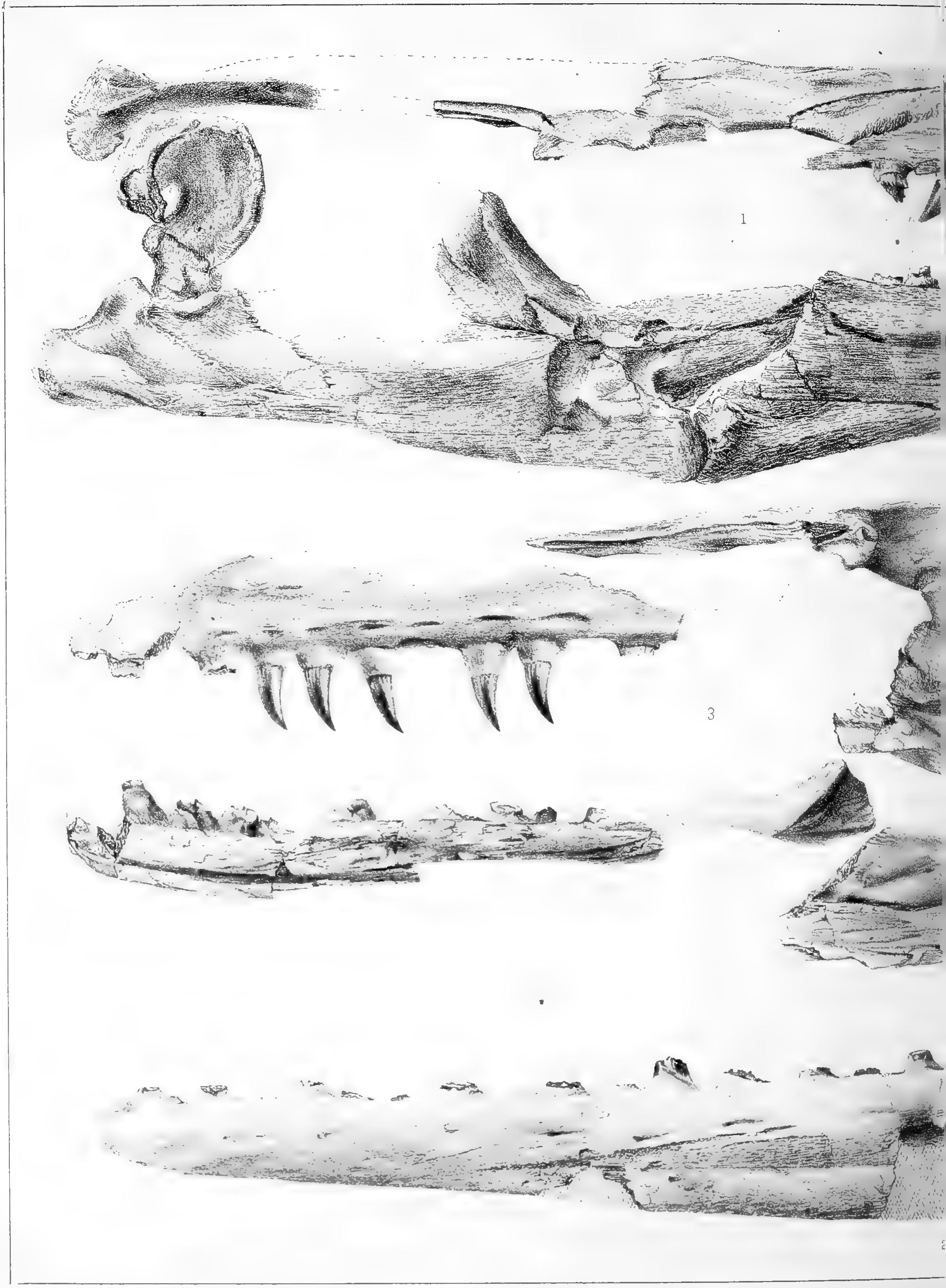
Figures one-half natural size.

FIG. 1. Cranium of *Clidastes tortor,* side-view: end of dentary bone wanting; mandible viewed from the outer side.

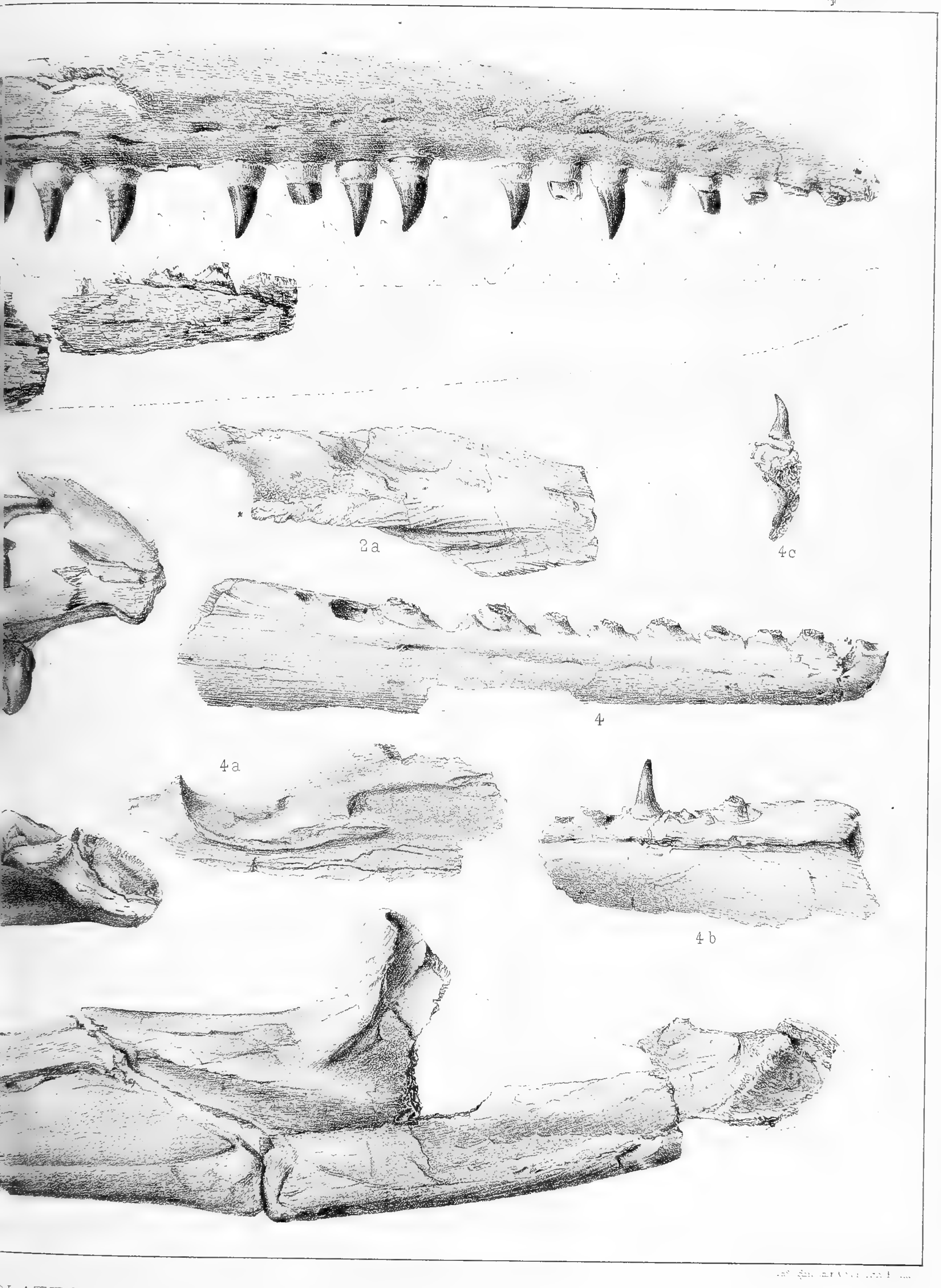
2. *Clidastes stenops,* right ramus of the mandible; 2 *a,* side-view of prefrontal bone.

3. Cranium of *Platecarpus curtirostris,* side-view: the mandible viewed from the inner side.

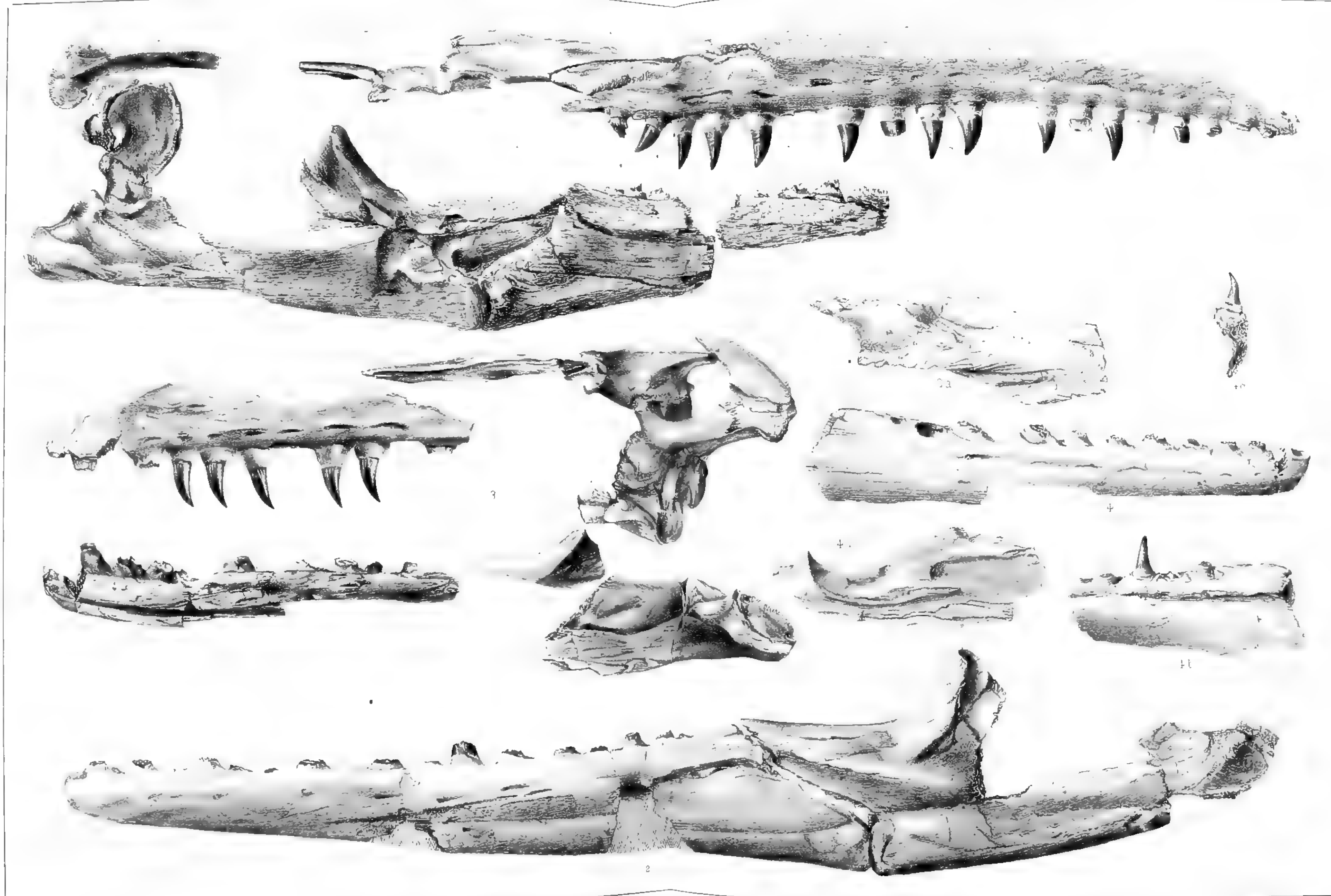
4. *Platecarpus ictericus,* right dentary bone from the outside; *a,* surangular bone from the inside; *b,* inner view of fragment of left dentary bone; *c,* proximal view of the fragment.



1. CLIDASTES TORTOR. 2. CLIDASTES STENOP



PLATECARPUS CURTIROSTRIS. 4. PICTERICUS.

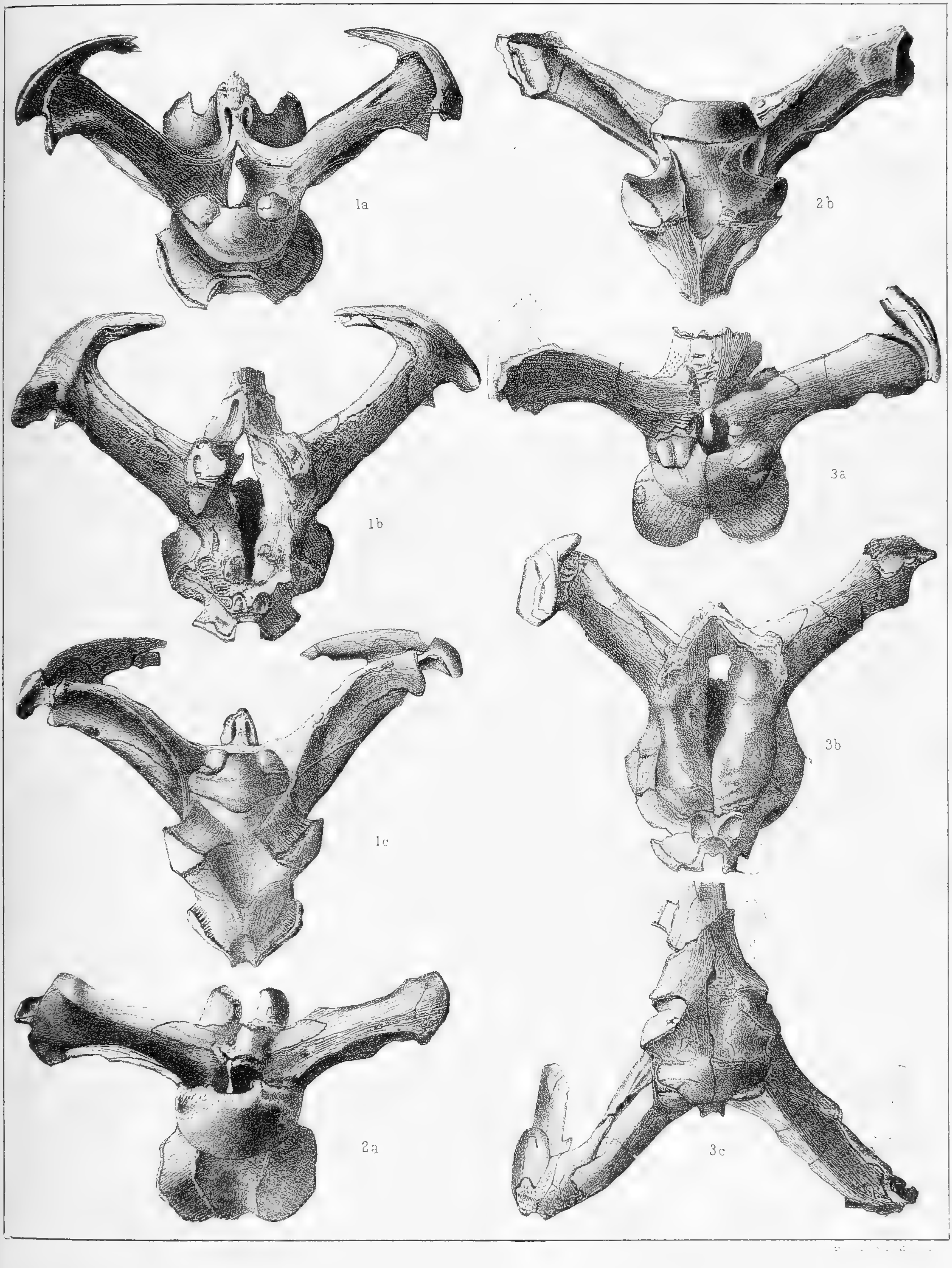


1. CLIDASTES TORTOR. 2. CLIDASTES STENOPS 3. PLATECARPUS CURTIROSTRIS 4. PICTERICUS

EXPLANATION OF PLATE XV.

Occipital regions and suspensoria of *Pythonomorpha*, one-half natural size.

FIG. 1. *Platecarpus coryphæus :* *a*, from behind ; *b*, from before ; *c*, from below.
2. *Platecarpus ictericus :* *a*, from behind ; *b*, from below.
3. *Platecarpus curtirostris :* *a*, from behind ; *b*, from in front ; *c*, from below.



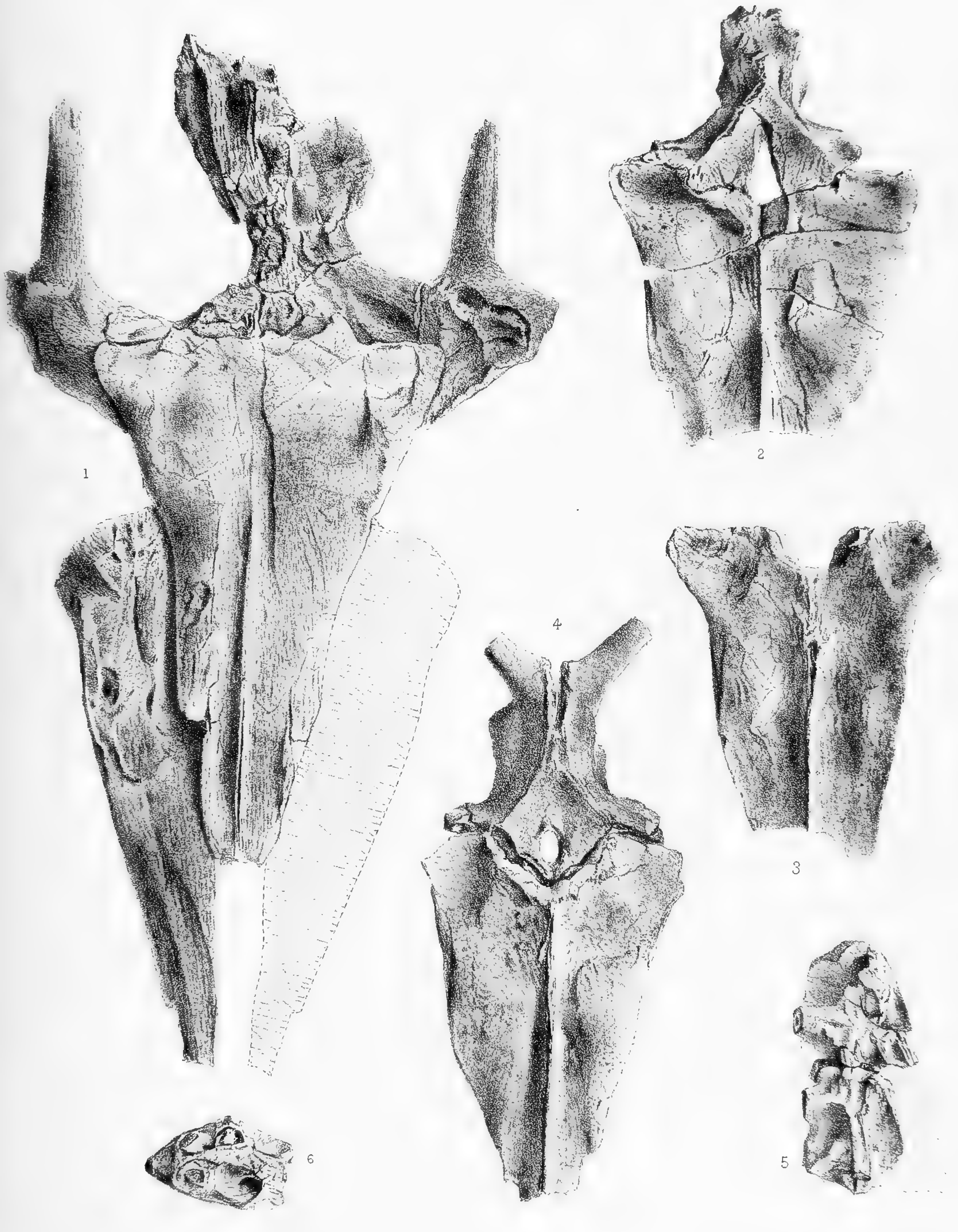
1. PLATECARPUS CORYPHAEUS. 2. P. ICTERICUS. 3. P. CURTIROSTRIS.

EXPLANATION OF PLATE XVI.

View of crania of *Pythonomorpha*, from above, one-half natural size.

FIG. 1. *Clidastes tortor;* 6, premaxillary bone, from below.
2. *Platecarpus mudgei*, frontal and parietal bones.
3. *Platecarpus coryphæus*, frontal bone only.

FIGS. 4–5. *Platecarpus curtirostris:* 4, frontal and parietal bones, from above; 5 premaxillary and adjacent part of right maxillary bones, from left side and below.



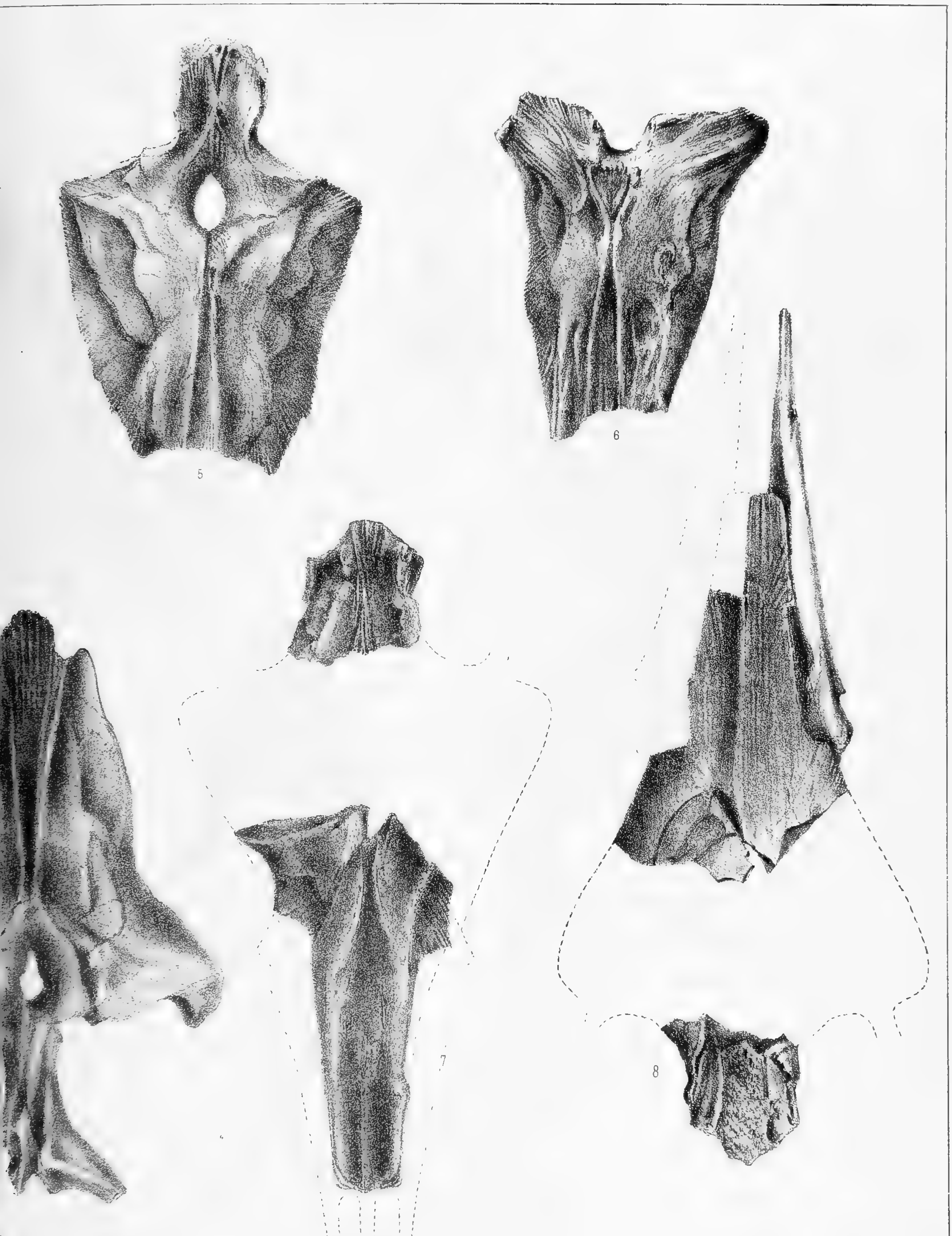
1 & 6. CLIDASTES TORTOR. 2-5. PLATECARPUS SPECIES.

EXPLANATION OF PLATE XVII.

Superior cranial walls of *Pythonomorpha,* from below and above, one-half natural size.

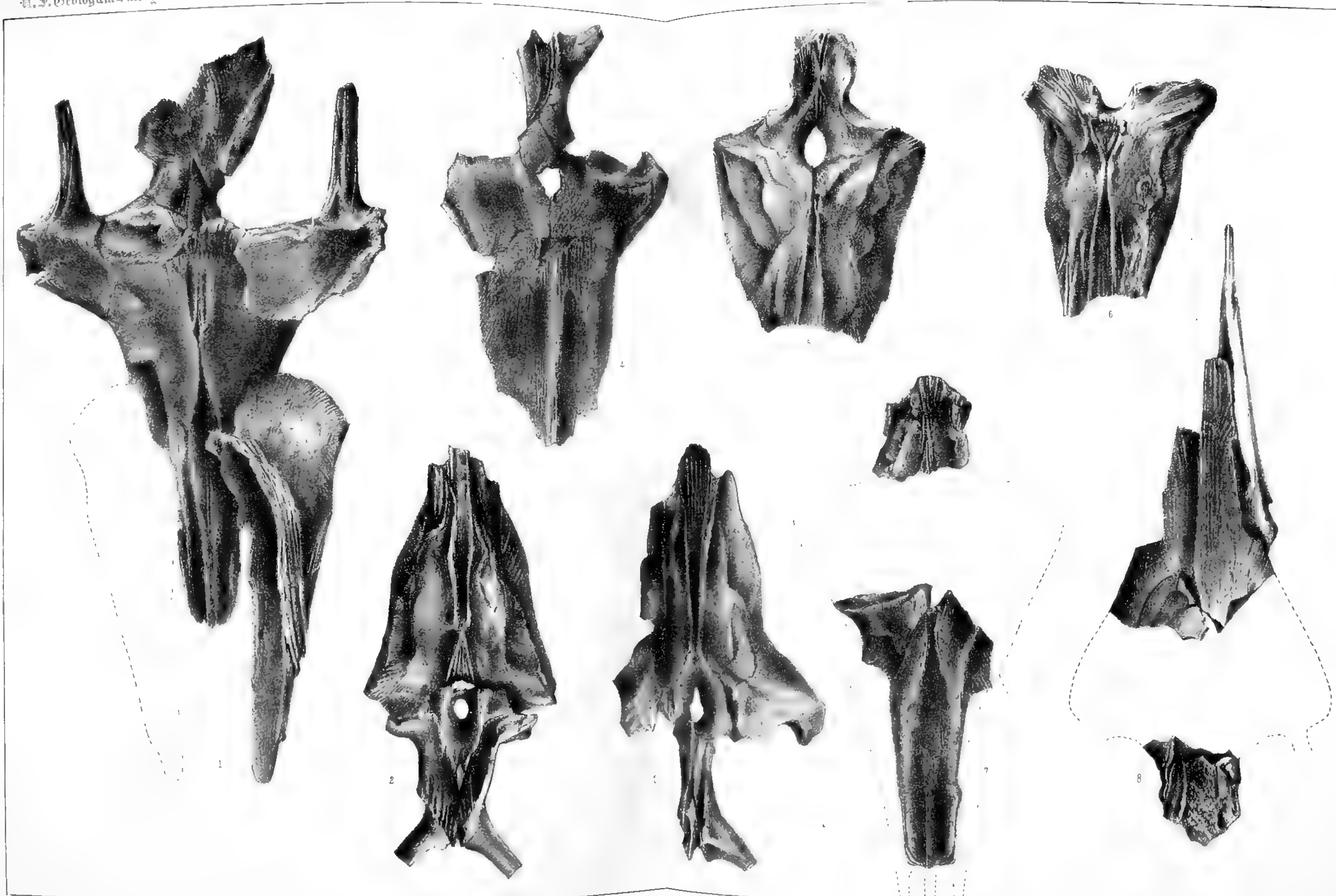
FIG. 1. *Clidastes tortor,* from below.
2. *Platecarpus curtirostris,* from below.
3. *Platecarpus ictericus,* from below.
4. *Platecarpus ictericus,* from above.
5. *Platecarpus mudgei,* from below.
6. *Platecarpus coryphaeus,* from below.
7. *Clidastes stenops,* from below, without prefrontal bone.
8. *Clidastes stenops,* from above, with right prefrontal bone.

1. CLIDASTES TORTOR. 2. PLATECARPU
5 LIODON MUDGEI. 6. PLATECARPUS



Thos Sinclair & Son lith. Phila

TIROSTRIS. 3-4. PLATECARPUS ICTERICUS.
PHAEUS. 7-8. CLIDASTES STENOPS.



1. CLIDASTES TORTOR. 2. PLATECARPUS CURTIROSTRIS. 3-4. PLATECARPUS ICTERICUS
5. LIODON MUDGEI. 6. PLATECARPUS CORYPHAEUS. 7-8. CLIDASTES STENOPS.

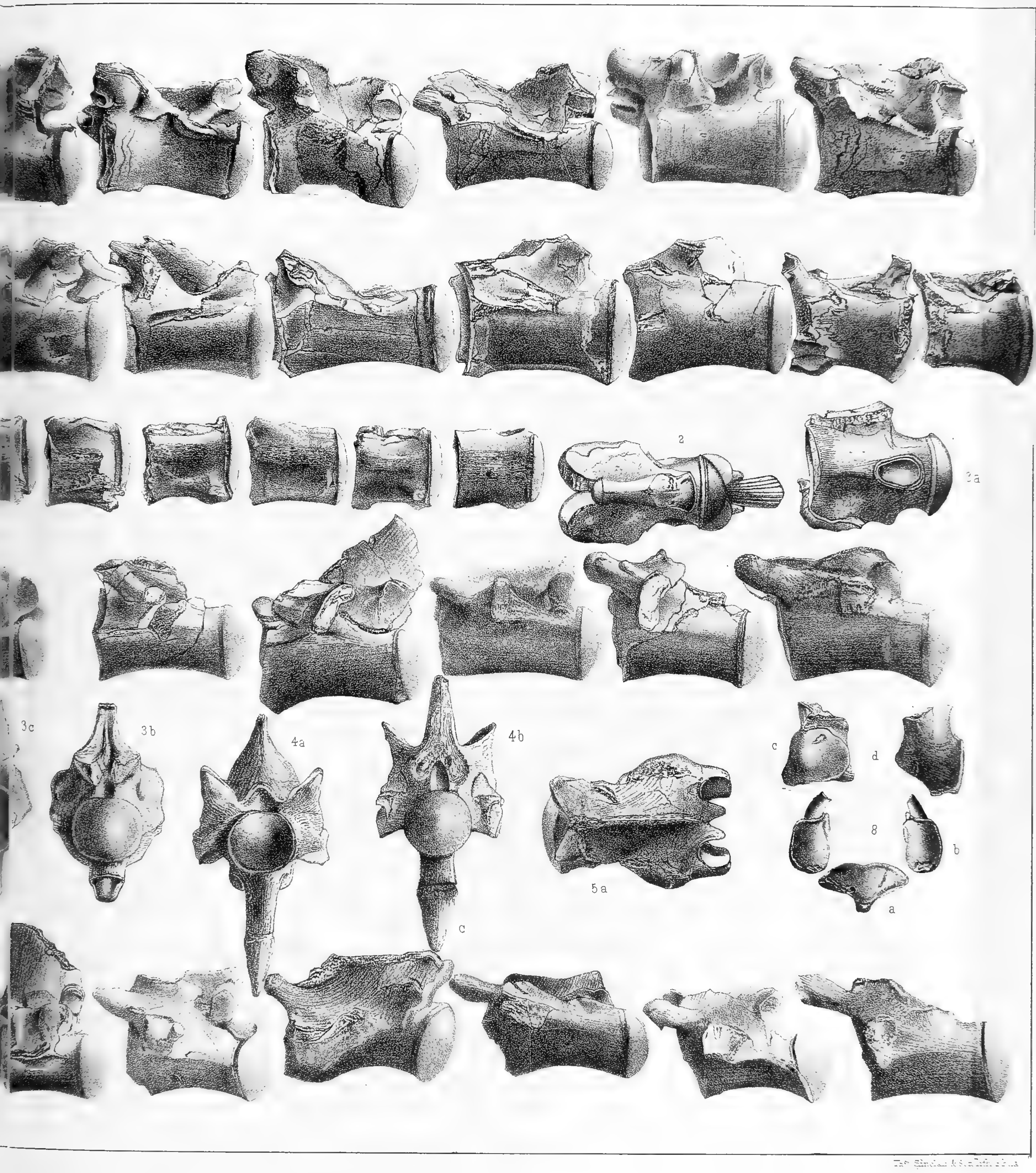
EXPLANATION OF PLATE XVIII.

Vertebræ of *Pythonomorpha* of three species, all more or less incomplete; one-half natural size.

FIG. 1. Column of *Clidastes stenops*, including some of the cervical, dorsal, lumbar, and caudal vertebræ; side view, beginning with the axis.

2. The axis, from below.
3. Third cervical: *a*, from below; *b*, from behind; *c*, from in front.
4. Fourth cervical: *a*, from before; *b*, from behind; *c*, free hypapophysis.
5. A dorsal vertebra: *a*, from above; *b*, from below.
6. Part of vertebral column of *Platecarpus ictericus*, from the side; *a* dorsal vertebra from above.
7. Part of vertebral column of *Platecarpus curtirostris*.
8. The atlas of *Platecarpus curtirostris*: *a*, centrum; *b*, the neurapophysis from the front; *c*, from the inside; *d*, from the outside.

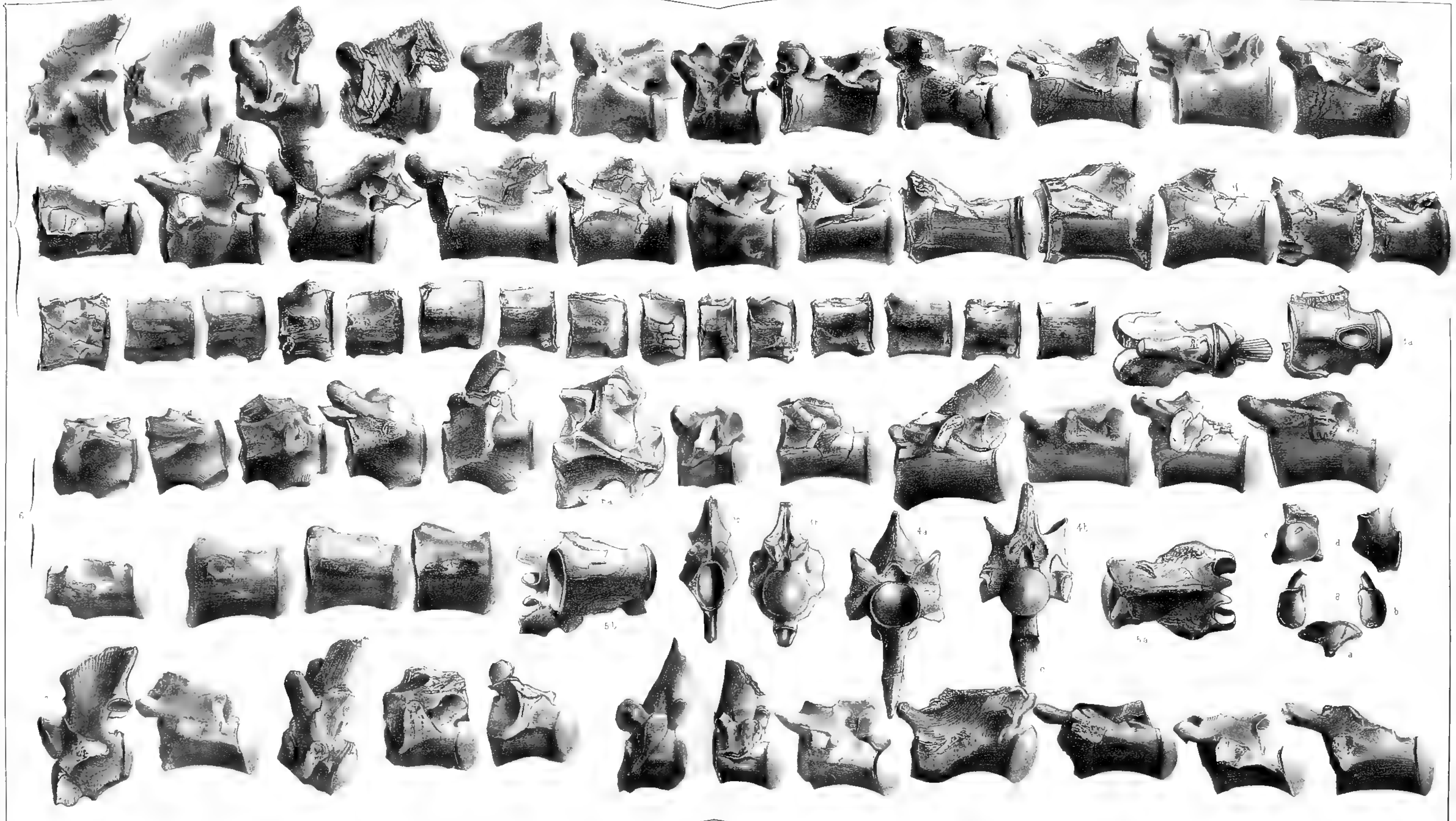
1-5. CLIDASTES STEN(?
7-8. PLATECAR



Thos Sinclair & Son lith. Phila

. PLATECARPUS ICTERICUS.

: CURTIROSTRIS.

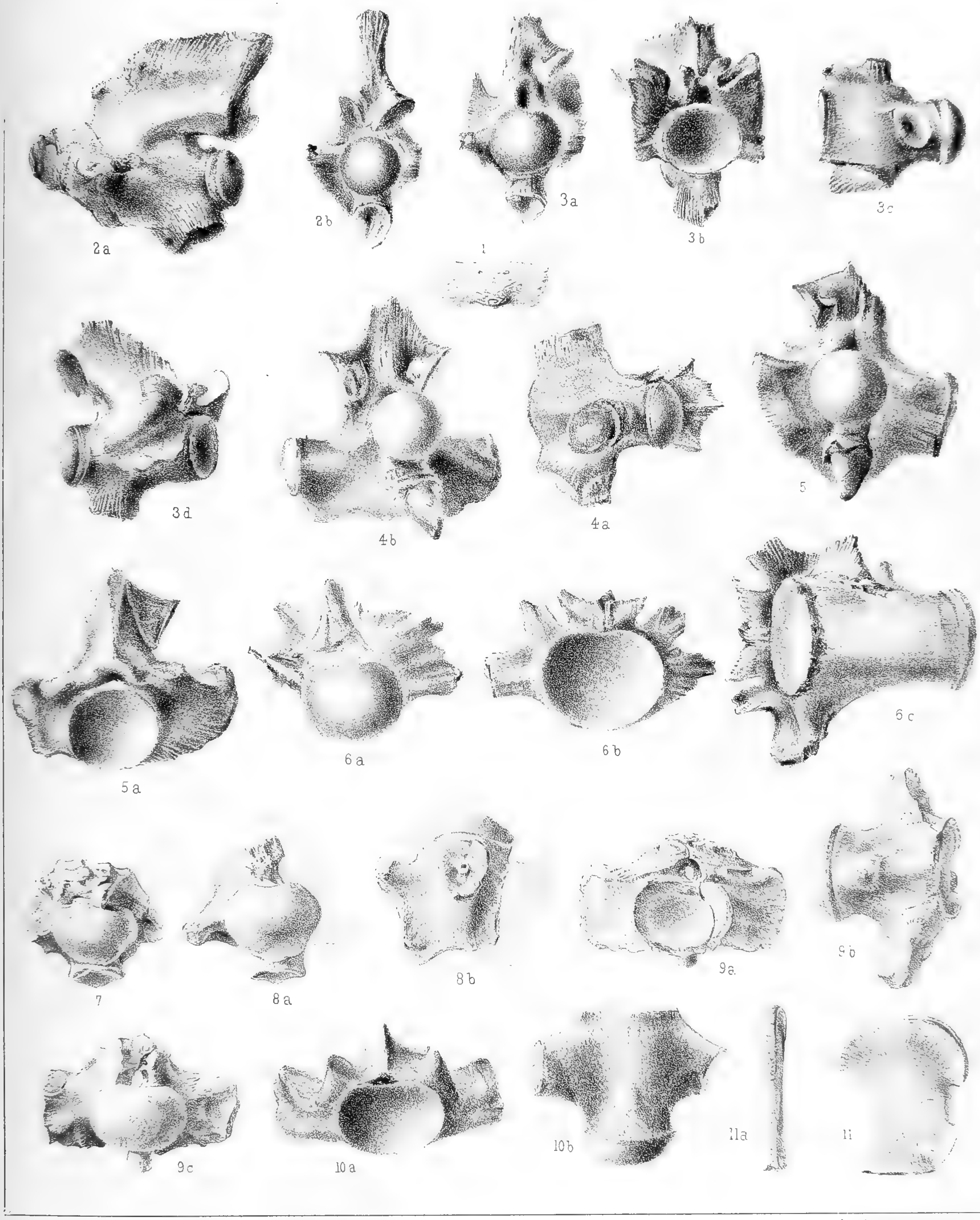


1-5 CLIDASTES STENOPS, 6 PLATECARPUS ICTERICUS.
7-8. PLATECARPUS CURTIROSTRIS.

EXPLANATION OF PLATE XIX.

Vertebræ of *Pythonomorpha:* of *Clidastes tortor* and *Platecarpus ictericus*, one-half natural size.

FIG. 1. *Clidastes tortor*, atlas centrum.
2. Ditto, axis: *a*, from the side; *b*, from behind.
3. Third cervical vertebra: *a*, from behind; *b*, from before; *c*, from below; *d*, from the side.
4. Cervical more posterior: *a*, from below, showing free hypapophysis attached and crushed; *b*, from behind.
5. Cervical vertebra behind the last figured, from behind; *a*, from before.
6. Posterior dorsal vertebra: *a*, from behind; *b*, from in front; *c*, from below.
7. *Platecarpus ictericus*, axis vertebra, from behind.
8. Third vertebra: *a*, from behind; *b*, from below.
9. A posterior cervical: *a*, from front; *b*, from below; *c*, from behind.
10. Last cervical: *a*, from front; *b*, from below.
11. Radius or fibula of a small *Clidastes* from Fossil Spring Canyon; *a*, the inner edge of the same.



1-6. CLIDASTES TORTOR. 7-10. PLATECARPUS ICTERICUS.
11. CLIDASTES.

EXPLANATION OF PLATE XX.

Vertebræ of *Pythonomorpha*, one-half natural size: species, *Platecarpus ictericus* and *Platecarpus coryphæus*

FIG. 1. *Platecarpus ictericus*, median dorsal vertebra: *a*, from behind; *b*, from below; *c*, from front.

FIGS. 2–3. *Platecarpus ictericus*, lumbar vertebra: *a*, from behind; *b*, from below. These vertebræ were found lying on their sides, and the form of the articular surfaces is slightly altered by pressure.

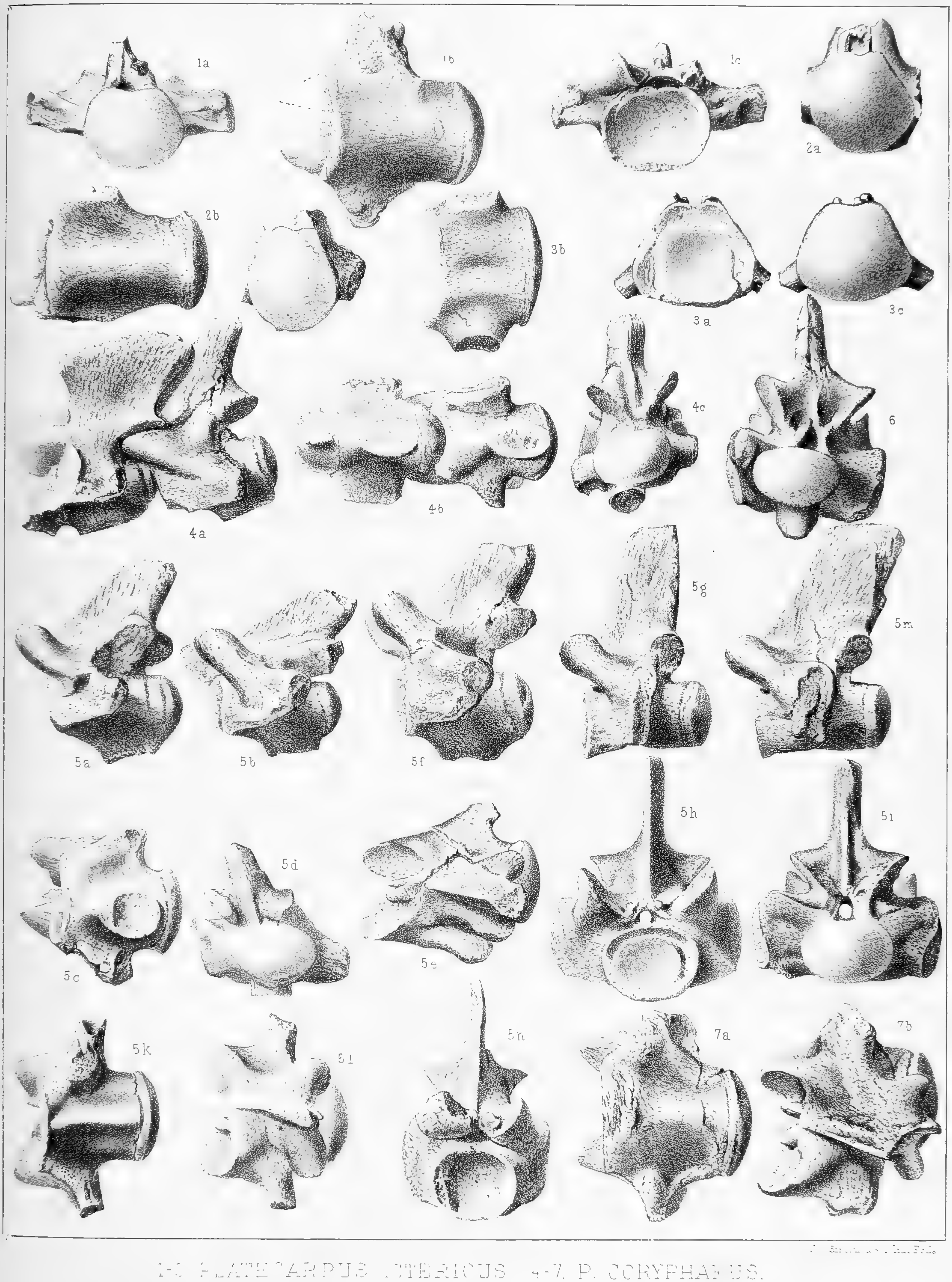
FIG. 3. Posterior lumbar vertebra: *a*, from before; *b*, from below; *c*, from behind.

4. *Platecarpus coryphæus*, axis and third vertebra: *a*, from the side; *b*, from below; *c*, from behind.

5. Three cervical and two dorsal vertebræ: *b*, *c*, *d*, and *e*, views from side, below, behind, and above, respectively; *g*, *h*, *i*, *k*, and *l*, similar views of another; *m*, *n*, side and front views of an anterior dorsal.

6. A posterior cervical from behind.

7. Posterior dorsal vertebra: *a*, from below; *b*, from above.



1-3 PLATECARPUS ICTERICUS. 4-7. P. CORYPHAEUS.

EXPLANATION OF PLATE XXI.

FIG. 1. Posterior dorsal vertebra of *Platecarpus coryphæus*: *a*, from front; *b*, from behind.

2. Dorsal vertebra near the position of the last, from below.

3. *Platecarpus tectulus*, specimen from Butte Creek; middle cervical vertebra: *a*, vertebra, from above; *b*, from below.

4. Anterior cervical vertebra; 4 *b*, from below.

5. Cervical vertebra, more anterior; *b*, centrum, from below.

6. Anterior dorsal vertebra, from front; *a*, from above.

7. *Platecarpus curtirostris*, one-half natural size; *a*, axis, from behind; *b*, from below.

8. *Platecarpus curtirostris*, third cervical: *a*, from front; *b*, from below: *c*, from behind; *d*, from above.

FIGS. 9–11. Anterior dorsal vertebræ of the same species: *a*, views from front; *b*, from behind; *c*, from above.

FIG. 12. Median dorsal, from the front.

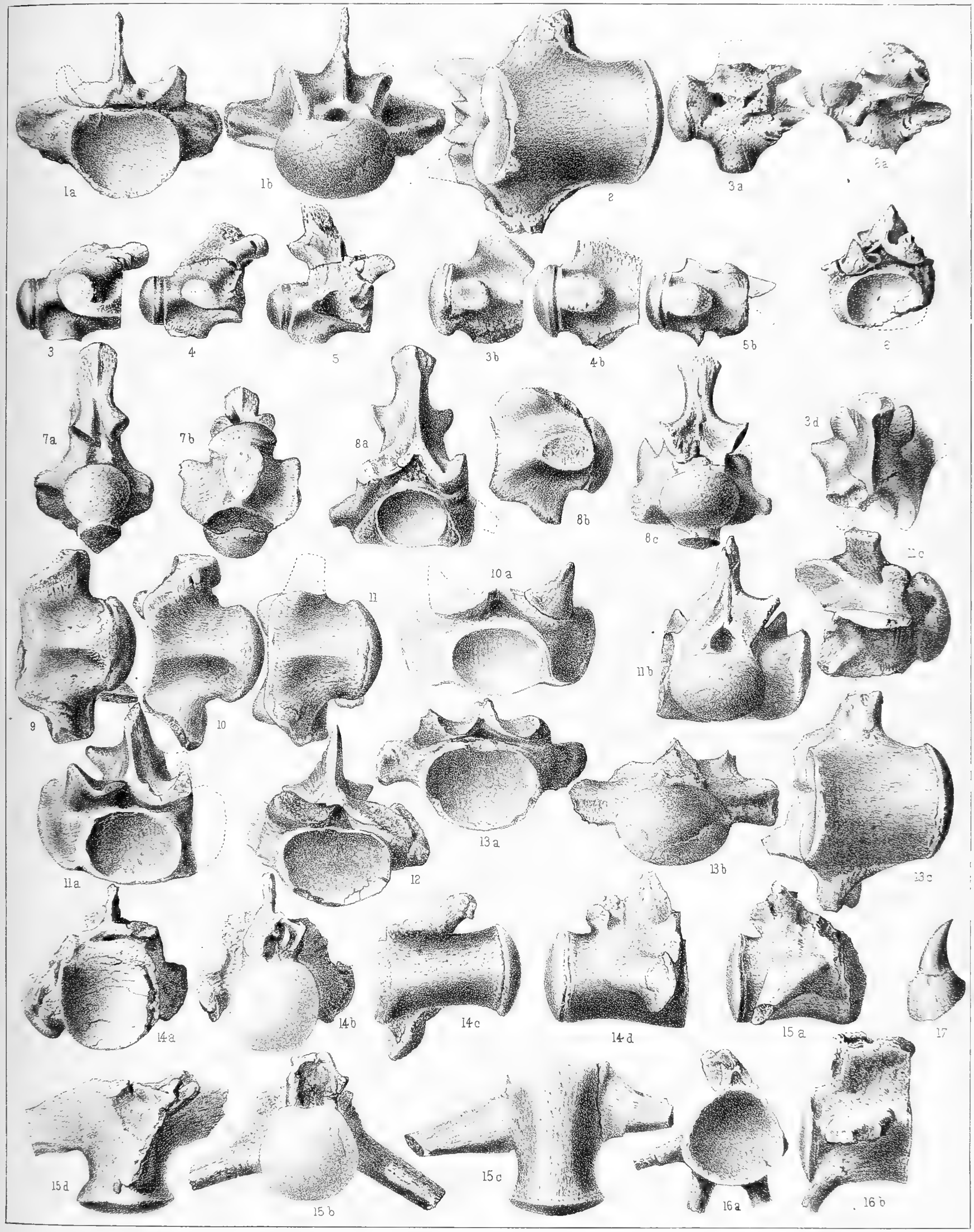
13. Posterior dorsal: *a*, from front; *b*, from behind; *c*, from below.

14. *Clidastes cineriarum*, Cope, postero-median dorsal vertebra: *a*, from front; *b*, from behind; *c*, from below; *d*, from the side.

15. Lumbar vertebra: *a*, from the side; *b*, from behind; *c*, from below; *d*, from above.

16. Anterior caudal vertebra: *a*, from front; *b*, from side.

17. Palatine tooth, natural size.



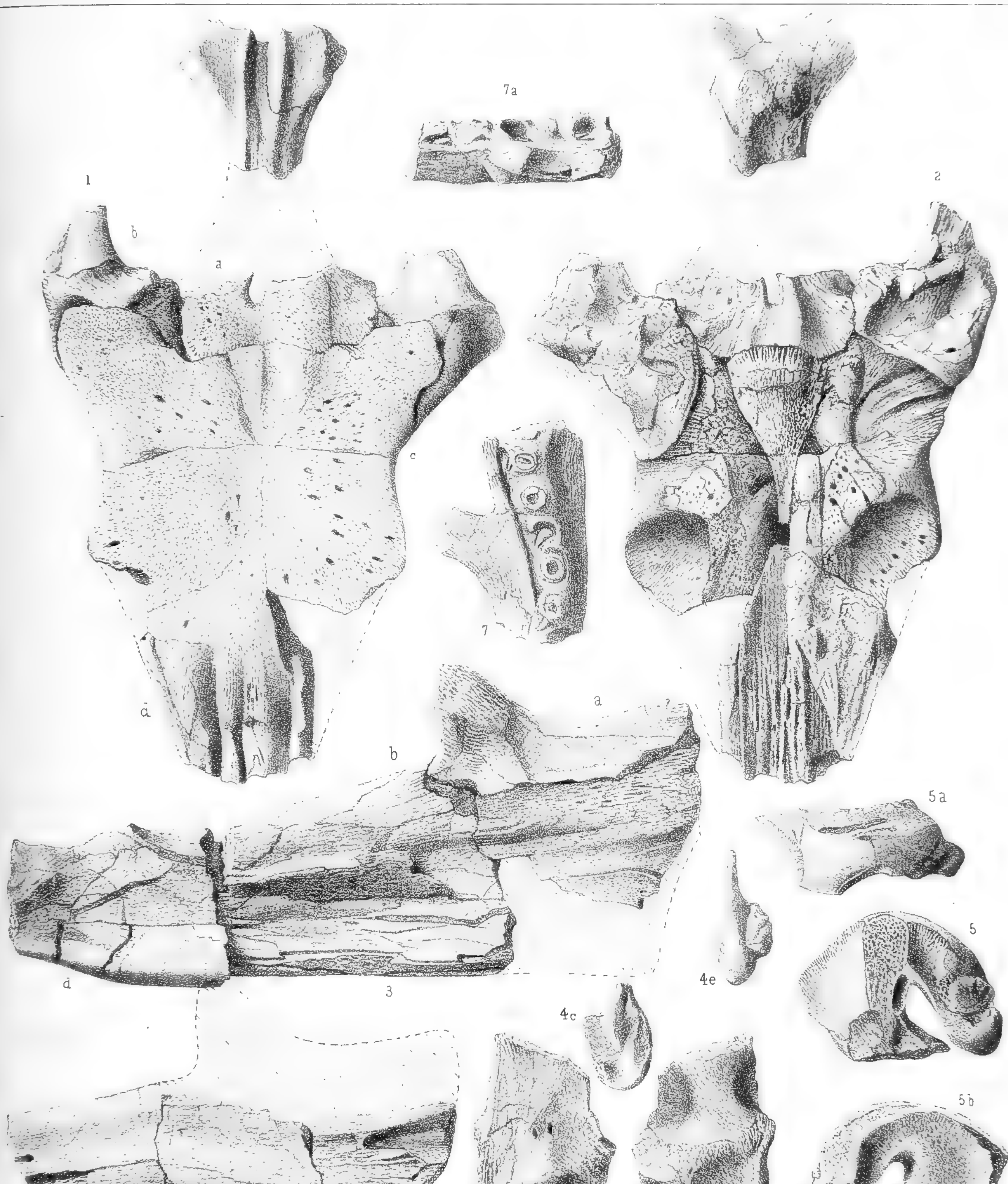
1-2 PLATECARPUS CORYPHAEUS. 3-6. P. TECTULUS.
7-13 P. CURTIROSTRIS. 14-17. CLIDASTES CINERIARUM.

EXPLANATION OF PLATE XXII

Clidastes planifrons, Cope, one-half natural size.

FIG. 1. Superior view of parts of cranium preserved, including parts of the parietal (*a*), postfrontal (*b*), prefrontal (*d*), and fronto-nasal (*c*) elements.

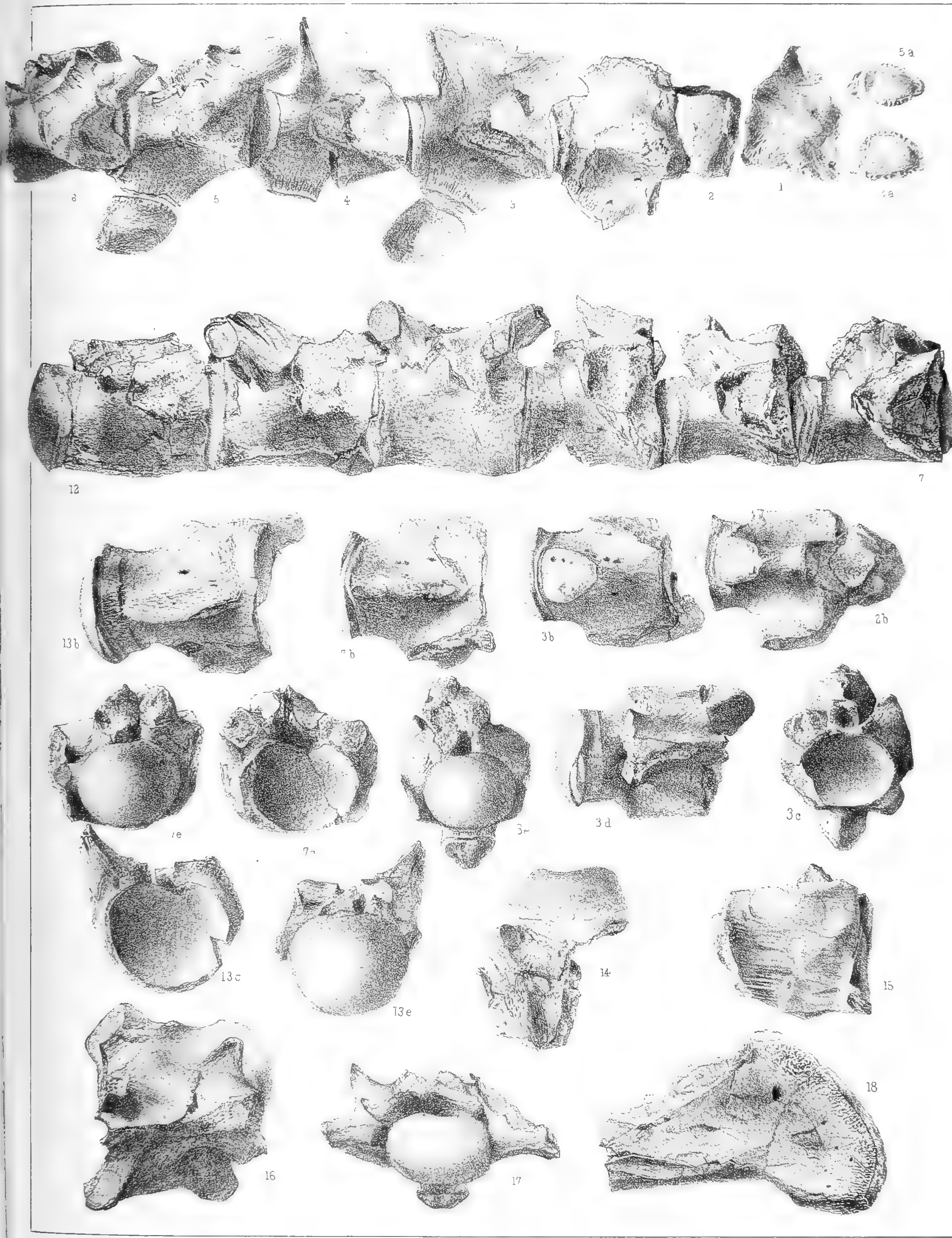
2. The same, seen from below.
3. Posterior part of left mandibular ramus, without angle.
4. Median portion of right mandibular ramus, showing hinge. In both figures, *a* is the coronoid, *b* the surangular, *c* angular, *d* articular, and *e* splenial.
5. Portion of the right quadrate bone: 5, proximal part, inner view; 5 *a*, proximal view of the same; 5 *b*, external view of the same.
6. Distal portion of left quadrate, external view; 6 *a*, internal view; 6 *b*, posterior view.
7. Right palatine bone, from below; 7 *a*, right palatine bone, from outer side.



CLIDASTES PLANIFRONS.

EXPLANATION OF PLATE XXIII.

FIGS. 1–14. *Clidastes planifrons*, one-half natural size.
FIG. 1. Right neurapophysis of the atlas.
2. Axis, with odontoid bone, hypapophysis of latter wanting; 2 *b*, the same, inferior view.
FIGS. 3–6. Cervical vertebræ in order; *a*, free hypapophysis, proximal surface; *b*, inferior, *c*, anterior, *d*, superior, and, *e*, posterior views of the same.
FIGS. 7–13. Some of the dorsal vertebræ in order; 7 *b*, the (?) first dorsal from below; *c*, from in front; and, *e*, from behind; 13 *b*, a posterior dorsal from below; *c*, front; *e*, posterior extremity.
FIG. 14. Basi-occipital and part of sphenoid, from below.
15. Exoccipital, from above and behind.
FIGS. 16–18. *Sironectes anguliferus*, one-half natural size.
FIG. 16. ? Third cervical from above, exhibiting zygosphen.
17. Last cervical, displaying zygantrum; zygosphenal articulation indistinct, through error of artist.
18. Terminal portion of the articular bone from the outside, showing the suture with the surangular.



1-15. CLIDASTES PLANIFRONS. 16-18. SIRONECTES ANGULIFERUS.

EXPLANATION OF PLATE XXIV.

FIGS. 1–14. *Sironectes anguliferus*, one-half natural size.

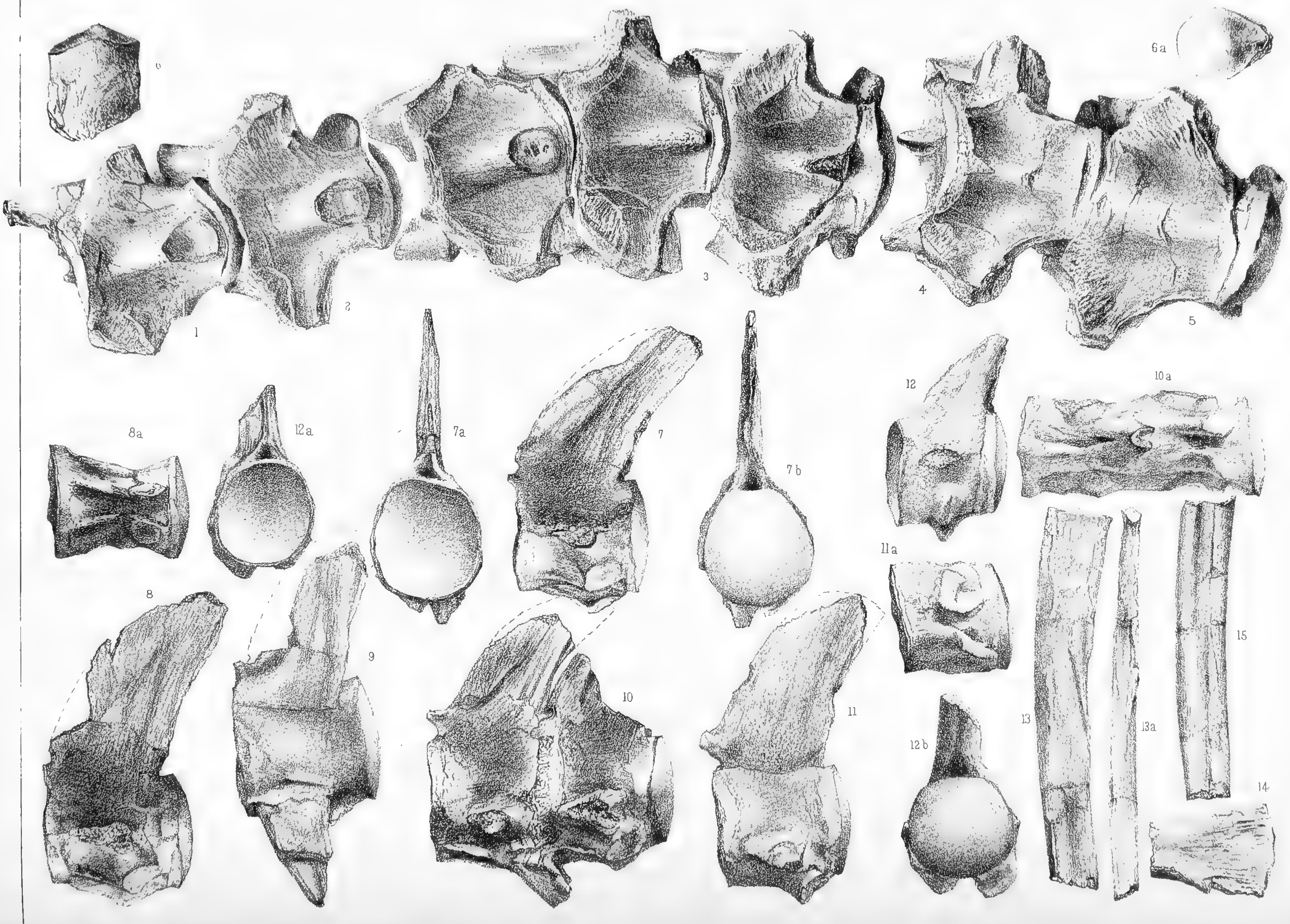
1–2. Two consecutive cervical vertebræ, the ? third and fourth followed by an interval, from which one or two vertebræ are missing; inferior view.

3–5. Five consecutive cervical and dorsal vertebræ, seen from below: 3, last cervicals; 4–5, anterior dorsals. Like 1 and 2, these have suffered somewhat from depression.

FIG. 6. A free cervical hypapophysis; *a*, proximal view.

FIGS. 7–12. Vertebræ from the anterior portion of the caudal series which bear diapophyses, commencing with the more anterior; 7 *a*, front; 7 *b*, posterior view of 7; 8 *a*, inferior view of number 8; 10 *a*, inferior view of two caudals (fig. 10), with broken chevron-bone on the anterior; 12 *a*, anterior, and, *b*, posterior view of 12, a distal one of the series.

13–15. Ribs: 13-14, proximal, and, 15, median portions.



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SIRONECTES ANGULIFERUS.

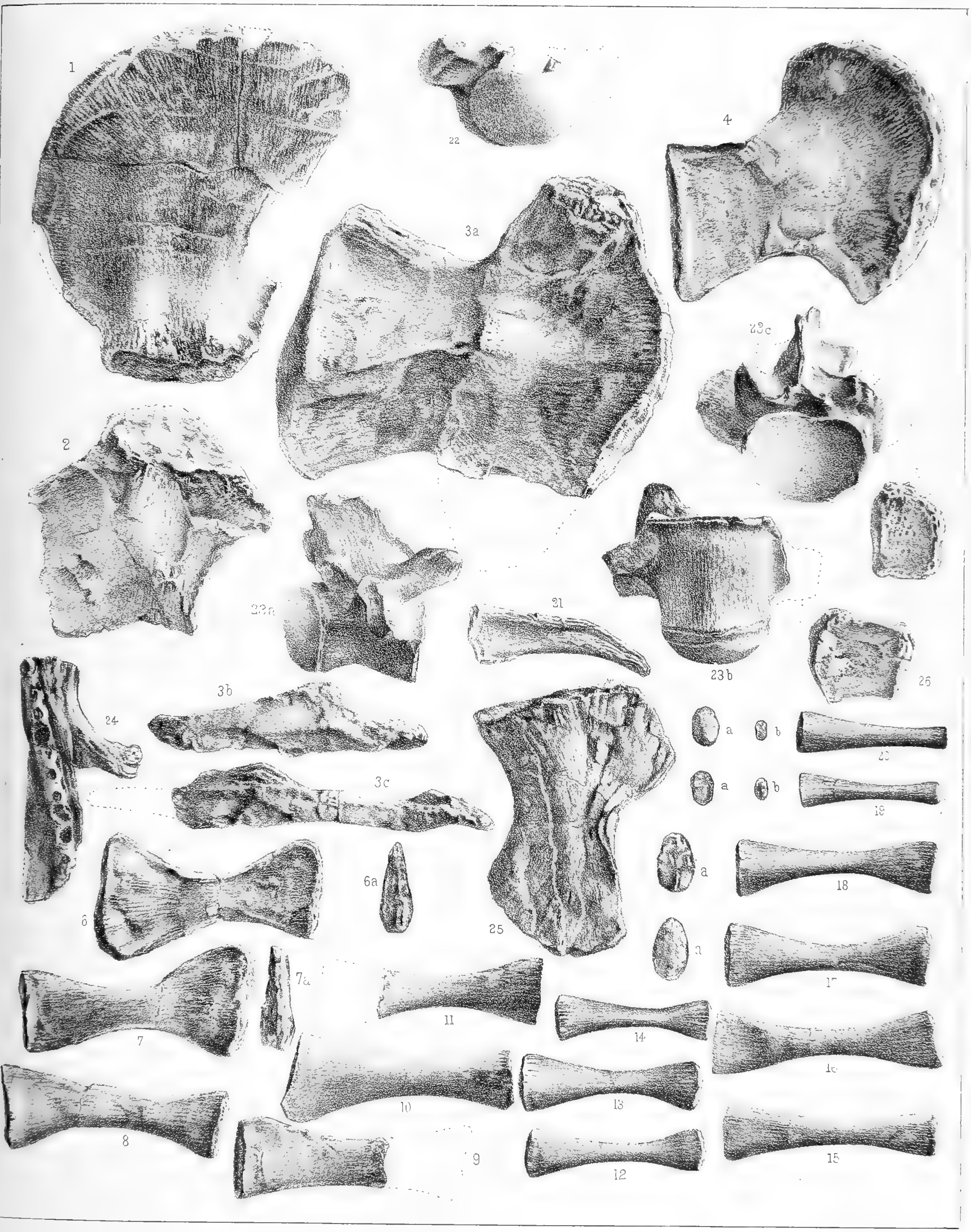
EXPLANATION OF PLATE XXV.

Vertebræ and limb-bones, etc., of *Platecarpus ictericus,* from Professor Mudge's collection, one-half natural size. From figs. 1-25 belong to one individual, and figs. 26-27 to a second.

FIG. 1. Scapula.
2. Fragment of coracoid.
3. Humerus: *a,* from outside; *b,* from proximal; *c,* from distal end.
4. Radius.
5. Carpal bone.

FIGS. 7-10. Supposed metacarpals, with (6 *a* and 7 *a*), their distal extremities.
11-20. Phalanges, with, *a,* their proximal, and, *b,* their distal extremities.

FIG. 21. A cervical rib.
22. A dorsal vertebra, viewed from behind.
23. A dorsal vertebra: *a,* from the side; *b,* from below; *c,* from the front.
24. The palatine bone, from below.
25. Ulna of a second specimen.
26. Metacarpal of the same.



PLATECARPUS ICTERICUS.

EXPLANATION OF PLATE XXVI.

Figures of vertebræ and limb-bones of *Pythonomorpha*, one-half natural size.

FIG. 1. A series of 28 caudal vertebræ of an undetermined species, taken from Butte Creek bluffs; the series is continuous except a definite interruption at the 15th, and two or three possibly in front of it: *a*, posterior surface of 28th vertebra; *b*, posterior surface of 24th vertebra; *c*, posterior surface of the 21st vertebra; *d*, the same, from the front; *e*, the 13th, from behind; *f*, the 13th, from the front. Many of the neural spines indicated by outlines are preserved on separate pieces of rock.

2. *Platecarpus ? mudgei*, specimen from Fox Cañon: *a*, posterior part of mandibular ramus from within, one-half natural size; *b*, posterior part of right dentary, natural size: *c*, posterior part of left dentary, natural size; *d*, coronoid bone, one-half natural size, from the outside; *e*, coronoid bone, one-half natural size, from the inside.

3. *Platecarpus mudgei*, from Professor Mudge's collection, original type: *a*, hypapophysis of axis, from below; *b*, hypapophysis of axis, from behind; *c*, centrum, or basal part, of atlas; *d*, articular extremity of scapula.

4. Middle dorsal vertebra of *Platecarpus crassartus*, Cope, from Professor B. F. Mudge's collection, profile: *a*, from front.

5. Adjacent vertebra of same, profile: *a*, from front; *b*, from behind; *c*, from below.

6. Lumbar vertebra: *a*, from behind; *b*, from below.

7. Anterior caudal vertebra, from front.

8. Caudal with diapophysis: *a*, from behind; *b*, from below.

9. Humerus of *Platecarpus crassartus*: *a*, from within; *b*, from without; *c*, proximal end; *d*, distal end.

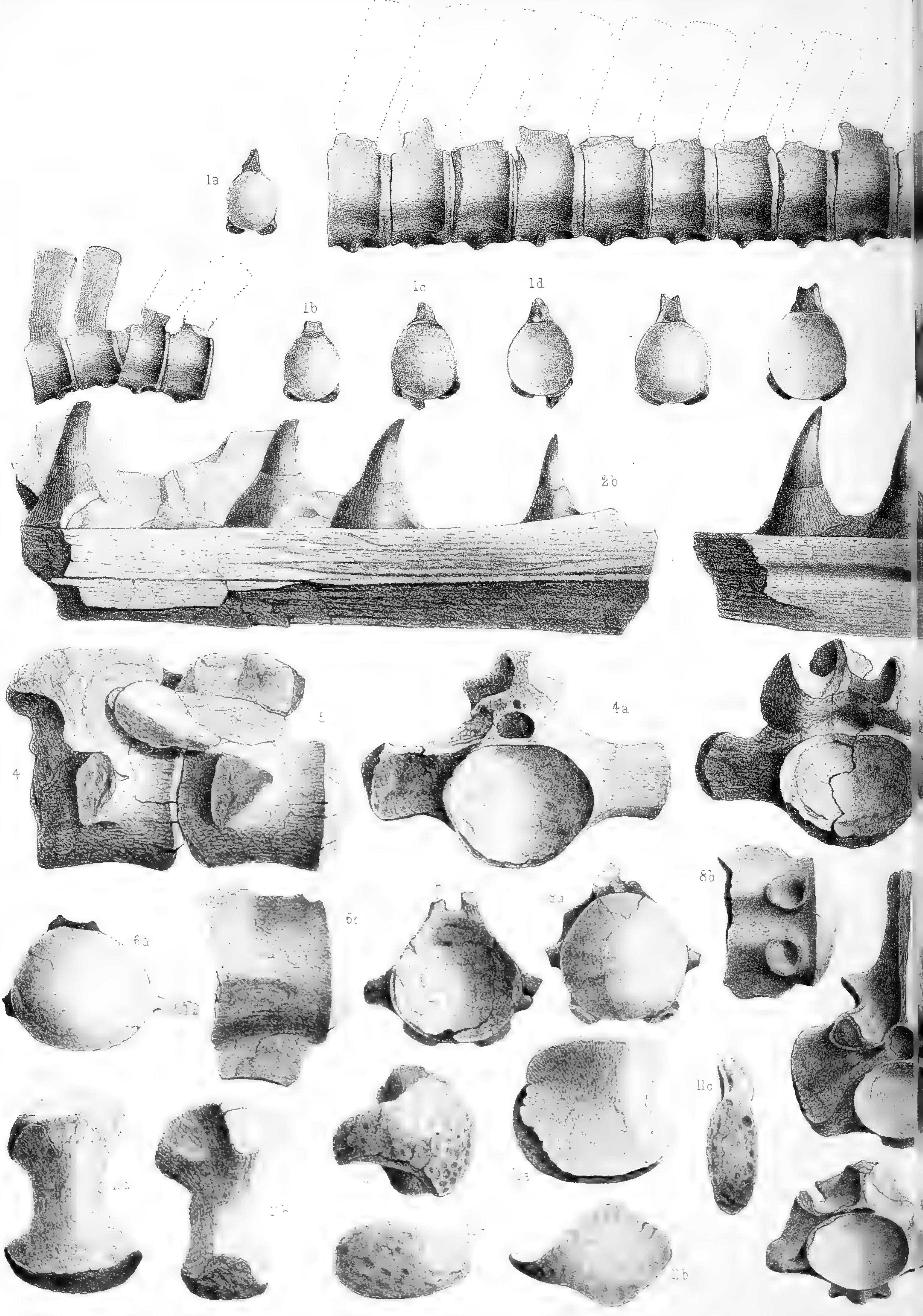
10. Femur of same: *a*, from within; *b*, from without; *c*, proximal, and, *d*, distal extremities.

11. Fibula of same: *a*, from side; *b*, proximal; and, *c*, distal extremities.

12. Phalange of same.

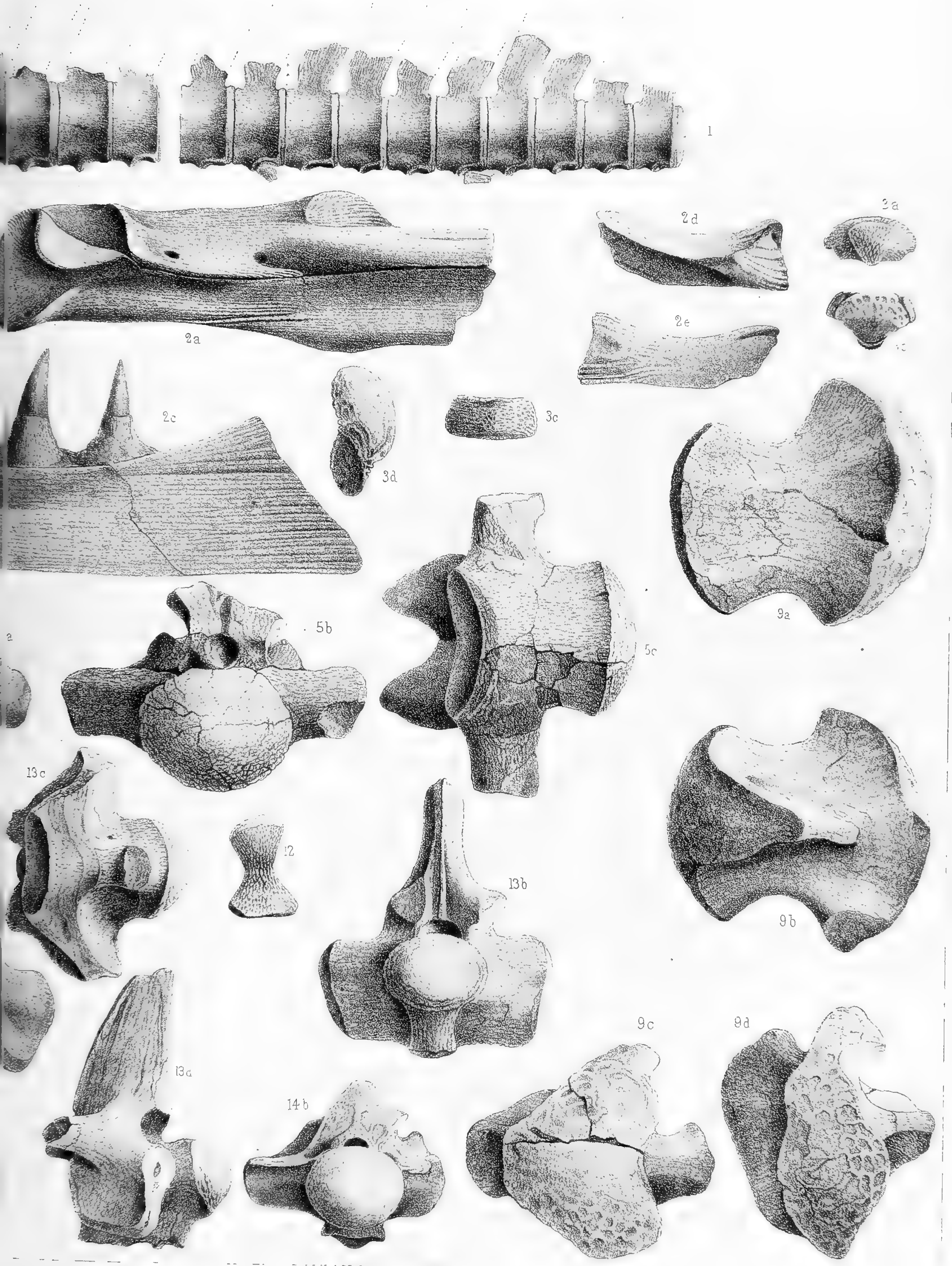
13. Cervical vertebra of *Platecarpus glandiferus*, from Professor Mudge's collection: *a*, from front; *b*, from behind; *c*, from below; *d*, profile.

14. Cervical vertebra of the same from Butte Creek: *a*, from front; *b*, from behind.

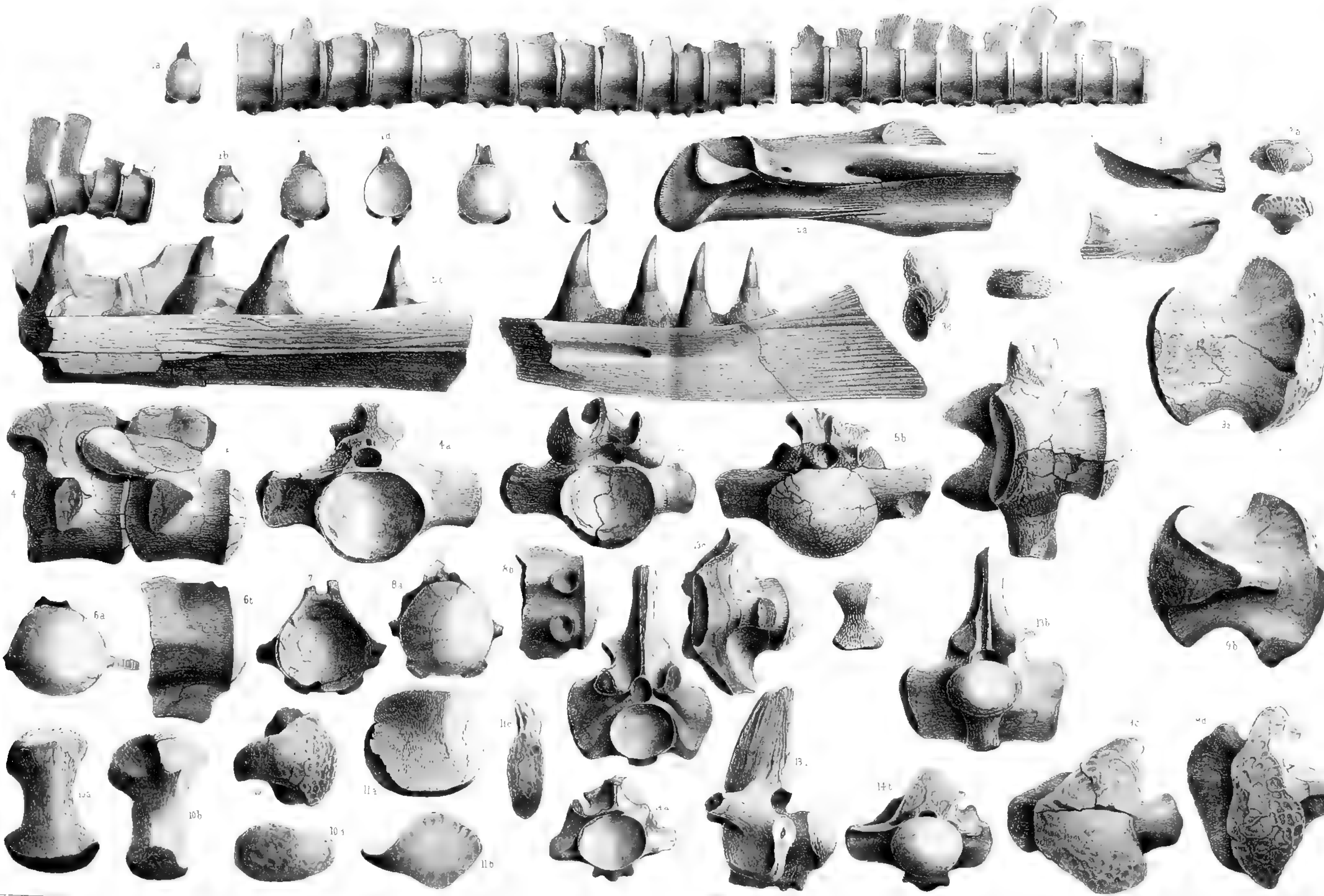


...PLATECARPUS SP. ...PLATECAR...

...PLATECA...



MUDGE? 4-12. PLAT. CRASSARTUS.



. FLATE 'ARFUC SP 2 FLATE 'AF[illegible] [illegible] 4 L. FLAT. TA[illegible]SARIUS
1--14 FLATE [illegible] [illegible]

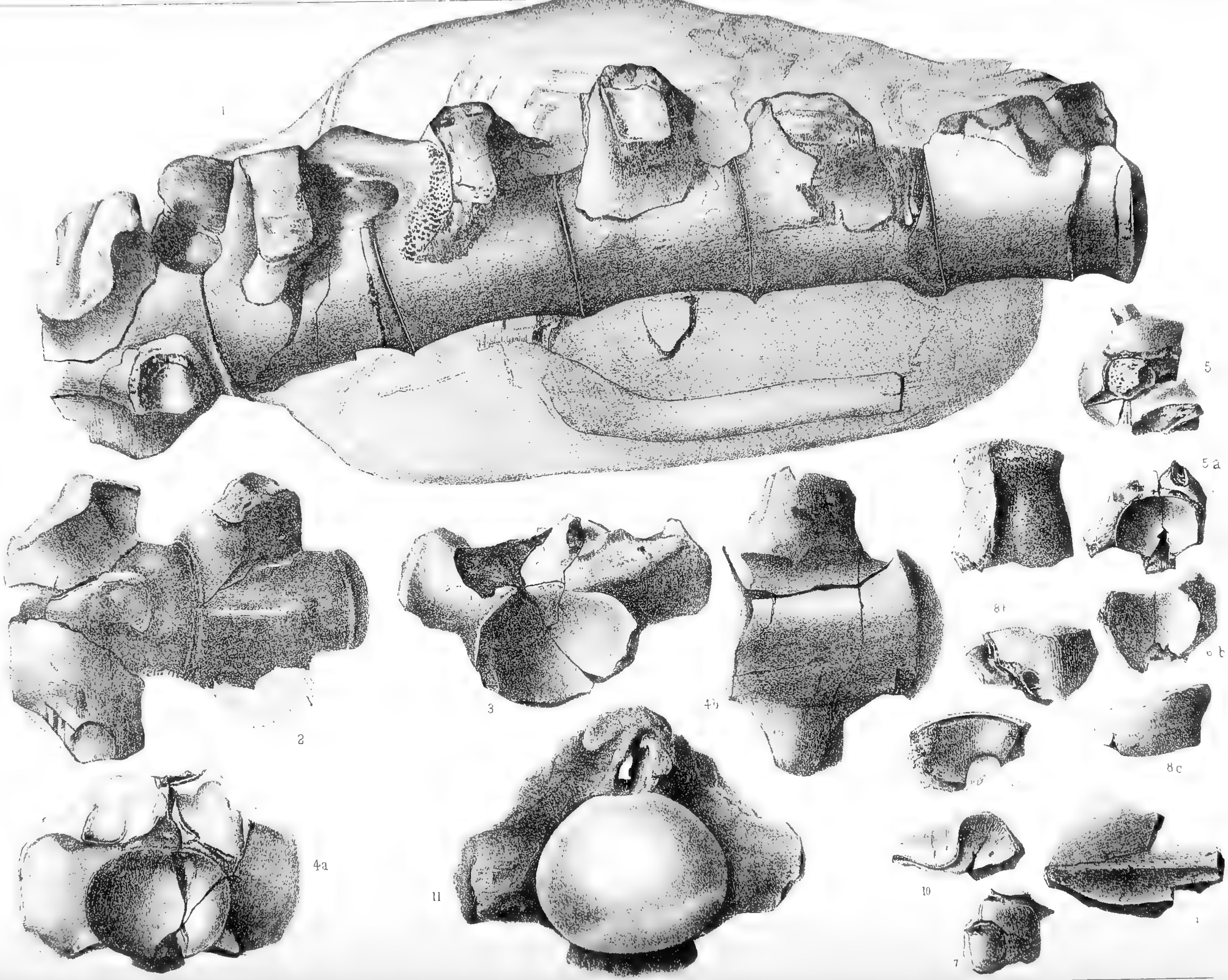
EXPLANATION OF PLATE XXVII.

FIG. 1. One cervical and five dorsal vertebræ, with a rib, of *Platecarpus latispinus*, in place, one-half natural size; from Professor Mudge's collection; profile.

2. Last cervical and first dorsal, from below.
3. Last cervical vertebra from front.
4. Sixth dorsal: *a*, from front; *b*, from below.

5–10. *Platecarpus tectulus*, specimen from Professor Mudge's collection from near Sheridan, one-half natural size.

5. Median cervical vertebra from front.
6. Median dorsal vertebra: *a*, centrum, from above; *b*, from front.
7. Atlas neurapophysis, from within.
8. Quadrate bone: *a*, from outside; *b*, from inside; *c*, proximal end of fragment.
9. Frontal bone, fragment, from above.
10. Parts of angular and articular bones with cotylus of mandible.
11. Third cervical vertebra of *Liodon dyspelor*, the Fort Wallace specimen, from behind, one-half natural size.



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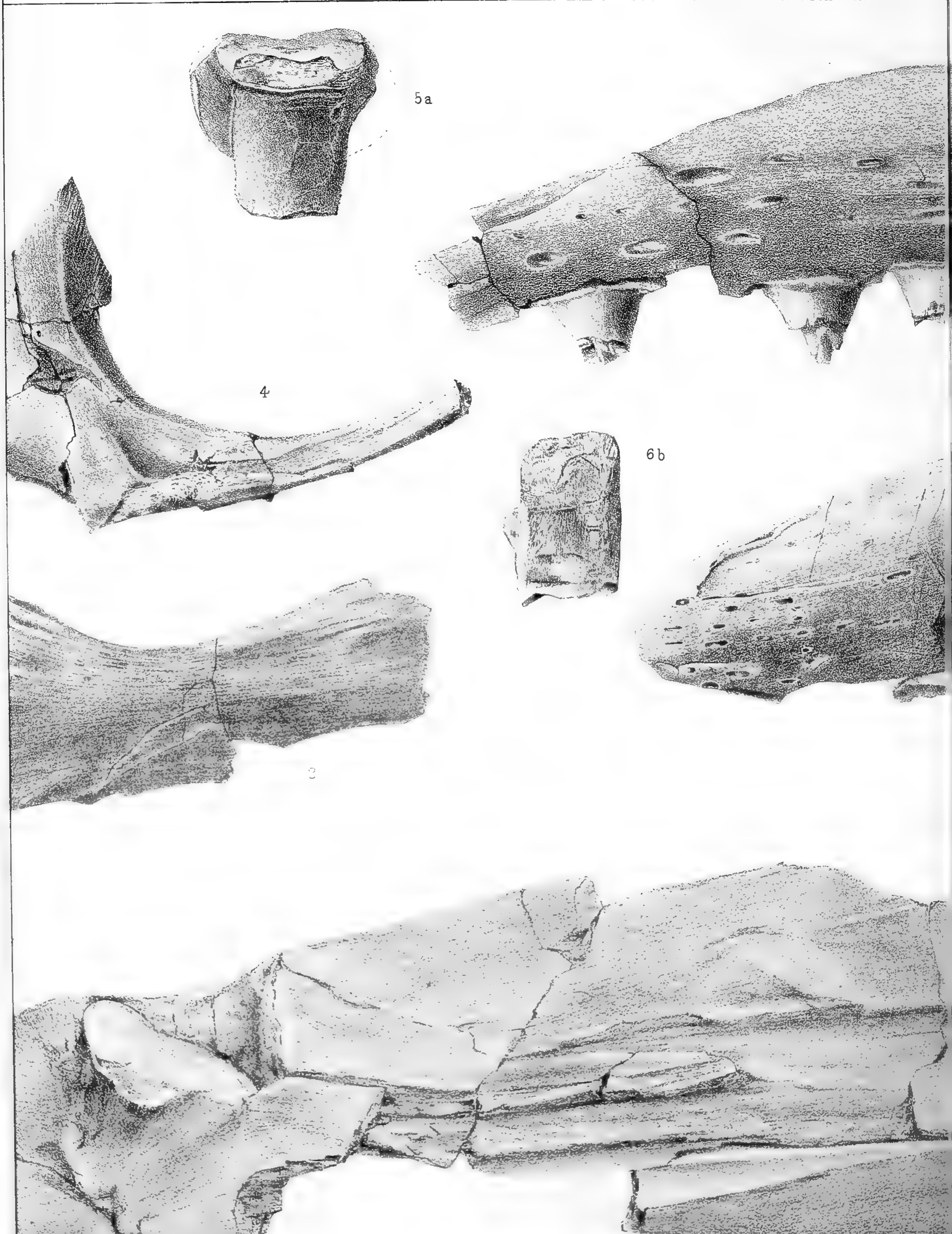
1-4. PLATECARPUS LATISPINIS. 5-10. PL. TECTULUS. 11. LIODON DYSPELOR.

EXPLANATION OF PLATE XXVIII.

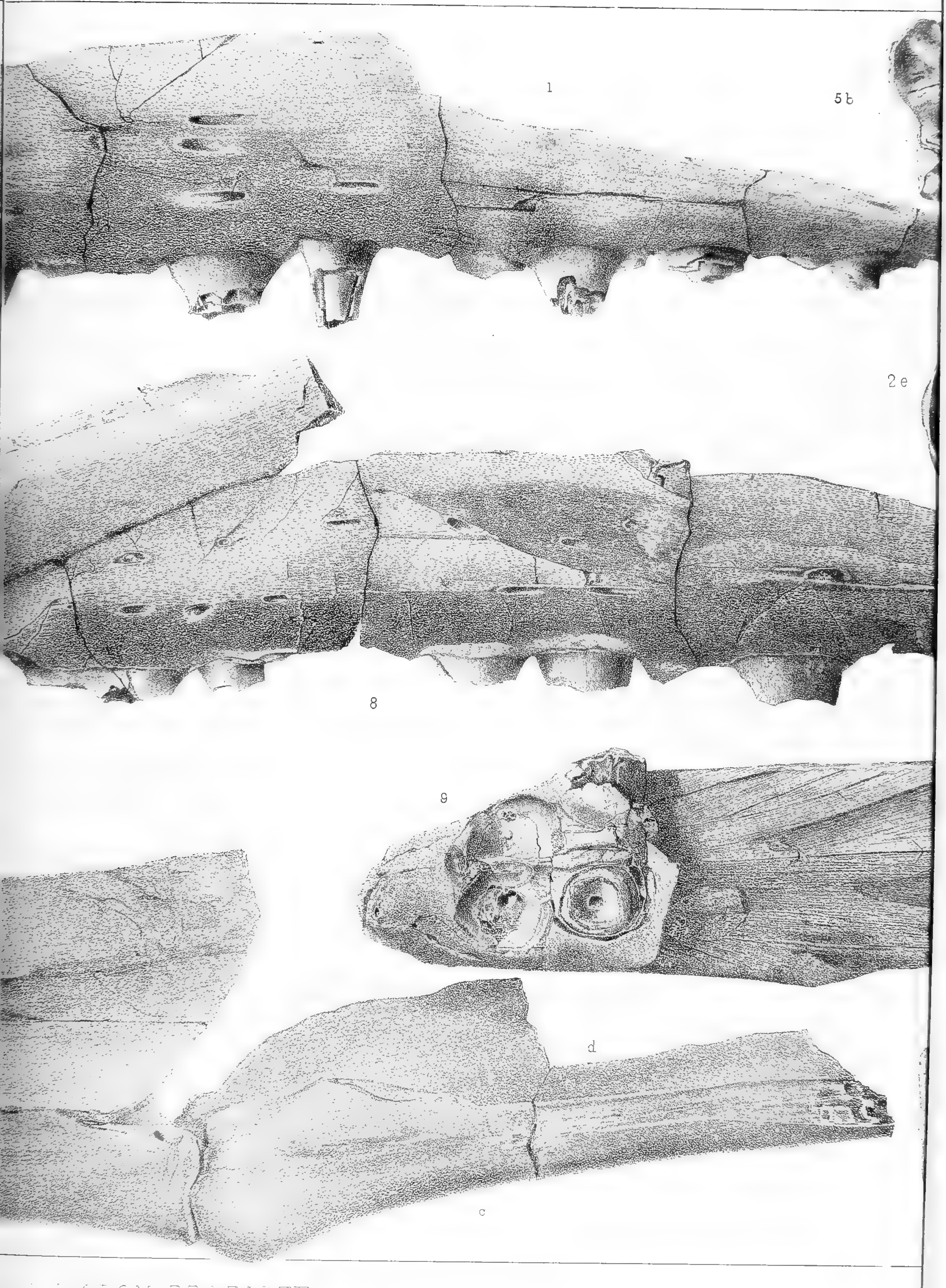
Cranial and vertebral bones of *Liodon dyspelor* and *L. proriger*, one-half natural size.

FIG. 1. *Liodon dyspelor*, left maxillary bone.

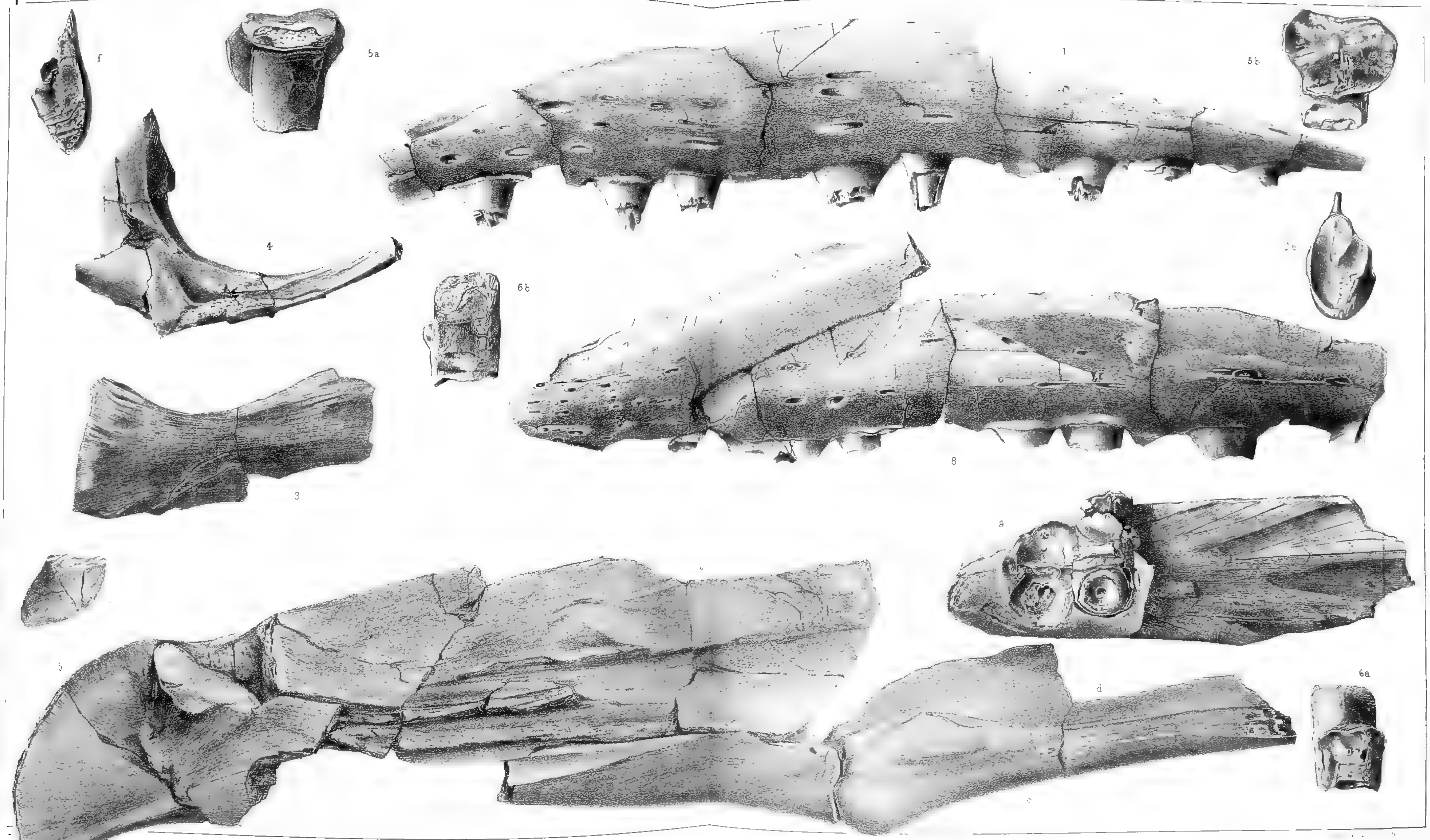
2. Left ramus mandibuli, posterior portion: *a*, surangular; *b*, articular; *c* and *d*, splenial bones; *e*, articular extremity of angular; *f*, articular extremity of splenial.
3. Coronoid bone, from within.
4. Cranial bone, ? postfrontal.
5. Hypapophysis of odontoid: *a*, from front; *b*, from back.
6. Hypapophysis of axis: *a*, from above; *b*, from below; somewhat distorted by pressure.
7. Hypapophysis of a median cervical vertebra.
8. Premaxillary and part of maxillary bone of *Liodon proriger*, in profile.
9. Premaxillary bone of *Liodon proriger*, from below.



1-7. LIODON DYSPELOR



LIODON PRORIGER.



1-7 LIODON DYSPELOR 8-9 LIODON PRORIGER.

EXPLANATION OF PLATE XXIX.

Vertebræ of *Liodon dyspelor*, from Butte Creek, one-half natural size. They are selected from various points in the column, the best-preserved being preferred; most of the dorsal and caudal vertebræ are omitted.

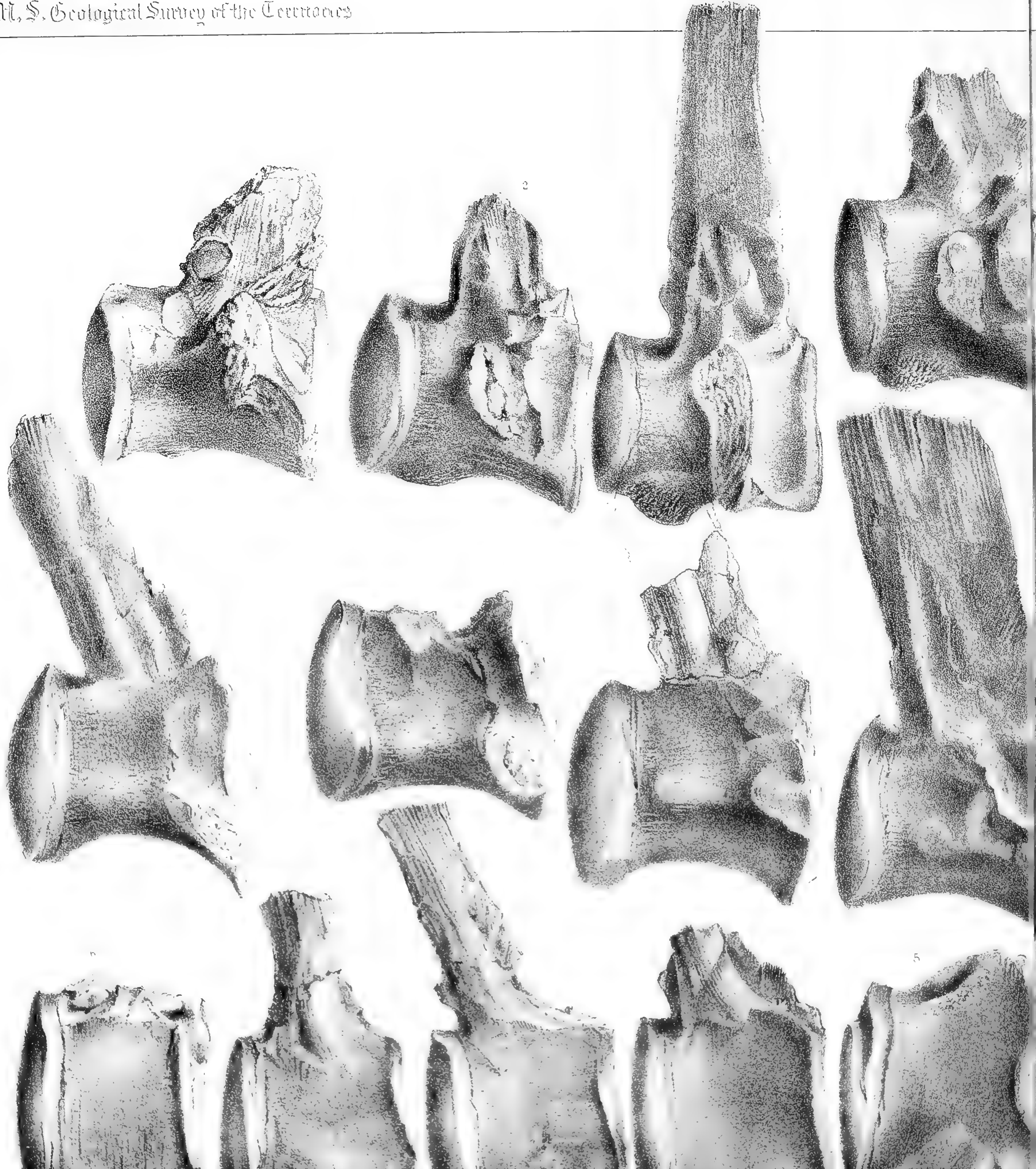
FIG. 1. Atlas and axis from the side: *a*, centrum of atlas; *b*, neurapophysis; *c*, hypapophysis; *d*, centrum of axis, free hypapophysis omitted (*see* Plate xxviii, fig. 6).

2. Last cervical.

3. A posterior dorsal.

4. A lumbo-sacral, with its posterior face upward, with neural arch on right, and diapophysis on left side.

FIGS. 5 to 6. Caudal vertebræ.



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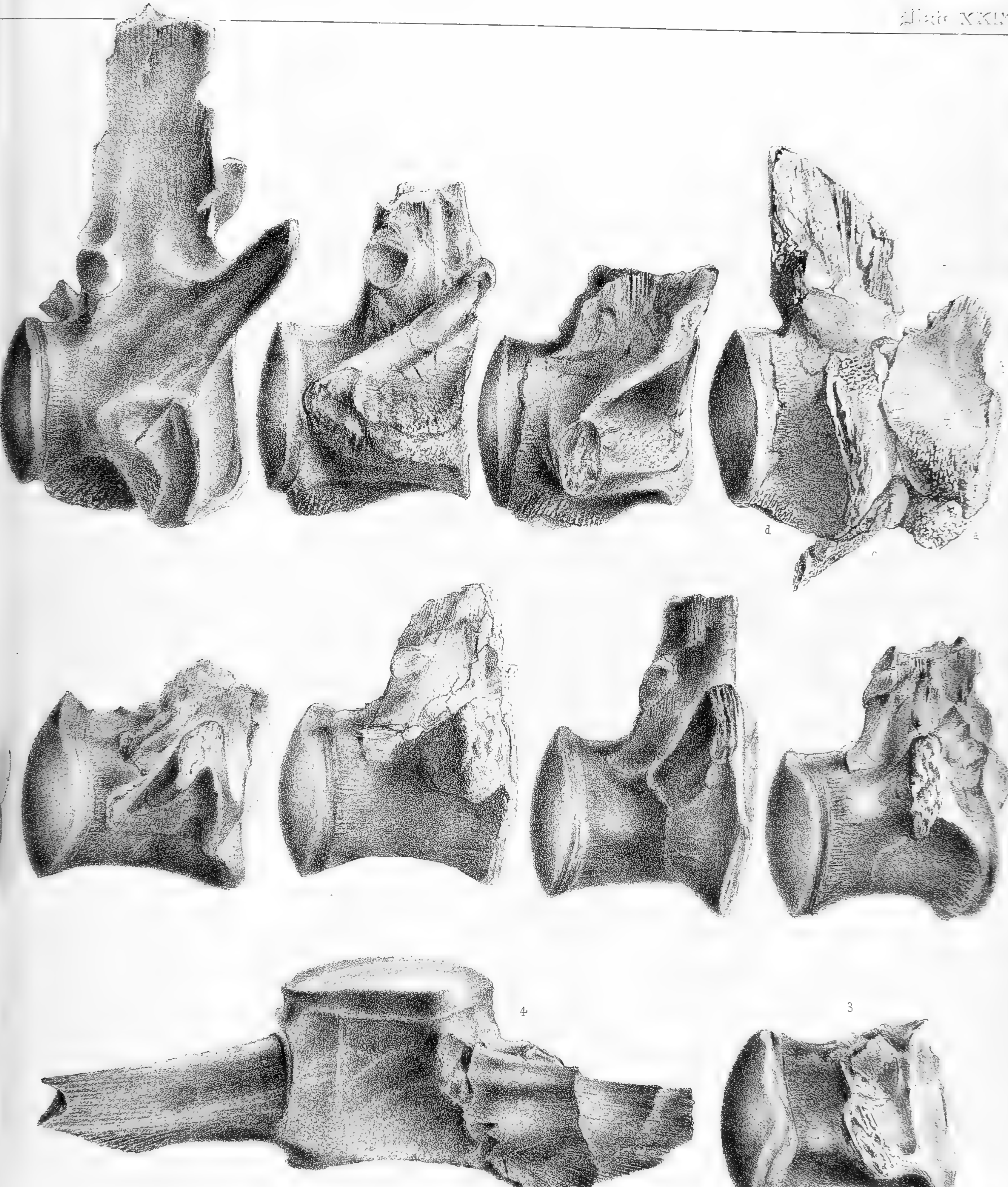

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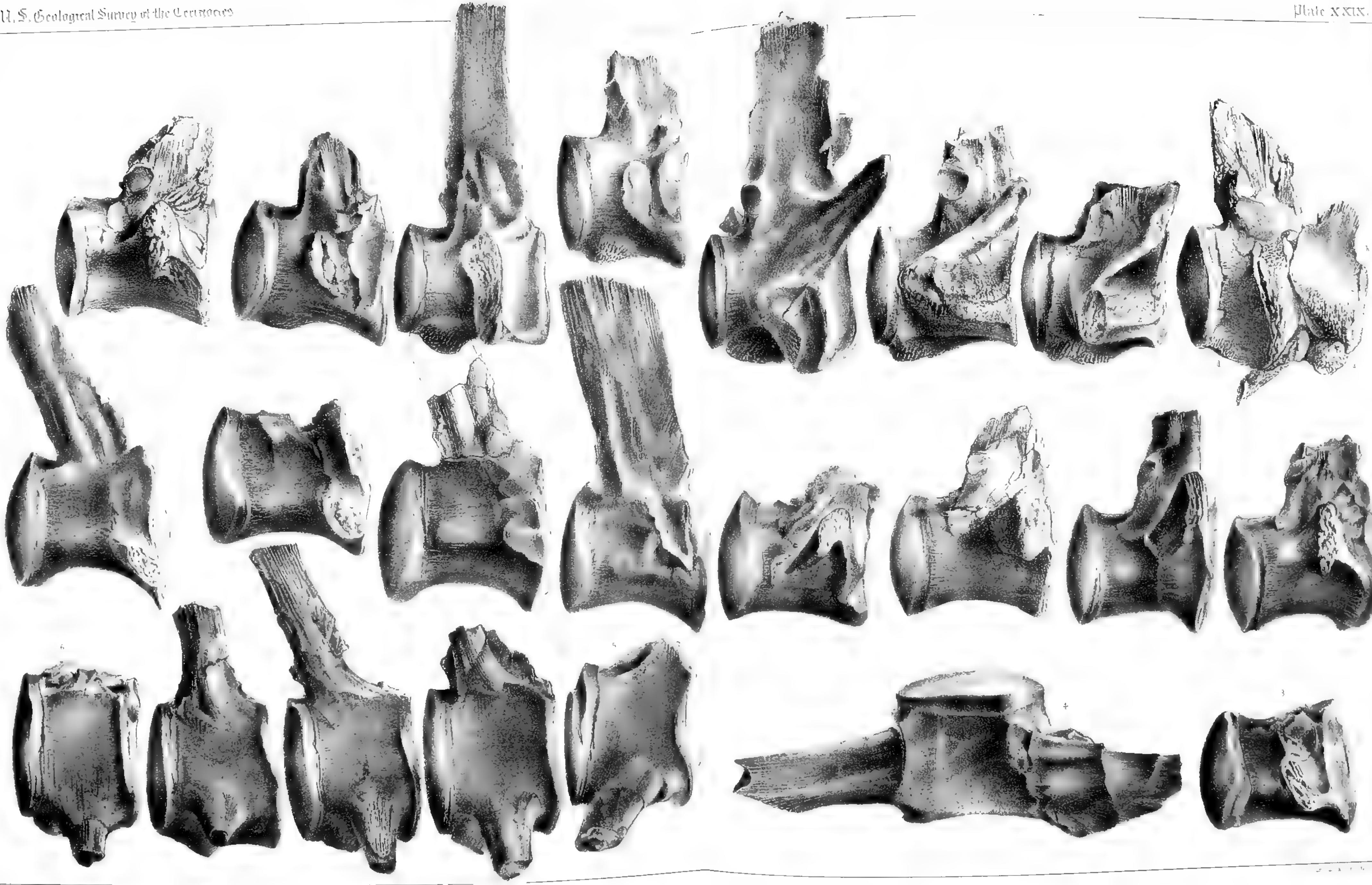
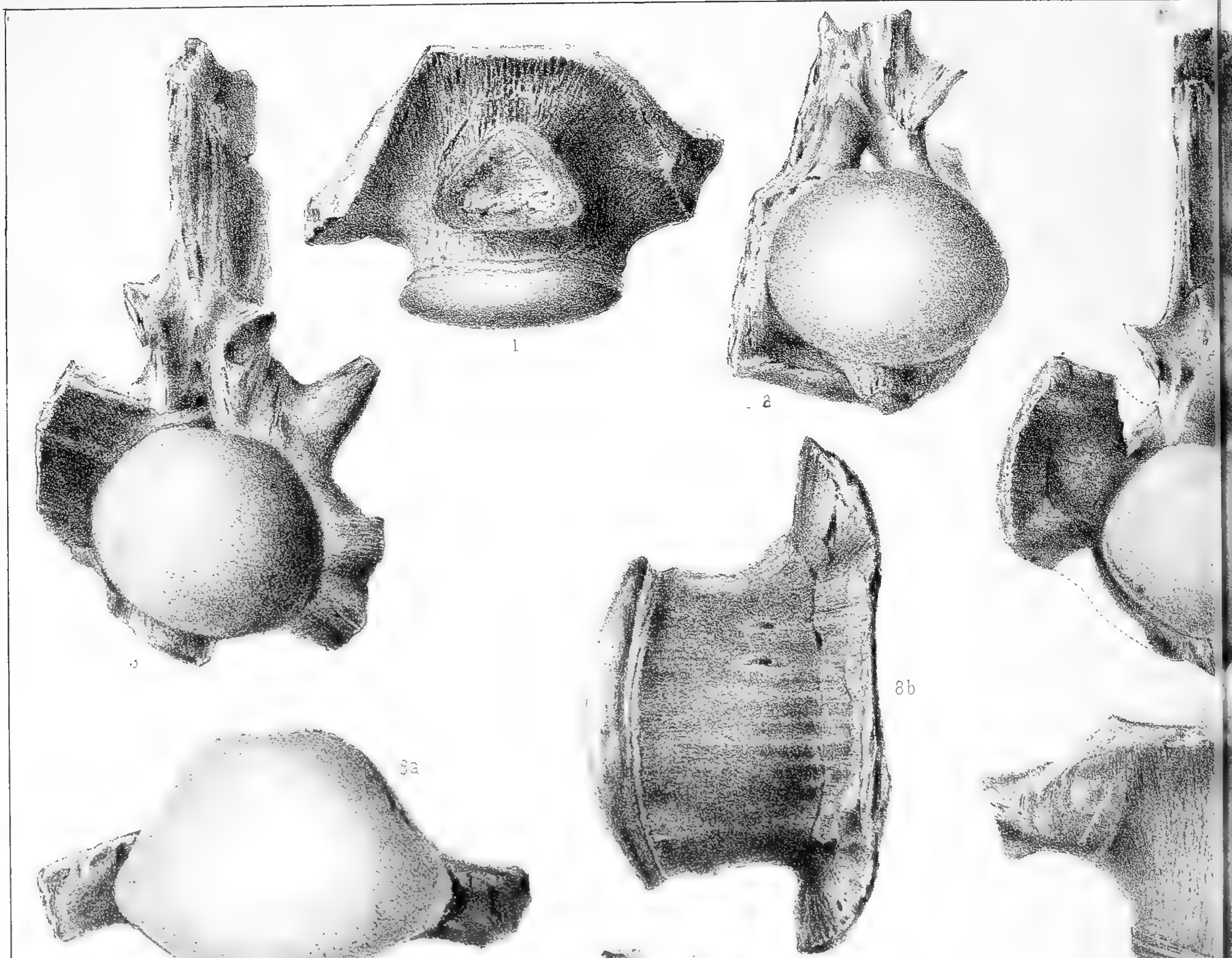


LIODON DYSPELOR COPE.

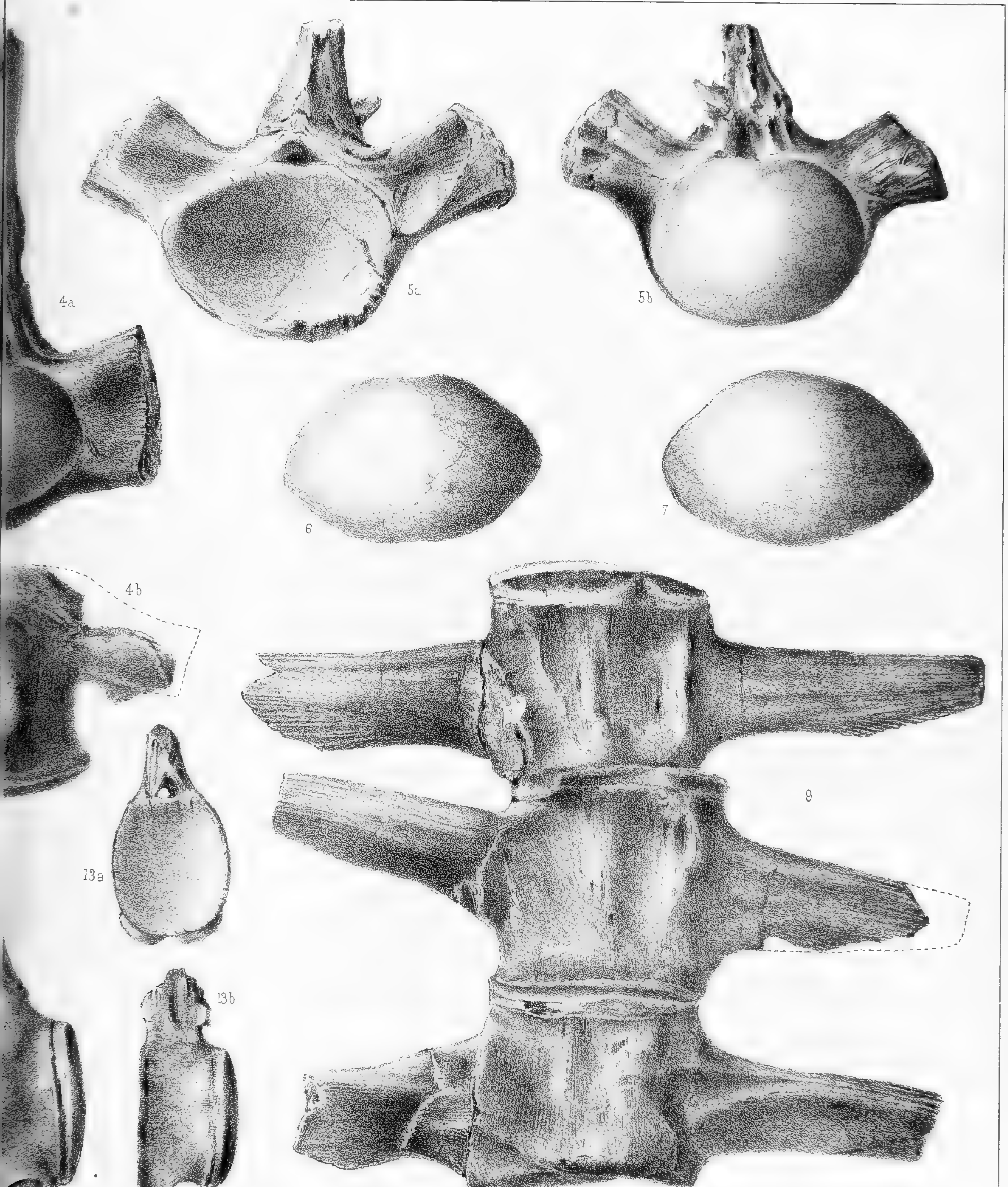
EXPLANATION OF PLATE XXX.

Vertebræ of *Liodon dyspelor*, from Butte Creek, and *L. proriger*, type-specimen, one-half natural size.

FIG. 1. Third cervical vertebra of *L. dyspelor*, from below.
2. Fifth cervical vertebra, from behind; slightly distorted by pressure.
3. Middle cervical, from behind.
4. Last cervical: *a*, from behind; *b*, from below.
5. Anterior dorsal vertebra: *a*, from front; *b*, from rear.
6. Middle dorsal, centrum from behind.
7. Posterior dorsal, centrum from behind.
8. Posterior dorsal or anterior lumbar: *a*, from behind; *b*, from below.
9. Three consecutive lumbar vertebræ, from below.
10. Cervical vertebra of *Liodon proriger*, from the front; belonging with the remaining figures to fig. 14, inclusive, to the type-specimen in the Museum of Comparative Zoölogy, Cambridge.
11. Anterior caudal vertebra of the same individual, from behind.
12. Median caudal: *a*, from front; *b*, from the side.
13. Posterior caudal vertebra: *a*, from front; *b*, from side.
14. Four distal caudals, profile.



1-9. LIODON DYSPELOR.
one ha



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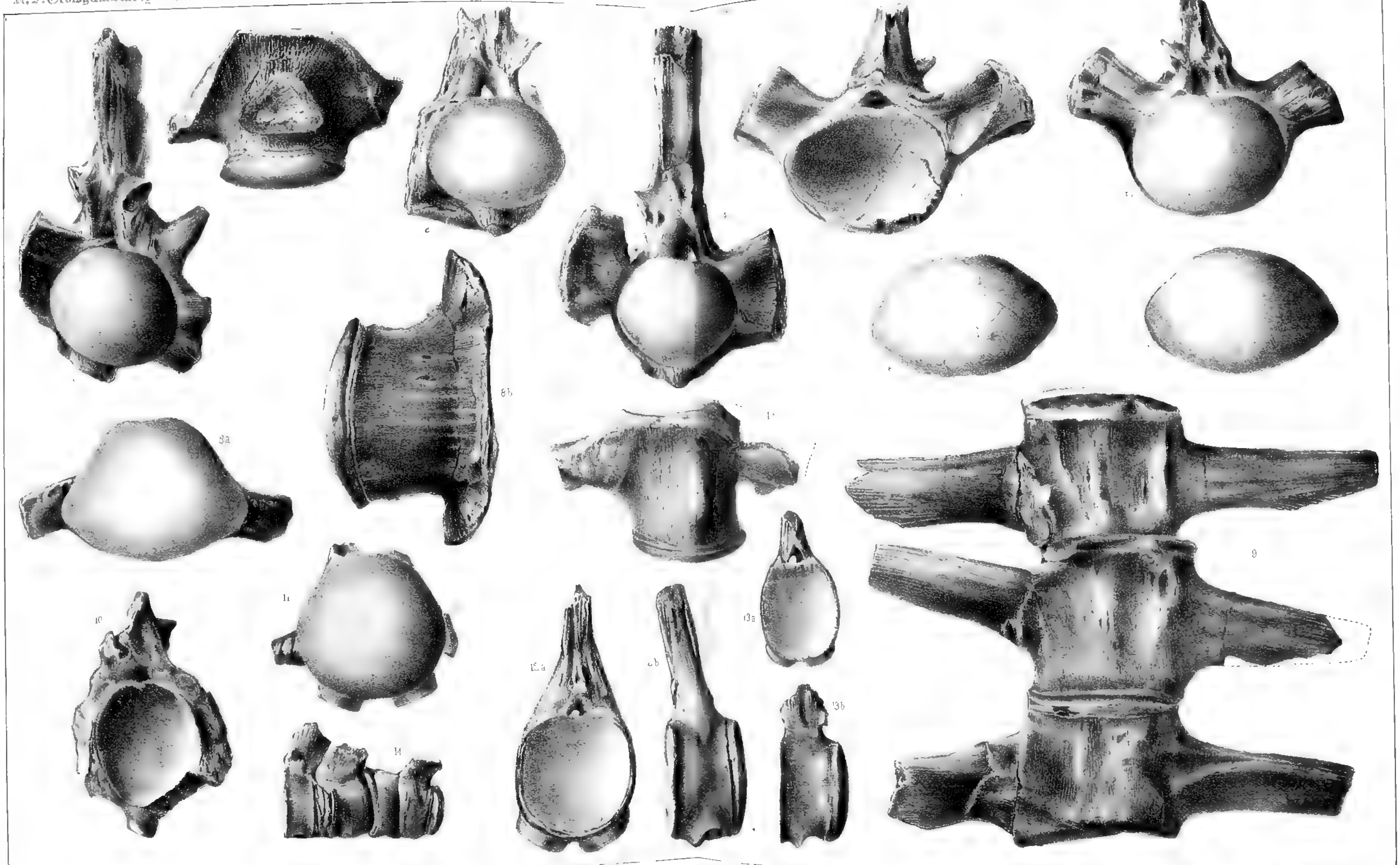
10 - 14. LIODON PRORIGER.
atural Size.



1-9. LIODON DYSPELOR 10-14. LIODON PRORIGER.
one half natural Size.

EXPLANATION OF PLATE XXXI.

FIGS. 1–3. Vertebræ of the *Liodon dyspelor* from Butte Creek, one-half natural size.

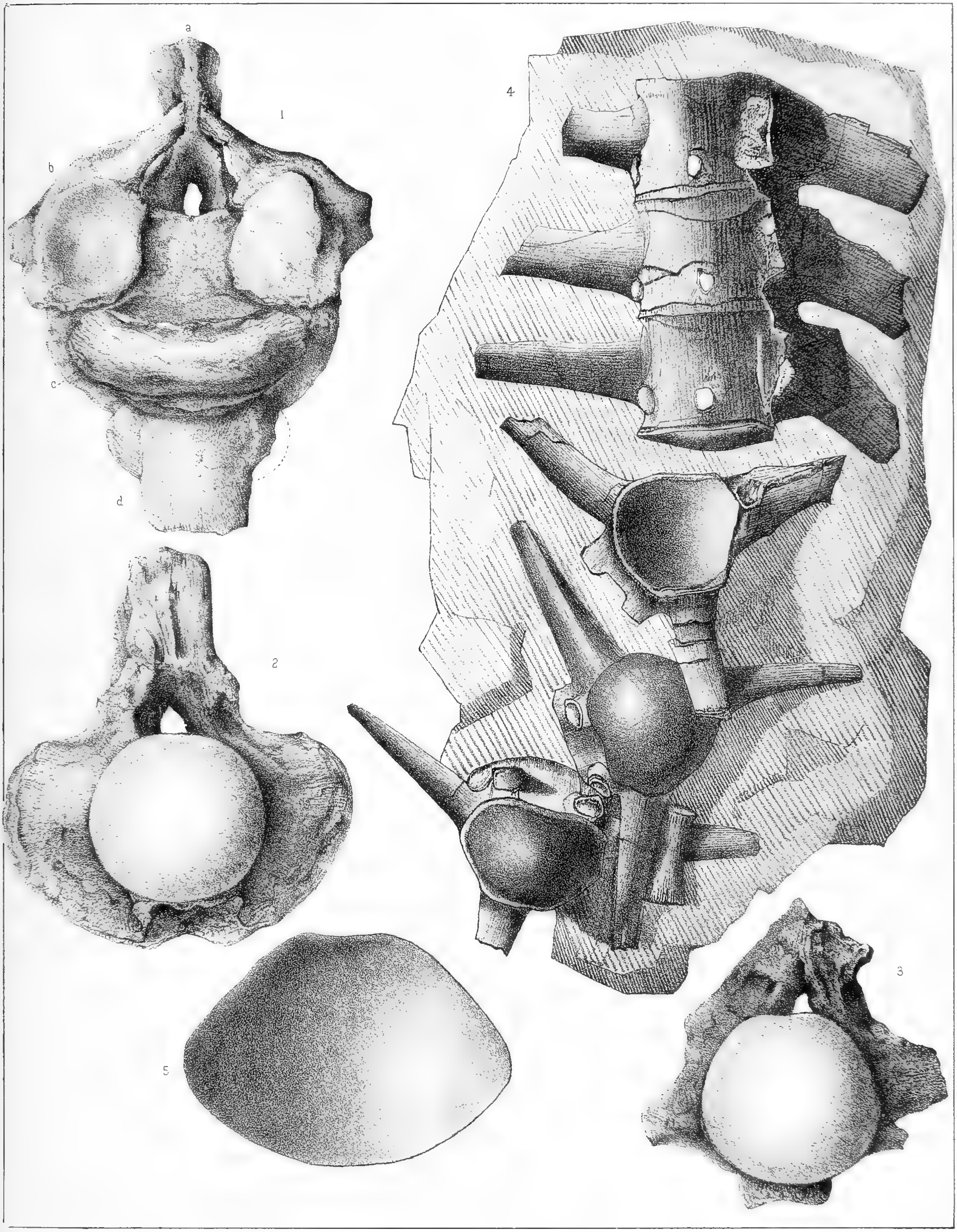
FIG. 1. Atlas and axis from the front, the odontoid bone wanting: *a*, axis; *b*, neurapophysis of atlas; *c*, basal element of atlas; *d*, hypapophysis of the odontoid.

2. Axis, posterior view.

3. Third cervical vertebra, from behind.

4. Six caudal vertebræ of *Liodon dyspelor*, consecutive, except an interval between the third and fourth; one-third natural size. Of the anterior three, the diapophyses of the left side are broken off, and the neural spines, being turned to that side by pressure, are displayed. From the specimen figured in Plates xxvii–xxx.

5. Centrum of a lumbar vertebra of *Liodon dyspelor*, from behind. From the type-specimen in the Museum of the Smithsonian Institution, from Fort McRae, New Mexico.

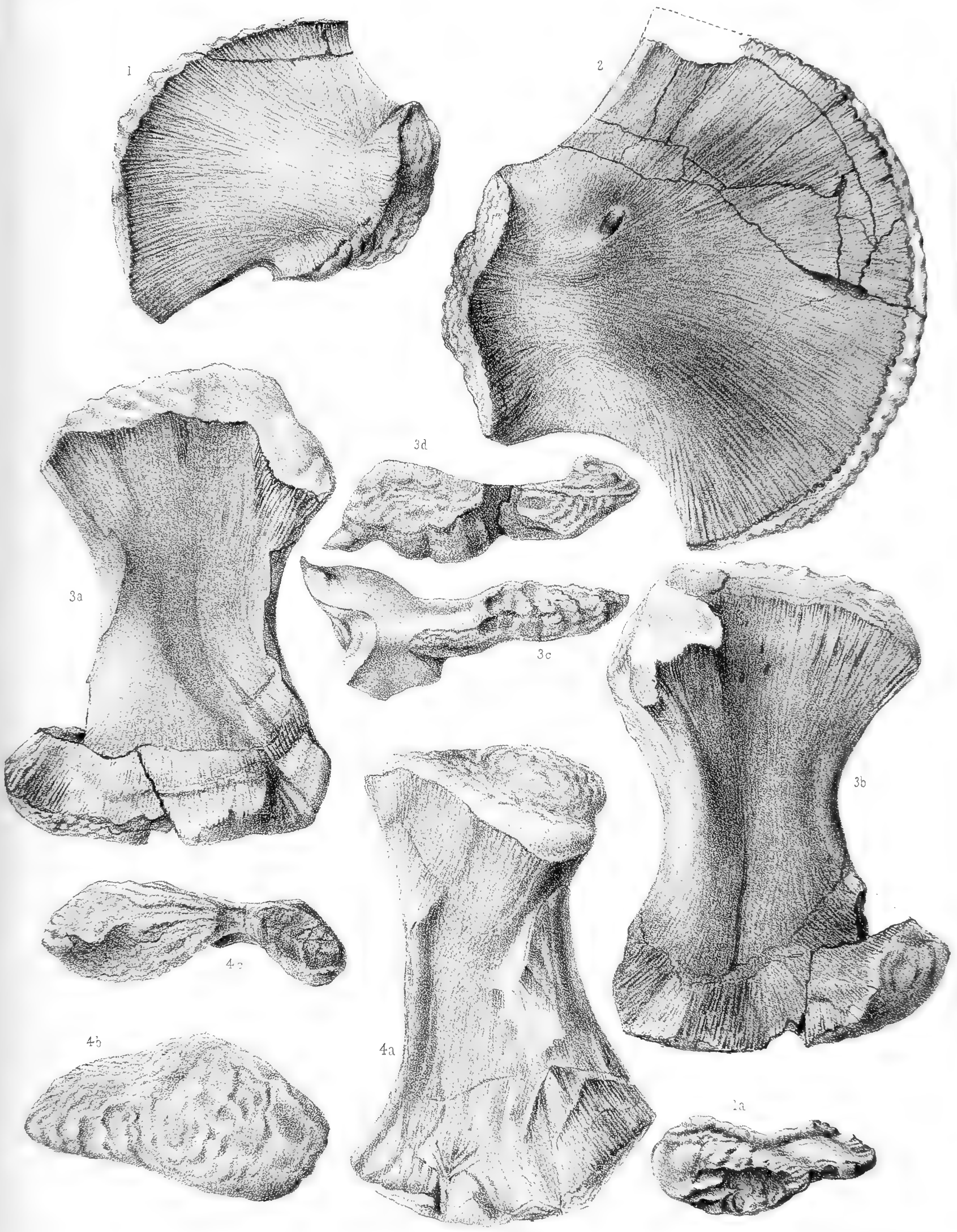


LIODON DYSPELOR

EXPLANATION OF PLATE XXXII.

Shoulder-girdle and anterior limb of *Liodon dyspelor*, from preceding specimen, one-half natural size.

FIG. 1. Scapula; *a*, articular extremity.
2. Coracoid.
3. Humerus: *a*, from inside; *b*, from outside; *c*, proximal; *d*, distal articular extremity.
4. ? Ulna: *a*, from side; *b*, proximal; *d*, distal extremities.



LIODON DYSPELOR.

EXPLANATION OF PLATE XXXIII.

Pelvic arch with posterior limb and some cranial fragments of the same specimen of *Liodon dyspelor*, one-half natural size.

FIGS. 1–5. Pelvic arch from above: 1, right ilium from above; 2, left ilium from side; 3 and 4, right and left ischia in normal relation: 5, pubis, distal end.

7–9. Right side of pelvic arch, bones separated: 7, ilium; 8, pubis; and, 9, ischium.

FIG. 10. Femur of the right side, found in place: *a*, outer; *b*, inner sides; *c*, proximal; *d*, distal extremities.

11. Fibula, found with caudal vertebræ: *a*, from side; *b*, proximal; and, *c*, distal extremities.

12. Tibia, found in matrix close to the fibula: *a* and *b*, extremital faces.

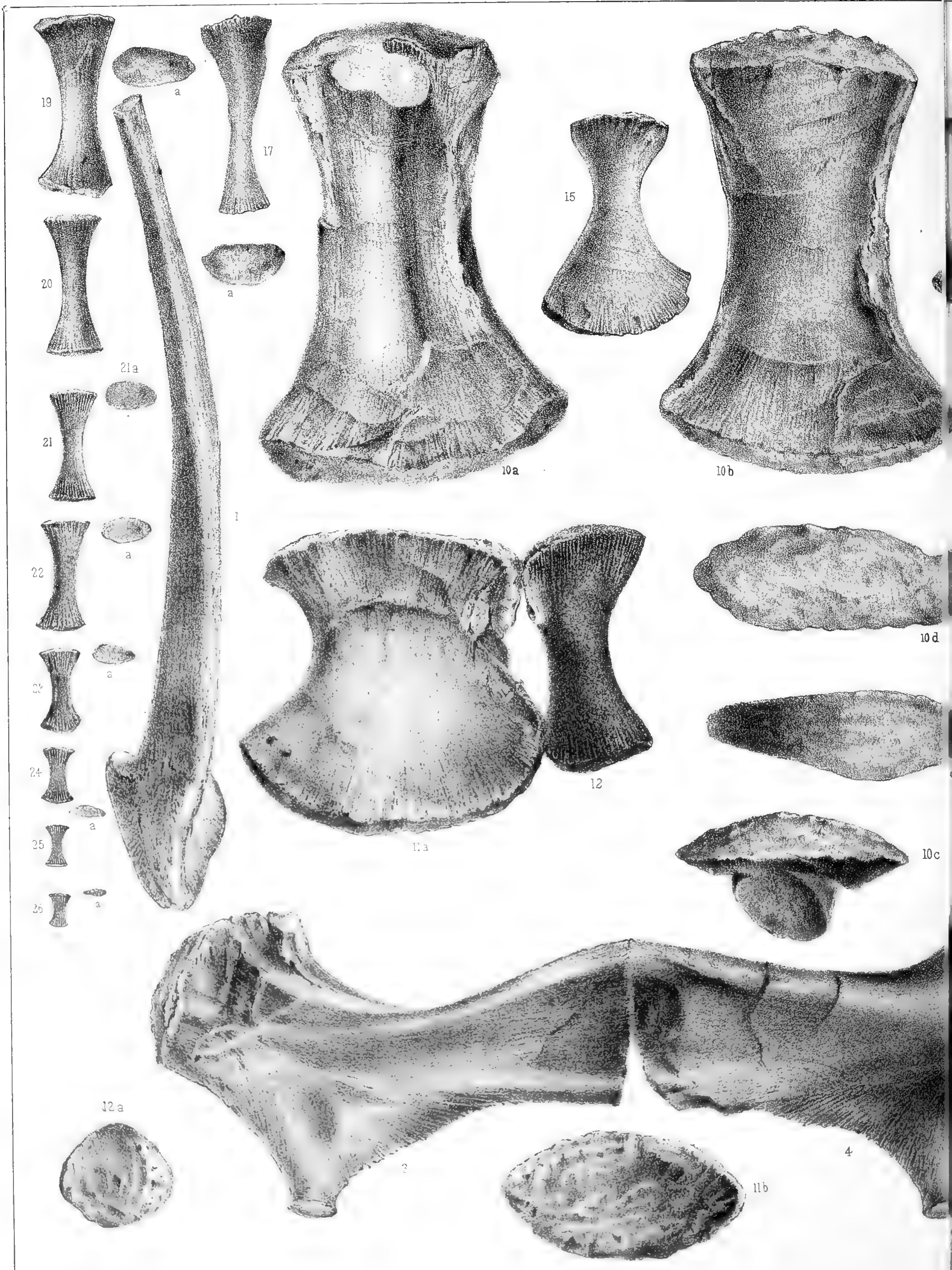
FIGS. 13–14. Metapodial bones; *a* and *b*, extremital views.

15–26. Phalanges, with accompanying extremital views.

FIG. 27. Probably exoccipital bone with part of condyle and suspensorium.

28. Probably part of parietal bone, showing foramen and base of arch.

FIGS. 29–30. Teeth; *a*, sections of crowns.


19
a
17
15
10a
10b
20
a
21a
21
1
22
a
10d
a
24
a
25
26
a
12
10c
12 a
3
4
11b

LIODON DY

ELOP. COPE.

Thos. Sinclair & Son lith. Phila.

LIODON DYSPELOR COPE.

EXPLANATION OF PLATE XXXIV.

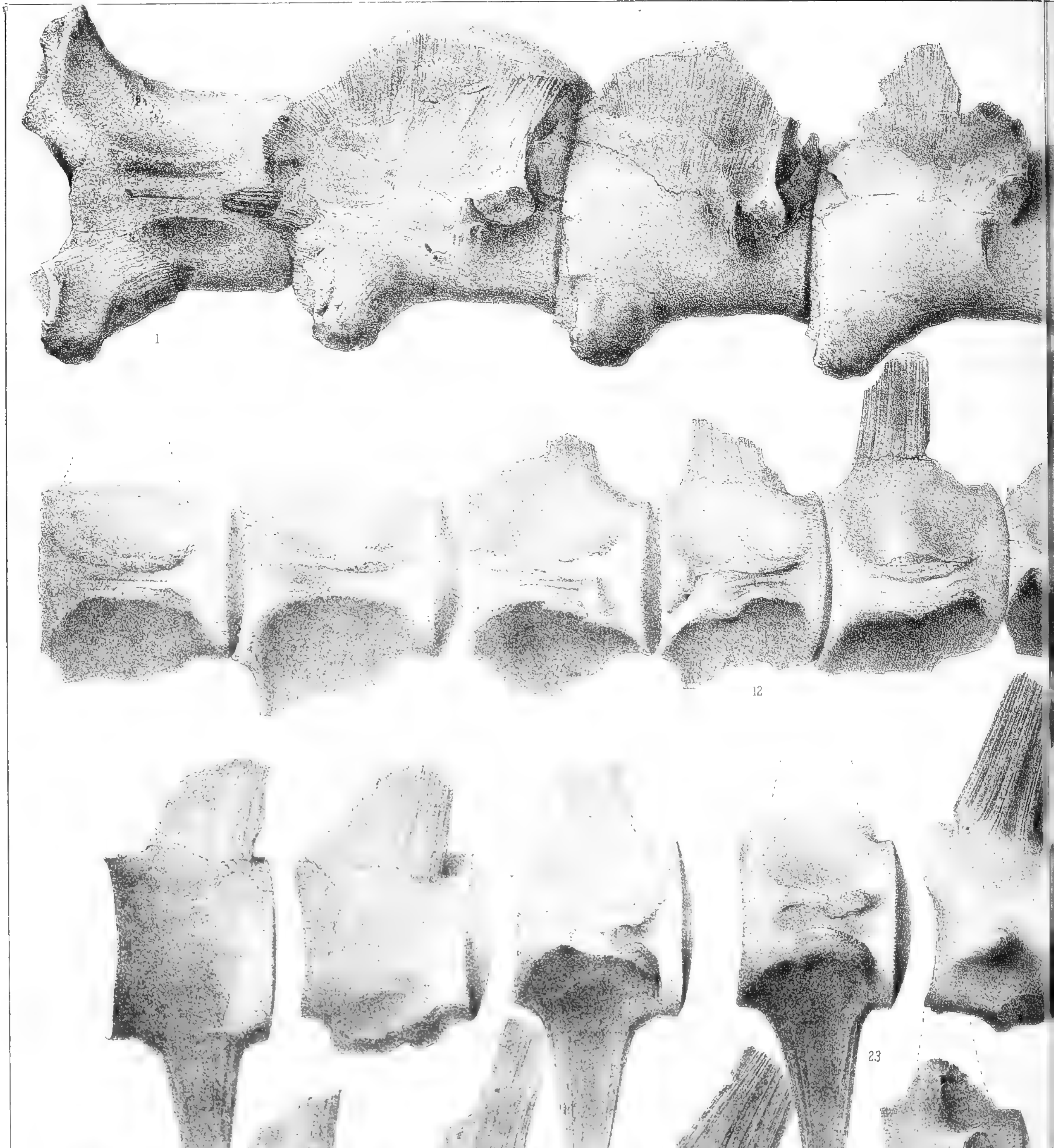
FIGS. 1–42. Series of dorsal, lumbar, and caudal vertebræ of a species of *Liodon*, obtained by Professor Mudge, one-half the natural size. The only hiatus is in the caudal series, where probably three vertebræ are wanting between Nos. 16 and 17.

1– 5. Dorsals, from above.

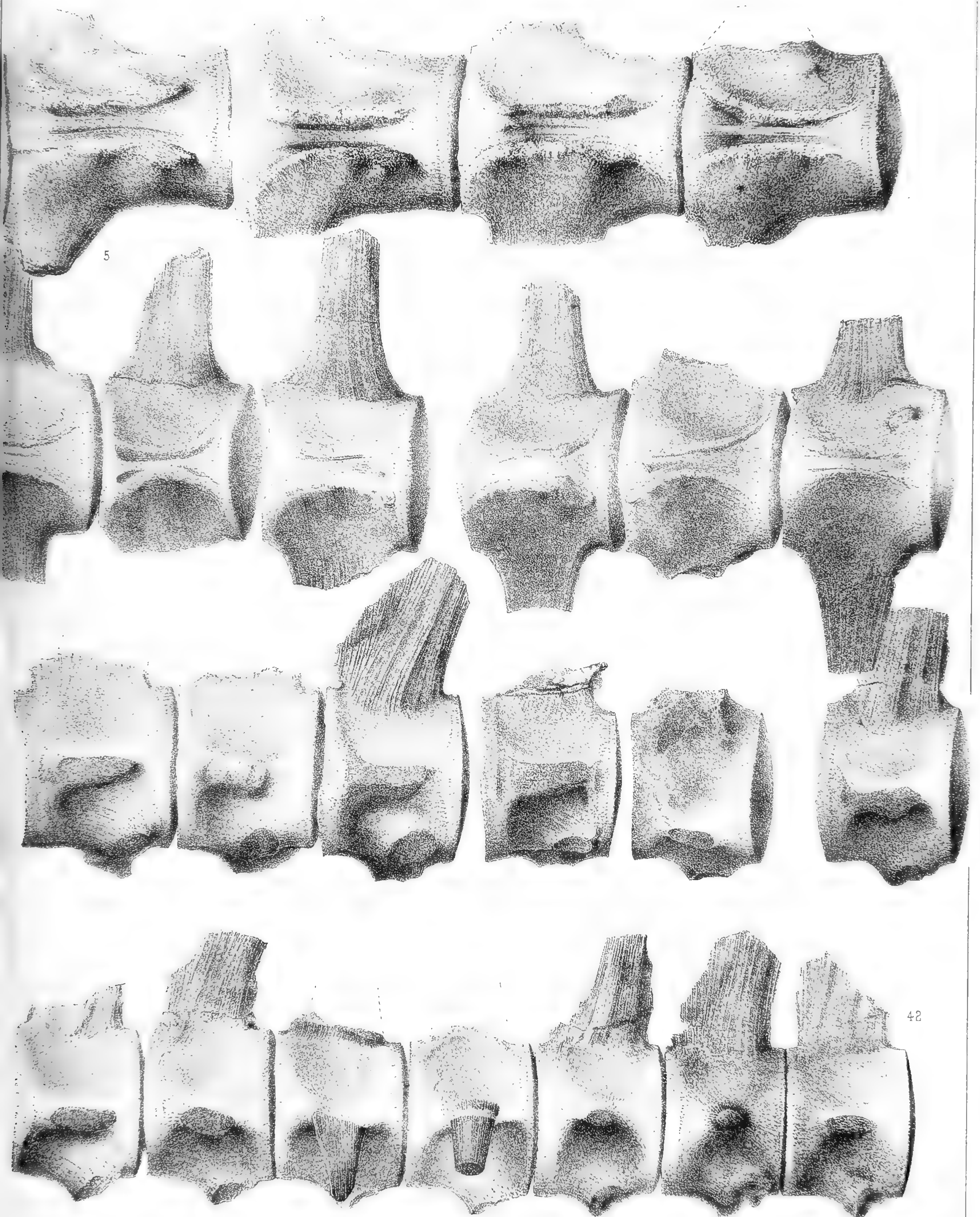
6–12. Lumbars, from above.

13–23. Caudals, from above.

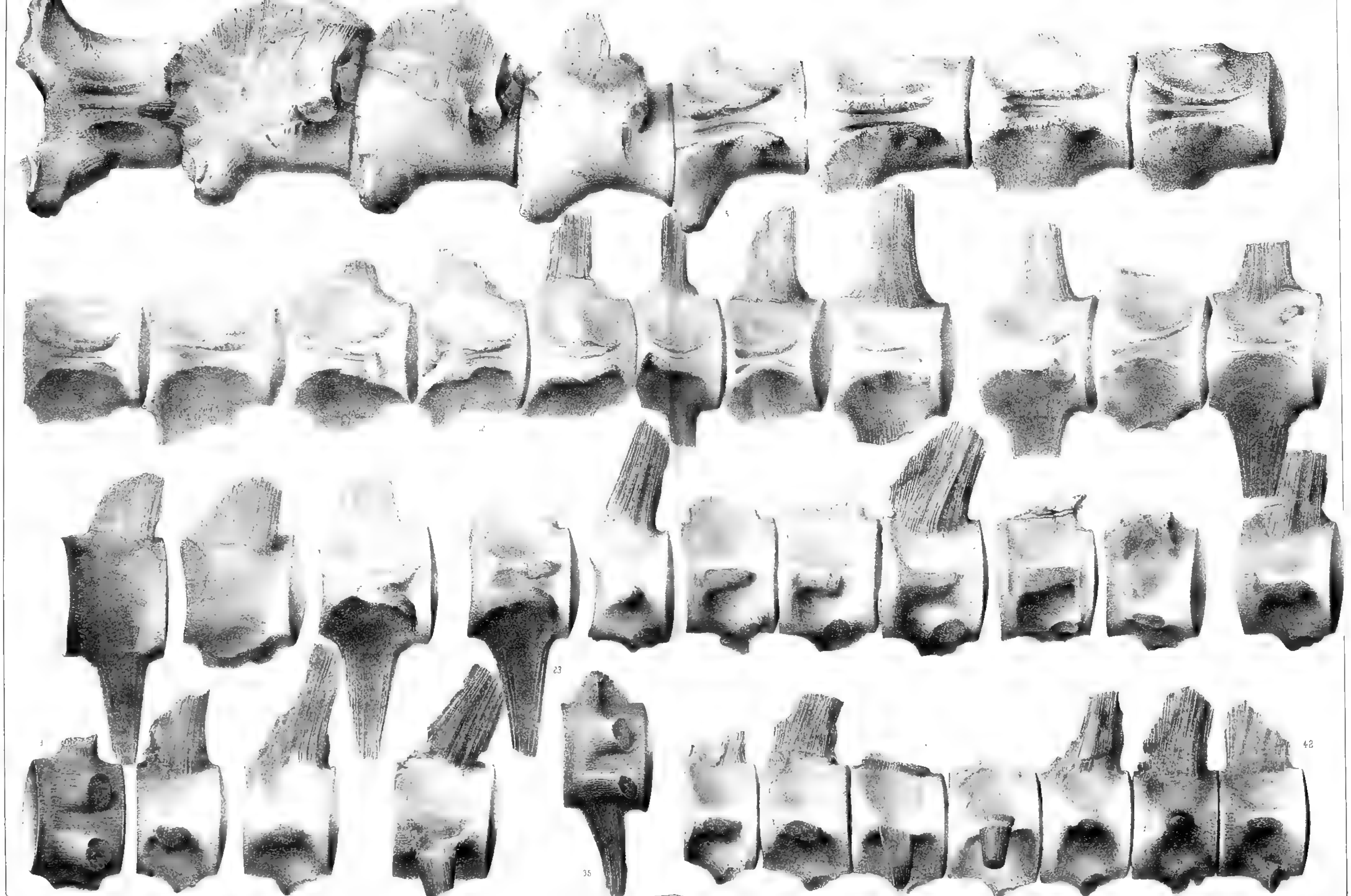
24–42. Caudals, from the side, except Nos. 31–35, which are viewed from below.



LIODON



PECIES.



LIODON SPECIES

EXPLANATION OF PLATE XXXV.

FIGS. 1–8. Vertebræ of *Liodon* (figured on preceding plate), one-half natural size.

1–6. Inferior views of lumbar and caudal vertebræ at transition-region, from No. 10 to No. 15.

FIG. 7. Cup of dorsal No. 1 (Plate xxxiv); 7 *a*, ball of dorsal No. 1.

8. Ball of another dorsal.

9. Caudal vertebra No. 33, posterior view.

10. Caudal vertebra No. 42, anterior; *a*, posterior views.

FIGS. 11–14. *Liodon nepæolicus*, Cope, one-half natural size.

FIG. 11. Quadrate bone from outside; *a*, from inside; *b*, proximally; *d*, distally.

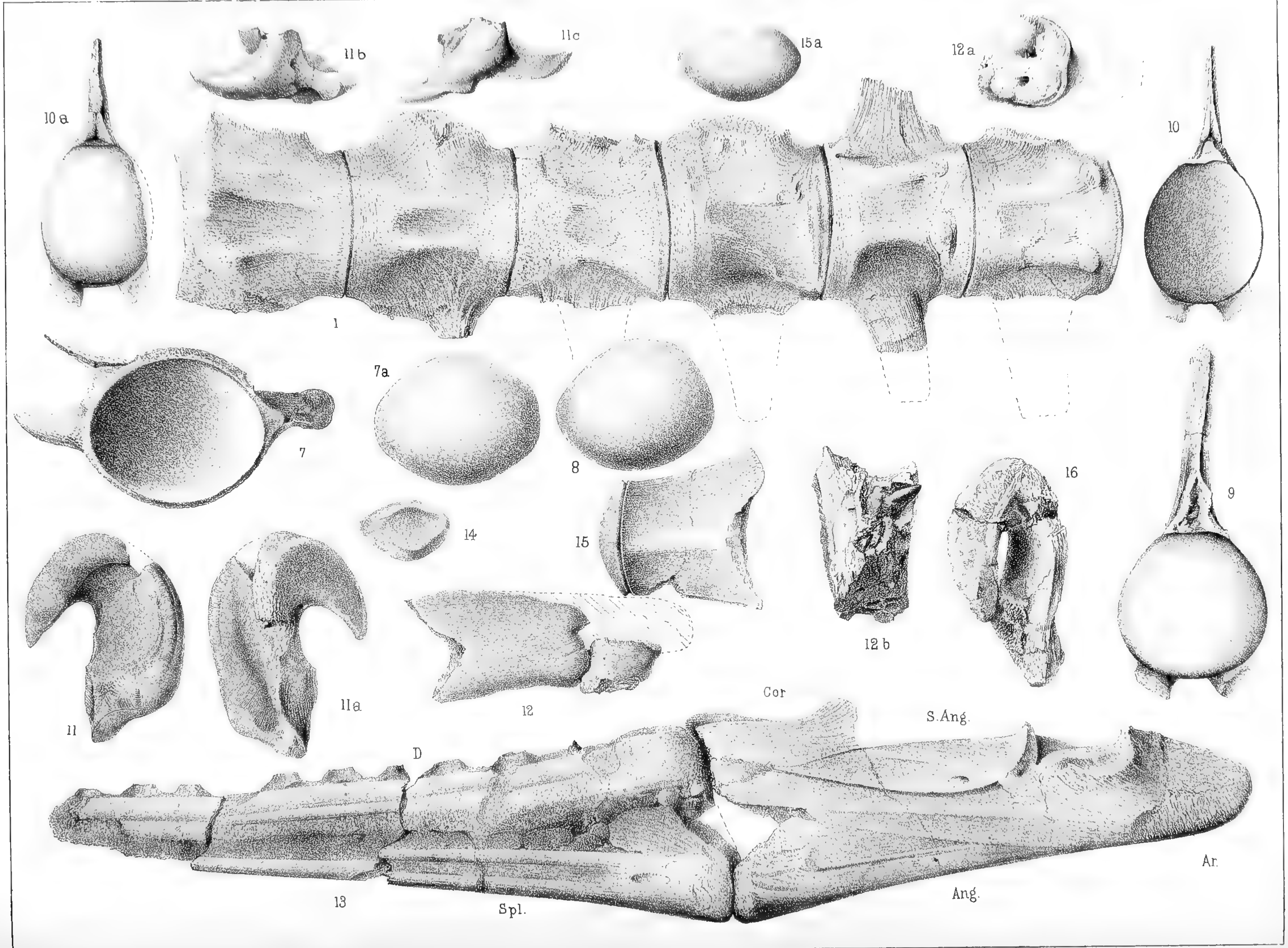
12. Profile of premaxillary bone (broken), and adjacent portion of maxillary; *a*, premaxillary from below; *b*, maxillary from below.

13. Mandibular ramus of left side from within, with apex broken off: *Ar.*, articular bone; *Ang.*, angular; *S. Ang.*, surangular; *Cor.*, coronoid; *Spl.*, splenial; *D.*, dentary.

14. Odontoid process, superior view.

15. A ? posterior dorsal vertebra, somewhat modified by pressure, from below; *a*, posterior articular face.

16. Quadrate bone of *Clidastes planifrons*, postero-interior view, one-half natural size.



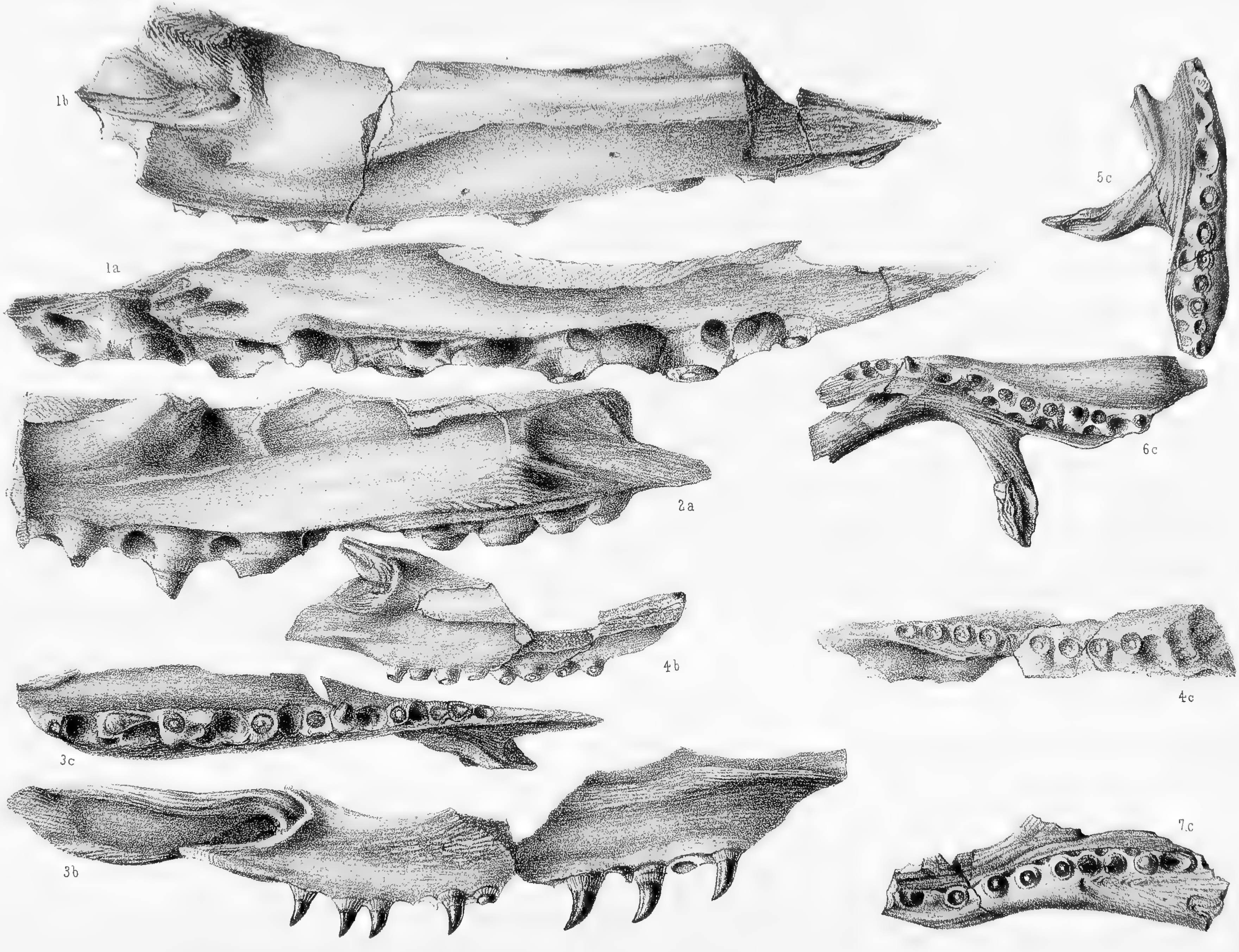
Thos. Sinclair & Son lith. Phila.

1-10. LIODON SP. 11-15. LIODON NEPAEOLICUS. 16. CLIDASTES PLANIFRONS.

EXPLANATION OF PLATE XXXVI.

Palatine bones of *Pythonomorpha*, one-half natural size: *a*, from the outside; *b*, from the inner side; and, *c*, from below.

FIG. 1. *Liodon dyspelor.*
2. *Liodon proriger.*
3. *Clidastes tortor.*
4. *Clidastes stenops.*
5. *Platecarpus curtirostris.*
6. *Platecarpus coryphæus.*
7. *Platecarpus ictericus.*



1. LIODON DYSPELOR. 2. LIODON PRORIGER. 3. CLIDASTES TORTOR. 4. C. STENOPS.
5. PLATECARPUS CURTIROSTRIS. 6. P. CORYPHAEUS. 7. P. ICTERICUS.

EXPLANATION OF PLATE XXXVII.

Quadrate bones of seventeen species of *Pythonomorpha*. From figs. 1 to 11, one-half natural size; figs. 12 to 17, one-third natural size. In all, fig. *a* represents the external side; fig. *b*, the postero-internal, or internal view; fig. *c*, the proximal; and, fig. *d*, the distal articular faces. In figs. 5, 10, and 13, the angles and ridges are indicated as follows: α is the "knob," or the ridge homologous with it; β, median posterior ridge; γ, the distal internal longitudinal; δ, the internal longitudinal, or simply the internal ridge; ε, the proximal internal angle; ζ, the alar process.

FIG. 1. *Clidastes propython*.

2. *Clidastes tortor*.

3. *Clidastes stenops*.

4. *Liodon validus*. In fig. *c*, the internal angle of the proximal articular face is turned to the left It should be turned to the right, in order to correspond with figs. *a* and *b*, and those of the other species. Moreover, the posterior hook and alar process are broken away.

5. *Liodon dyspelor*.

6. *Liodon proriger*, flattened by pressure.

7. *Platecarpus mudgei*.

8. *Platecarpus ictericus*.

9. *Platecarpus coryphæus*.

10. *Platecarpus curtirostris*.

11. *Platecarpus tympaniticus*.

12. *Mosasaurus depressus*.

13. *Mosasaurus fulciatus*.

14. *Mosasaurus giganteus*.

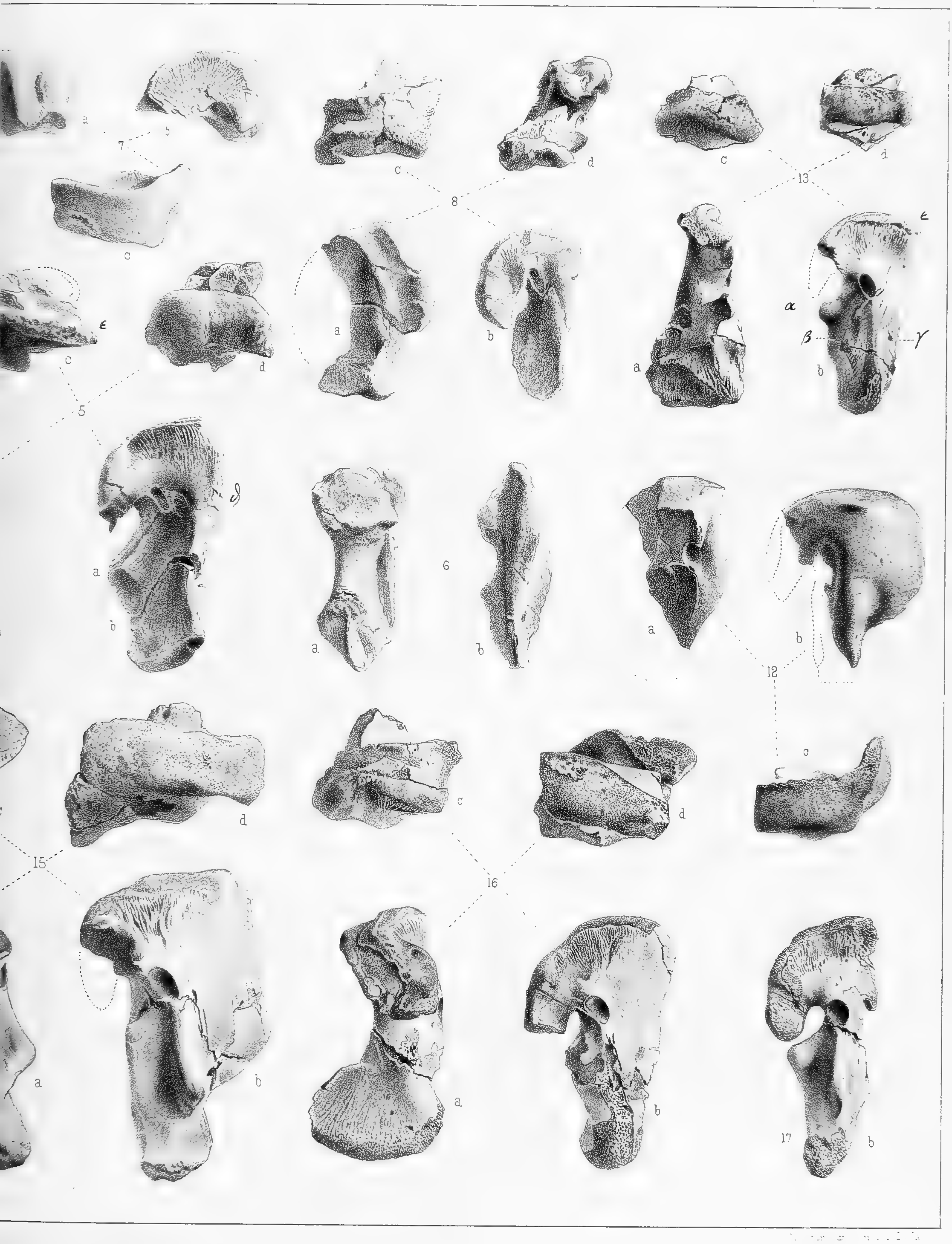
15. *Mosasaurus maximus*.

16. *Mosasaurus dekayi*.

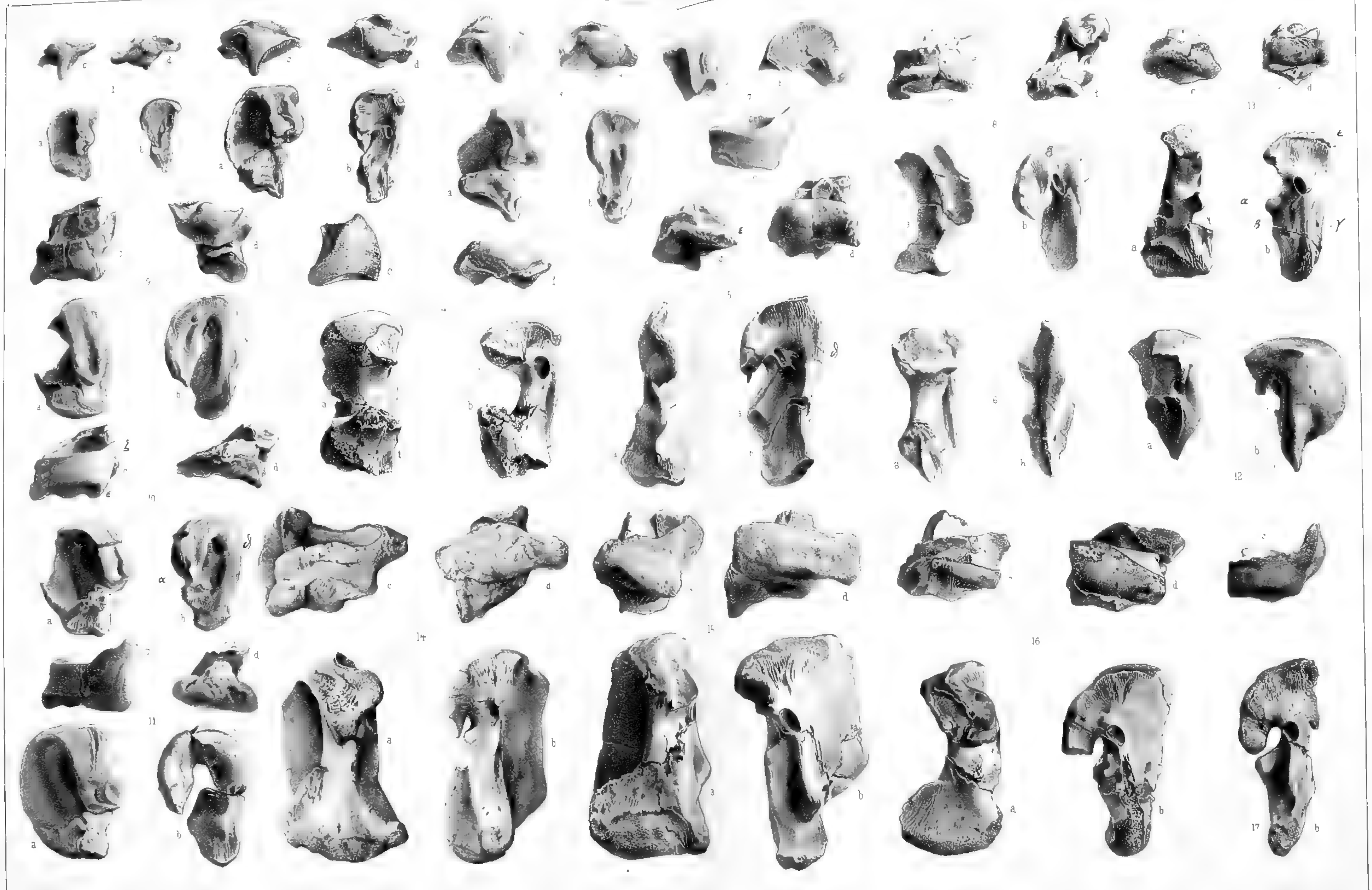
17. *Mosasaurus oarthrus*.

QUADRATE BONES. OF PYTHONOMORPHA.

12-17. M(



...LASTE... LIODON. 7-11. PLATECARPUS
...CARPUS.



QUADRATE BONES. OF PYTHONOMORPHA 1-3 LIDASTES. 4-6 LIODON. 7-11. PLATECARPUS 12-17 MOSASAURUS

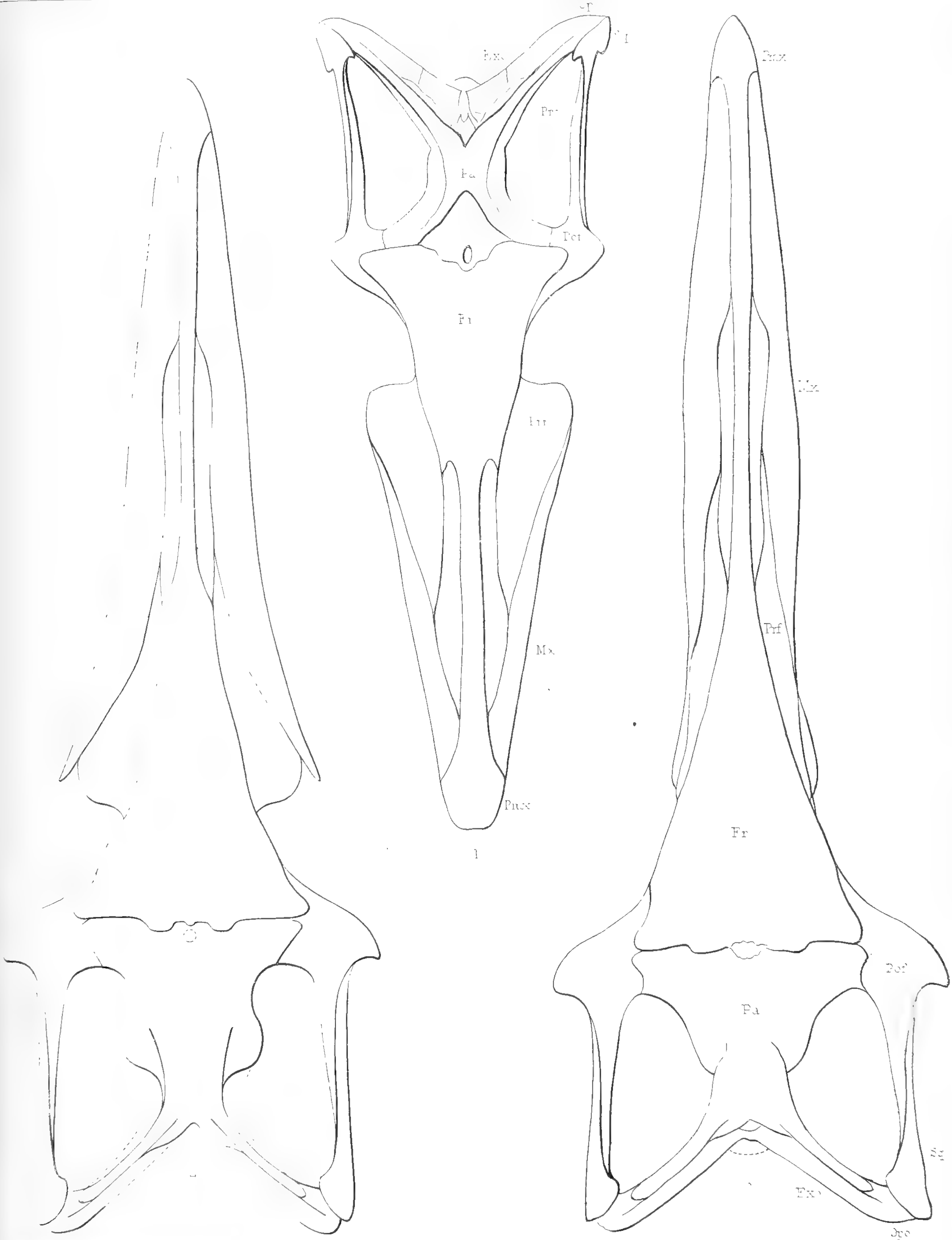
EXPLANATION OF PLATE XXXVIII.

Restorations of crania of three species of *Pythonomorpha*, viewed from above, one-third natural size: *Pmx.*, premaxillary bone; *Mx.*, maxillary; *Prf.*, prefrontal; *Fr.*, frontal; *Pof.*, postfrontal; *Pa.*, parietal; *Pro.*, proötic; *Exo.*, exoccipital; *Opo.*, opisthotic; *Sq.*, squamosal.

FIG. 1. *Platecarpus curtirostris.*

2. *Clidastes tortor.*

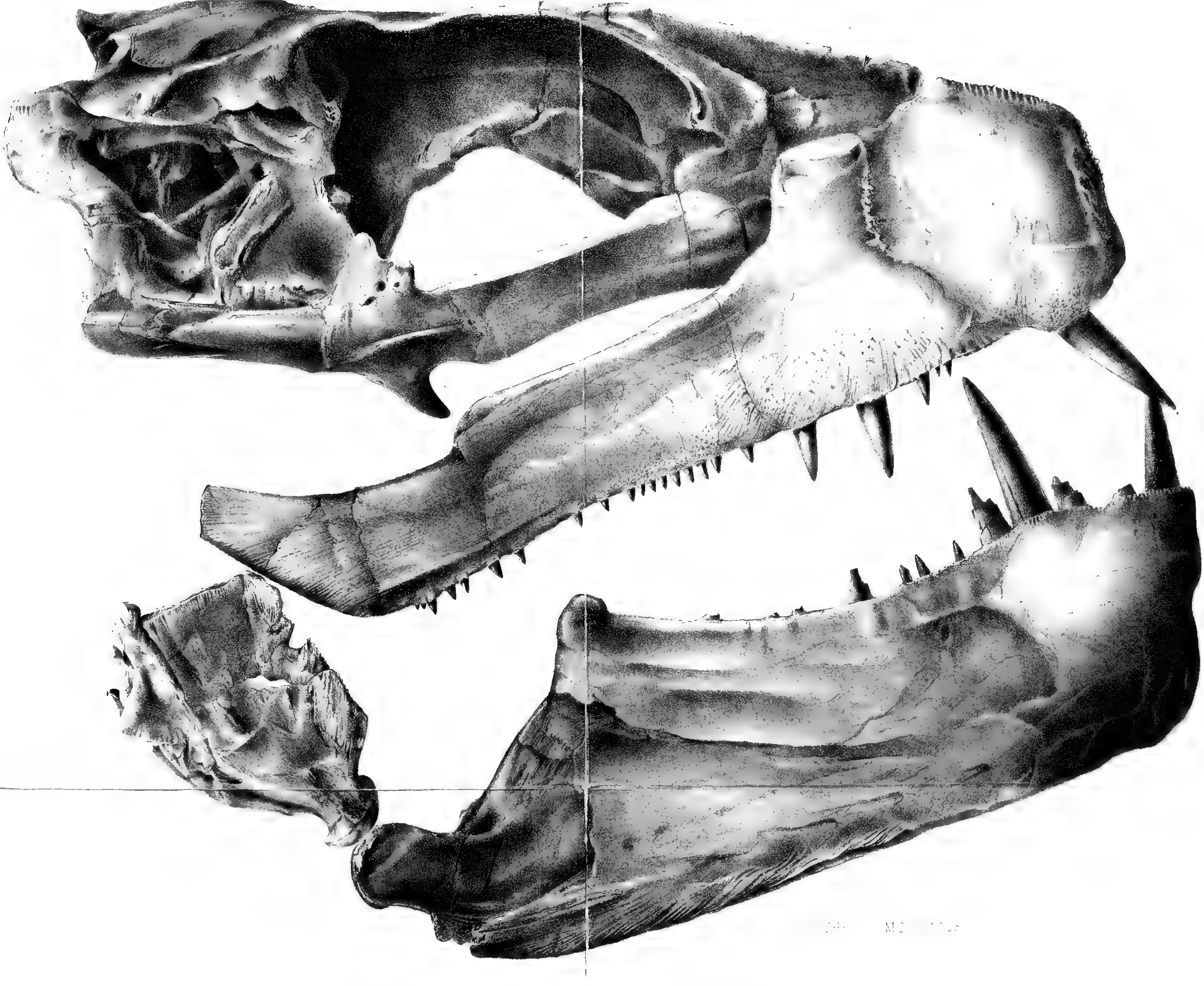
3. *Clidastes stenops*, parietal region inferential.



1. PLATECARPUS CURTIROSTRIS. 2. CLIDASTES TORTOR
3. CLIDASTES STENOPS.

EXPLANATION OF PLATE XXXIX.

Cranium of *Portheus molossus*, Cope, type-specimen, natural size; the maxillary and mandibular arches separated from their normal positions, so as to display the teeth and articulations.



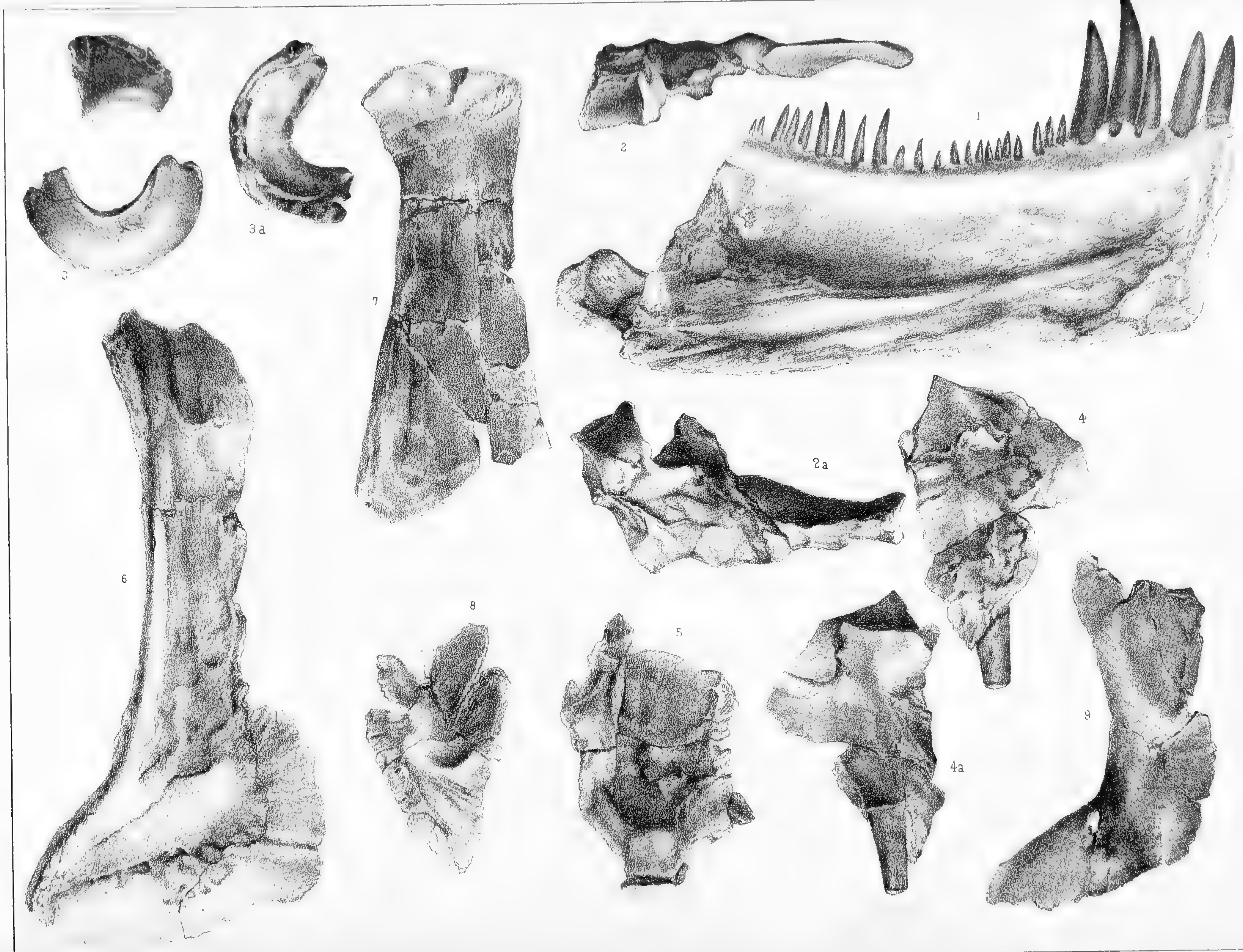
EXPLANATION OF PLATE XL.

Portheus molossus, one-half natural size, from the type-specimen (*See* Plate xxxix).

FIG. 1. Mandibular ramus, from the inner side.

2. Palatine bone, with malleolar body, from above; 2 *a*, from the outer side.
3. Sclerotic ossifications from the outer side; 3 *a*, from inner side.
4. ? Hyomandibular from the outer side; 4 *a*, from the inner side.
5. Quadrate bone, including the symplectic.
6. Preöperculum.
7. ? Interoperculum.

FIGS. 8–9. Uncertain bone



Thos. Sinclair & Son lith. Phila.

PORTHEUS MOLOSSUS.

EXPLANATION OF PLATE XLI.

Cranium of *Portheus molossus*, Cope, nine-sixteenths natural size: second specimen figured in cut 8, page 184.

PORTHEUS MOLOSSUS COPE. $\frac{9}{16}$

EXPLANATION OF PLATE XLII.

FIG. 1. Maxillary and palatine arches of *Portheus lestrio*, from Trego County, Kansas: displaying the premaxillary, maxillary, ethmoid, prefrontal, sclerotic, palatine, malleolus, ectopterygoid, pterygoid, and metapterygoid bones. One-half natural size.

2. Lower part of scapula, with adjacent parts of clavicle; the former with inferior articulation of pectoral spine; one-half natural size.

3. Upper part of the same scapula, showing two superior articular facets and two posterior fossæ for basilar bones.

4. External view of the pectoral spine and rays, and scapula of *Portheus*-like *Saurodont*, the articulation slightly dislocated to show the three facets; one-third natural size.

5. Internal view of the inferior part of the scapular arch of an allied species, exhibiting the scapula and coracoid and foramen inclosed by them, the three facets, and two cotyli; one-half natural size.

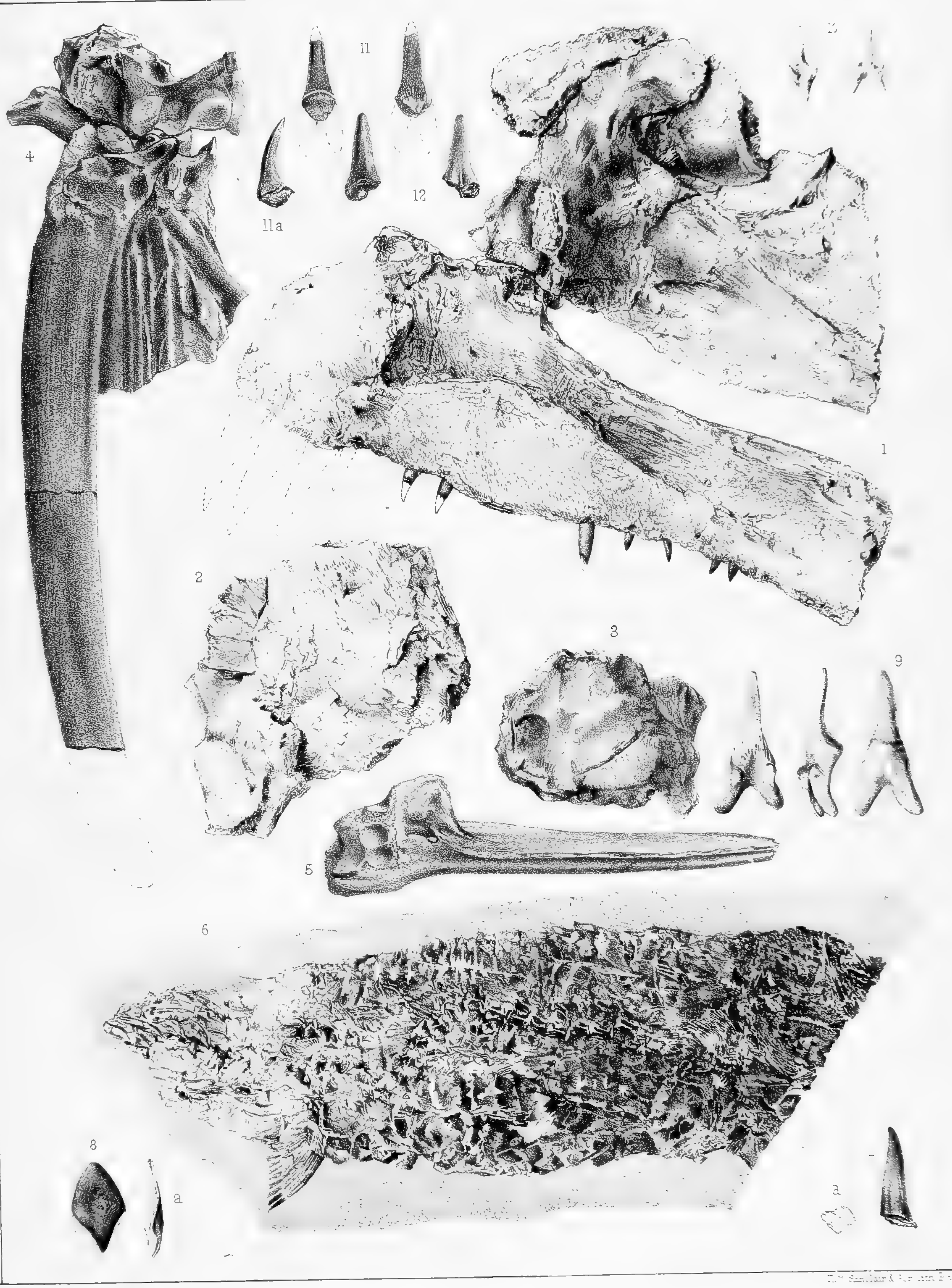
6. *Apsopelix sauriformis*, Cope, type-specimen from Brookeville, Kansas.

7. Tooth of *Enchodus gladiolus*, natural size; *a*, section of base, natural size.

8. Scales of a *Clastes*, from the Milk River, Saskatchewan, natural size; *a*, edge-view.

FIGS. 9–10. *Lamna macrorhiza*, Cope, from Rooks County, Kansas; natural size.

11–12. *Lamna mudgei*, Cope.



1-3. PORTHEUS LESTRIO. 4-5. SCAPULAE ETC. 6. APSOPELIX SAURIFORMIS.
7. ENCHODUS GLADIOLUS. 8. CLASTES. 9-10. LAMNA MACRORHIZA. 11-12. L. MUDGEI.

EXPLANATION OF PLATE XLIII.

Portheus thaumas, Cope, parts of one specimen from Butte Creek, Kansas.

FIG. 1. Basioccipital, parts of hyomandibular and preopercular, with the symplectic and quadrate bones in relation; natural size.

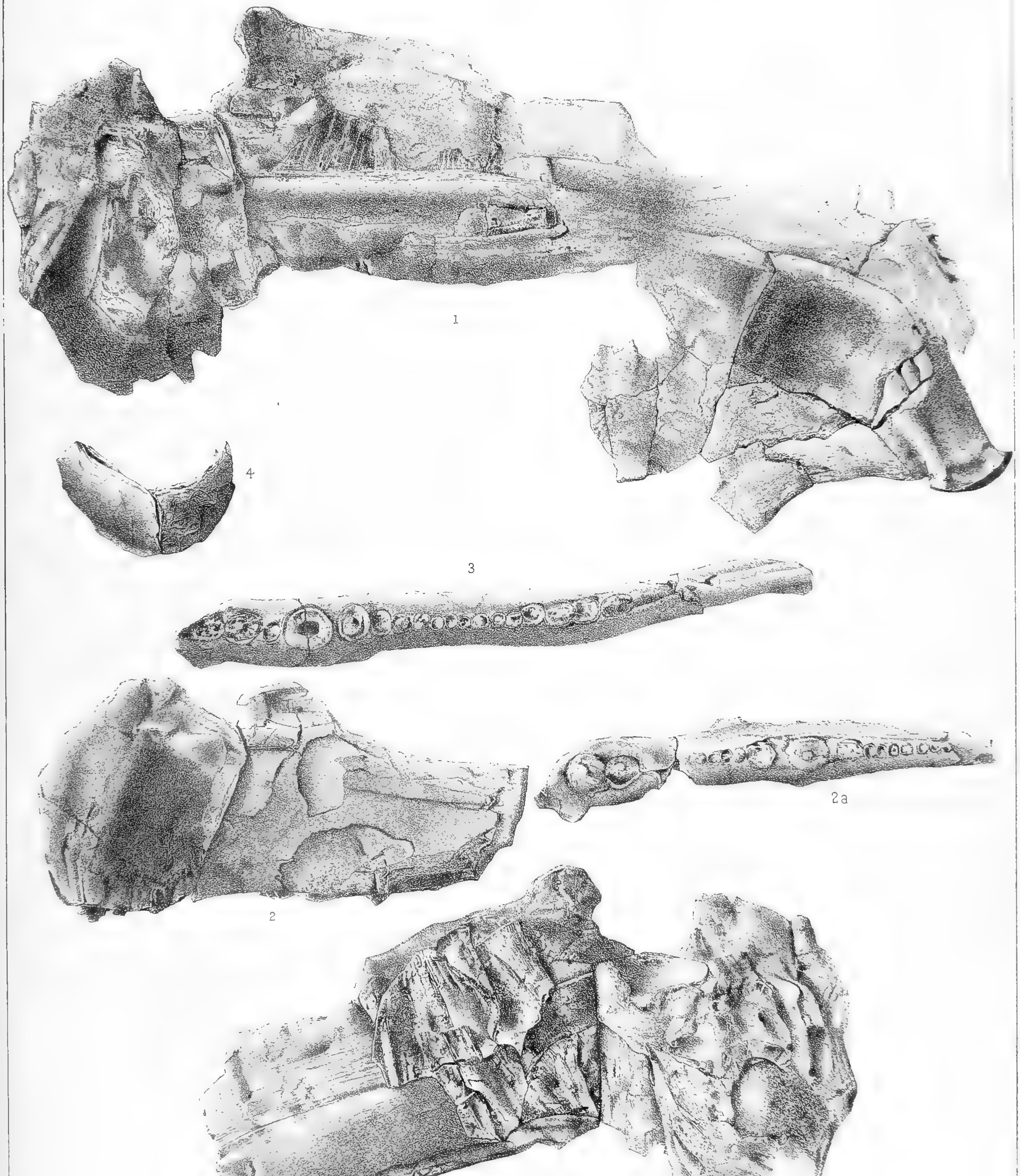
1 *a*. The same piece to the middle of the hyomandibular bone, viewed from the inner side; on the hyomandibular are seen fragments of the superior branchihyals.

2. Premaxillary and maxillary bones of the same; the latter broken off near the middle.

2 *a*. Inferior view of the same, displaying the bases of the teeth.

3. Superior aspect of the dentary bone.

4. Sclerotic bone of same.



PORTHEUS THAUMAS.

EXPLANATION OF PLATE XLIV.

FIGS. 1–4. *Portheus thaumas* type, natural size.

FIG. 1. Part of vertebral column.

2. Terminal vertebræ, with hæmal and neural spines supporting caudal fin; *a*, first fan-shaped hæmal spine.

3. First fan-shaped hæmal spine, viewed from above; 3 *a*, the same, proximal articular face.

4. Marginal rays of caudal fin.

5. Fragmentary pectoral spine of the type-specimen of *Portheus molossus*, Cope.

FIGS. 6–9. Ventral spines of a *Saurodont*, found together, species unknown: 6, the first; 7, the second; 8, third; *a*, opposite side of same; 9, basis of one more distal.

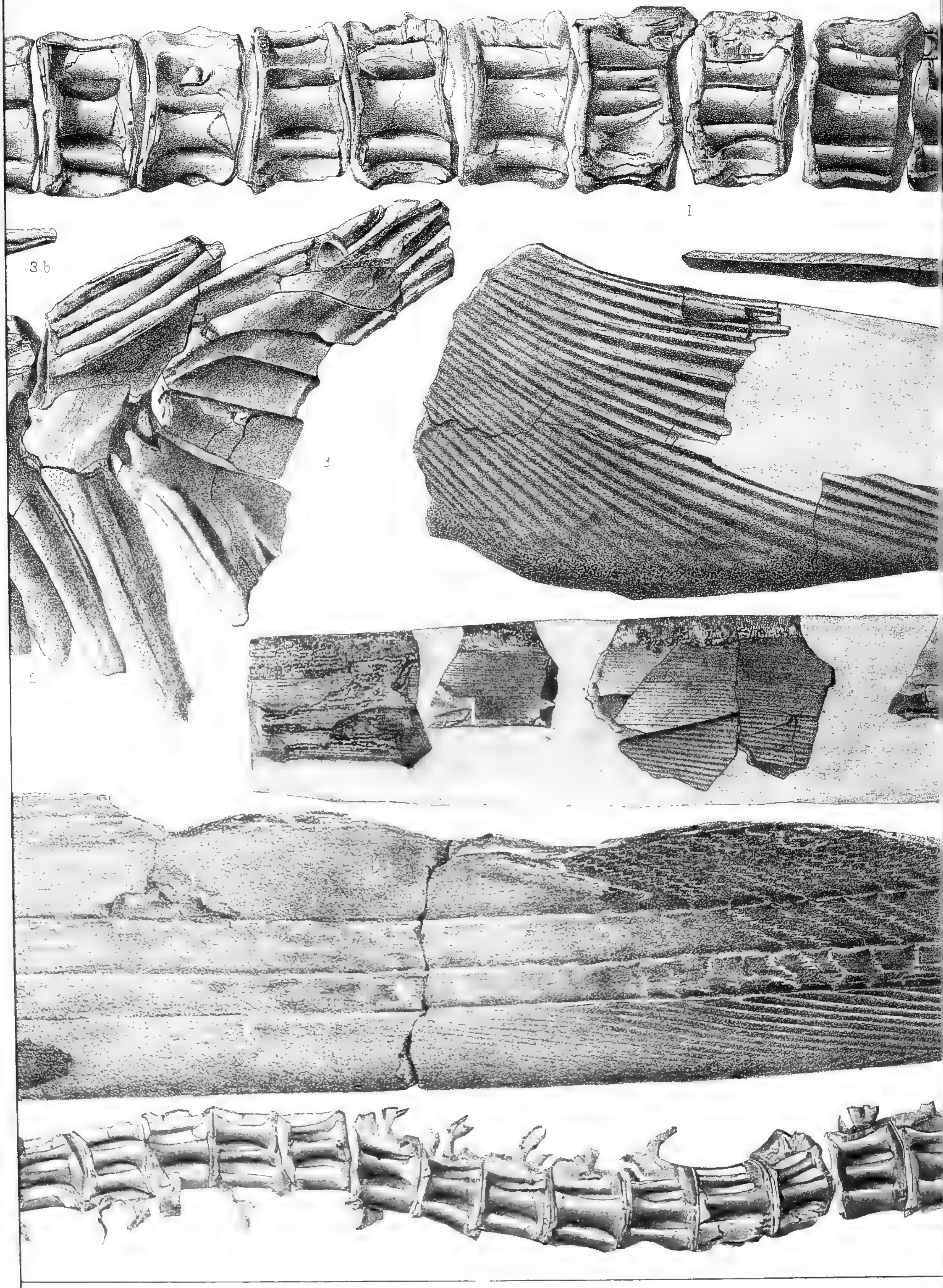
10–11. Scapula of *Portheus molossus*, type-specimen; inverted.

FIG. 12. Pectoral spine of *Pelecopterus gladius*; *a*, from anterior edge.

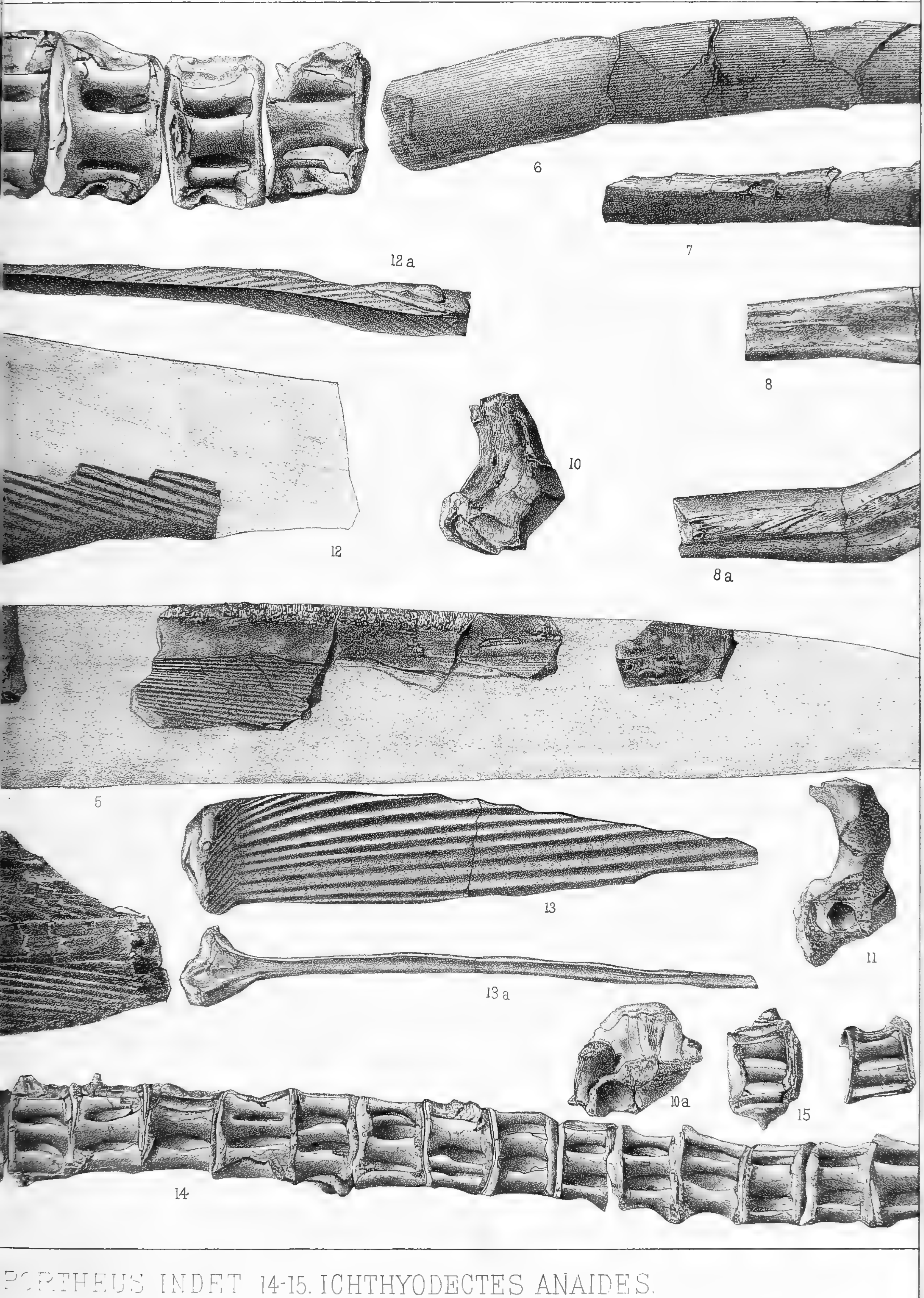
13. Pectoral spine of *Pelecopterus perniciosus*; *a*, from posterior edge.

14. Part of vertebral column of type of *Ichthyodectes anaides*, Cope, found in position, natural size.

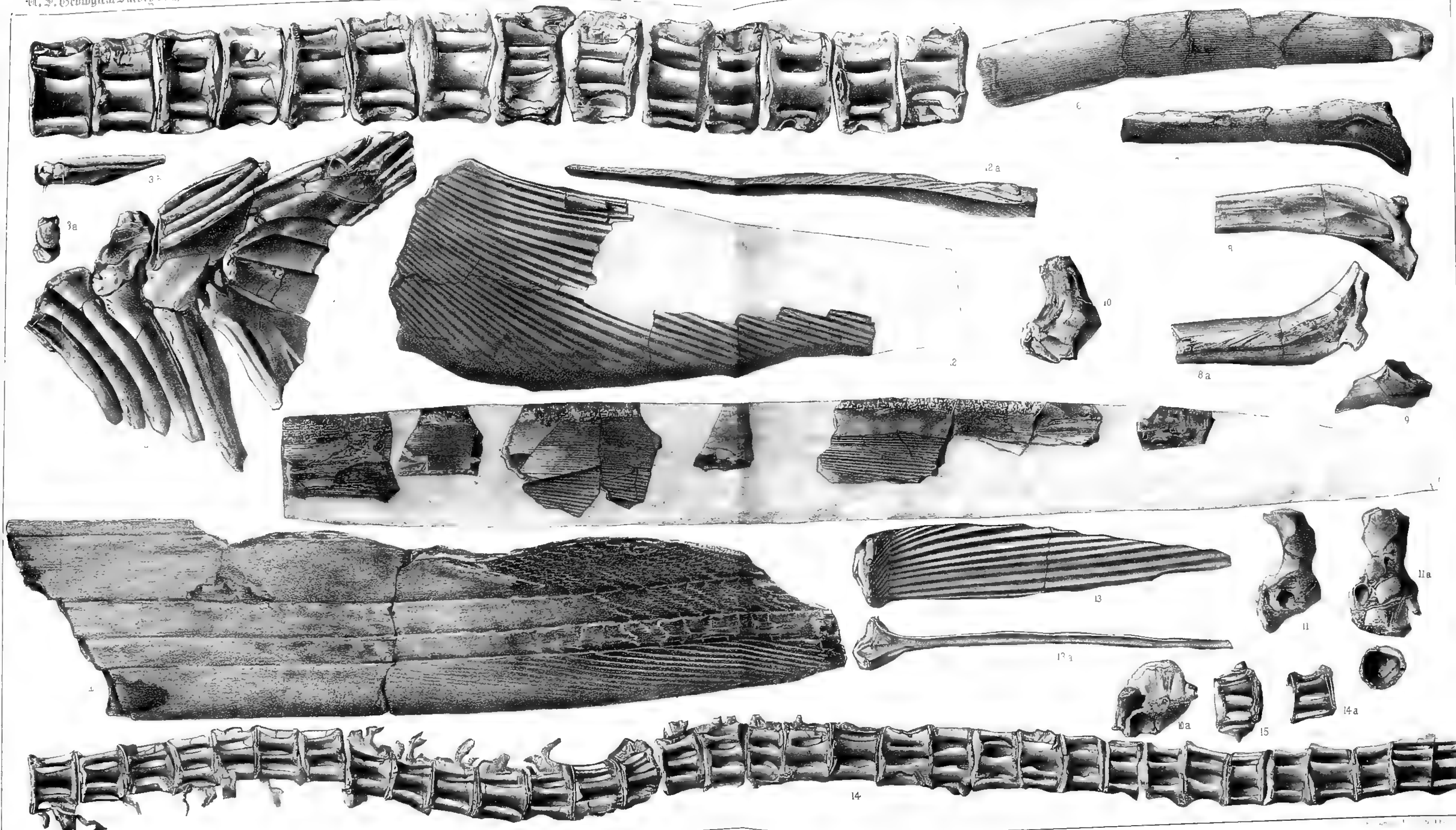
15. Vertebræ of the same specimen.



PORTHEUS THAUMAS. 5,10-11. P. MOLOSSUS. 6-



PORTHEUS INDET 14-15. ICHTHYODECTES ANAIDES.



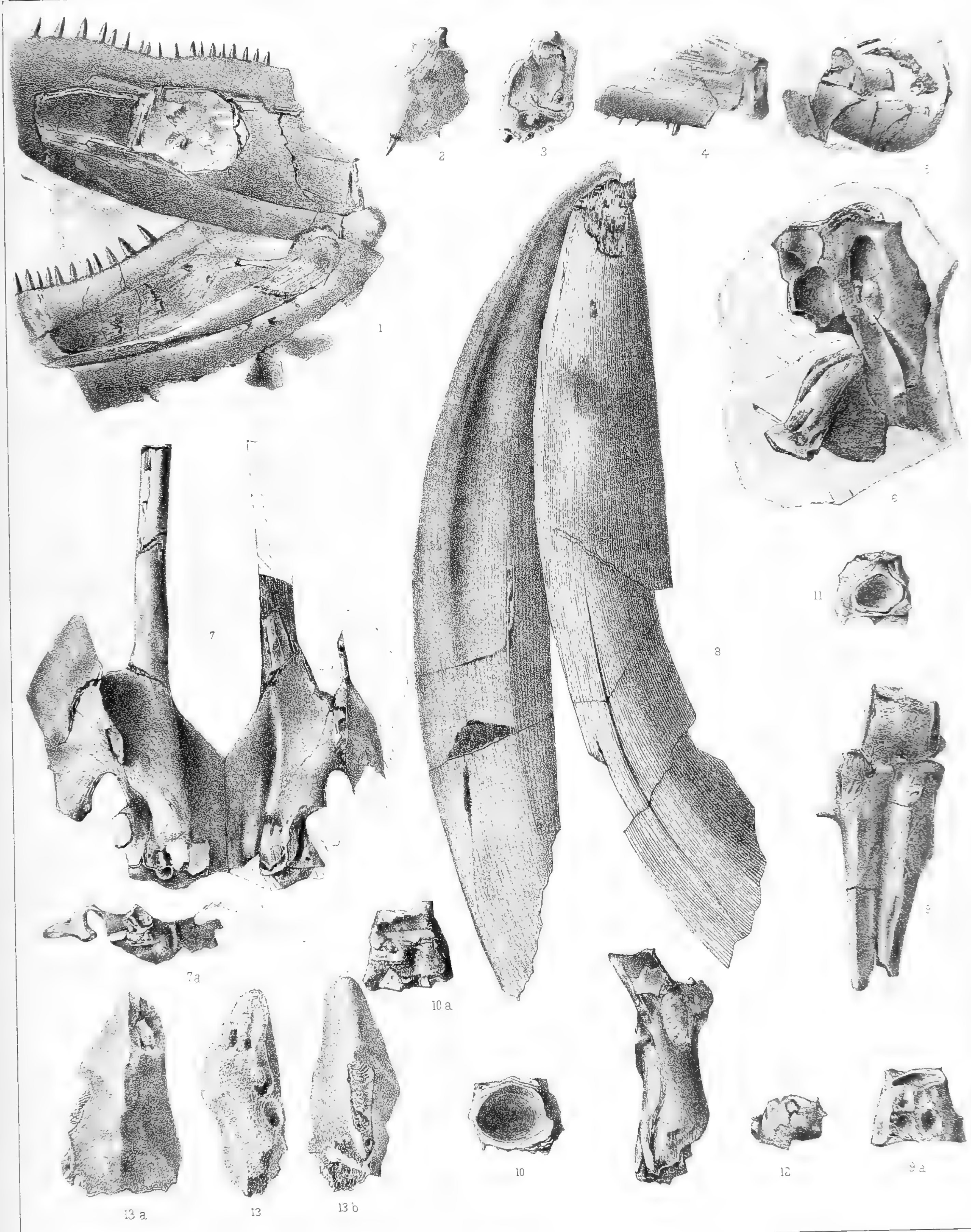
1-4. PORTHEUS THAUMAS 5.10-11 P MOLOSSUS 6-9. PORTHEUS INDET 14-15. ICHTHYODECTES ANAIDES.

EXPLANATION OF PLATE XLV.

FIGS. 1–8. *Ichthyodectes anaides*, Cope: figs. 1–4 and 6, one-half natural size; figs. 5, 7, and 8, natural size; from one, the type-specimen (see Plate XLIV, fig. 14).

FIG. 1. Mandibular rami, lying on a block of yellow chalk.
2. Premaxillary bone, outer side.
3. Premaxillary bone, inner side.
4. Right maxillary, outer side.
5. Sclerotic bones of the same.
6. Hyomandibular, symplectic, and quadrate bones.
7. Femoral bones, from below; 7 *a*, from behind.
8. Pectoral spine.

FIGS. 9–11. Terminal caudal vertebræ of *Portheus molossus*, from above; *a*, from front; *b*, from side.
12. Jaw of *Bryactinus amorphus*, Cope (p. 282), natural size: *a*, profile; *b*, masticating face; *c*, opposite border. From the greensand of New Jersey.

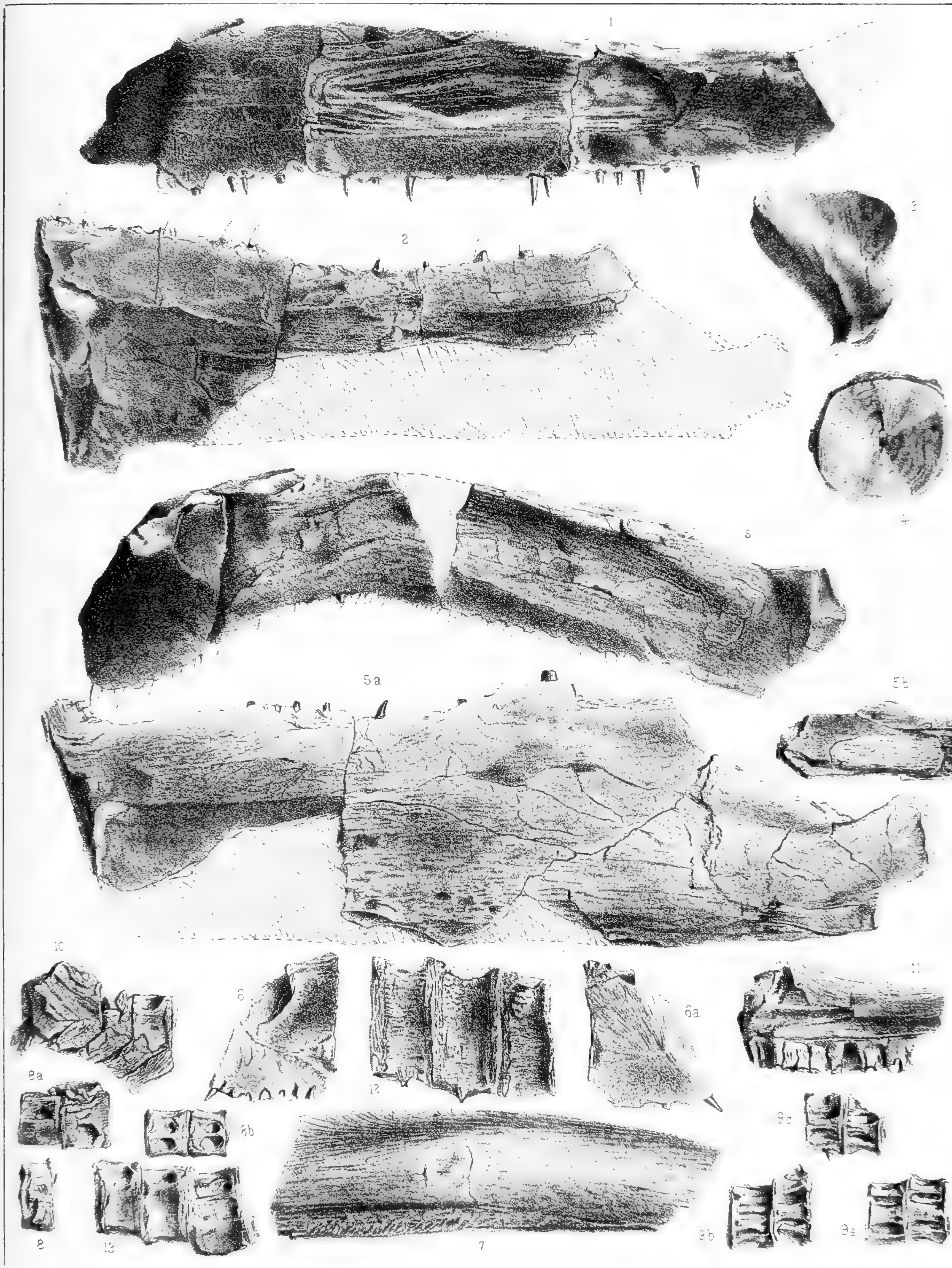


ICHTHYOLECTES ANAIDES. 9-12. PORTHEUS MOLOSSUS.
13. BRYACTINUS AMORPHUS.

EXPLANATION OF PLATE XLVI.

FIGS. 1–4. *Ichthyodectes ctenodon*, Cope, natural size.
FIG. 1. Maxillary bone, from the outside.
2. Dentary bone, from the inside.
3. Hyomandibular bone.
4. Cervical vertebra.
5. *Ichthyodectes hamatus*, Cope, natural size: 5, premaxillary and maxillary bones, from the outer side; 5 *a*, mandibular ramus, from the outer side.

FIGS. 6–10. *Ichthyodectes prognathus*, Cope: 6, the premaxillary, with anterior extremity of maxillary, from the inner side; 6 *a*, same, from the outer side; natural size.
7. Ventral spine accompanying the same, natural size.
8. Cervical vertebræ, one-half natural size.
9. Dorsal vertebræ, one-half natural size.
10. Terminal caudal vertebræ, with articulating spines; one-half natural size.
11. Maxillary bone of *Pachyrhizodus kingii*, from the inner side, natural size.
12. Three vertebræ of *Anogmius*, largest species, accompanying remains of *Ichthyodectes ctenodon*, one-half natural size.
13. Cervical vertebræ of a ? *Portheus*, one-half natural size.

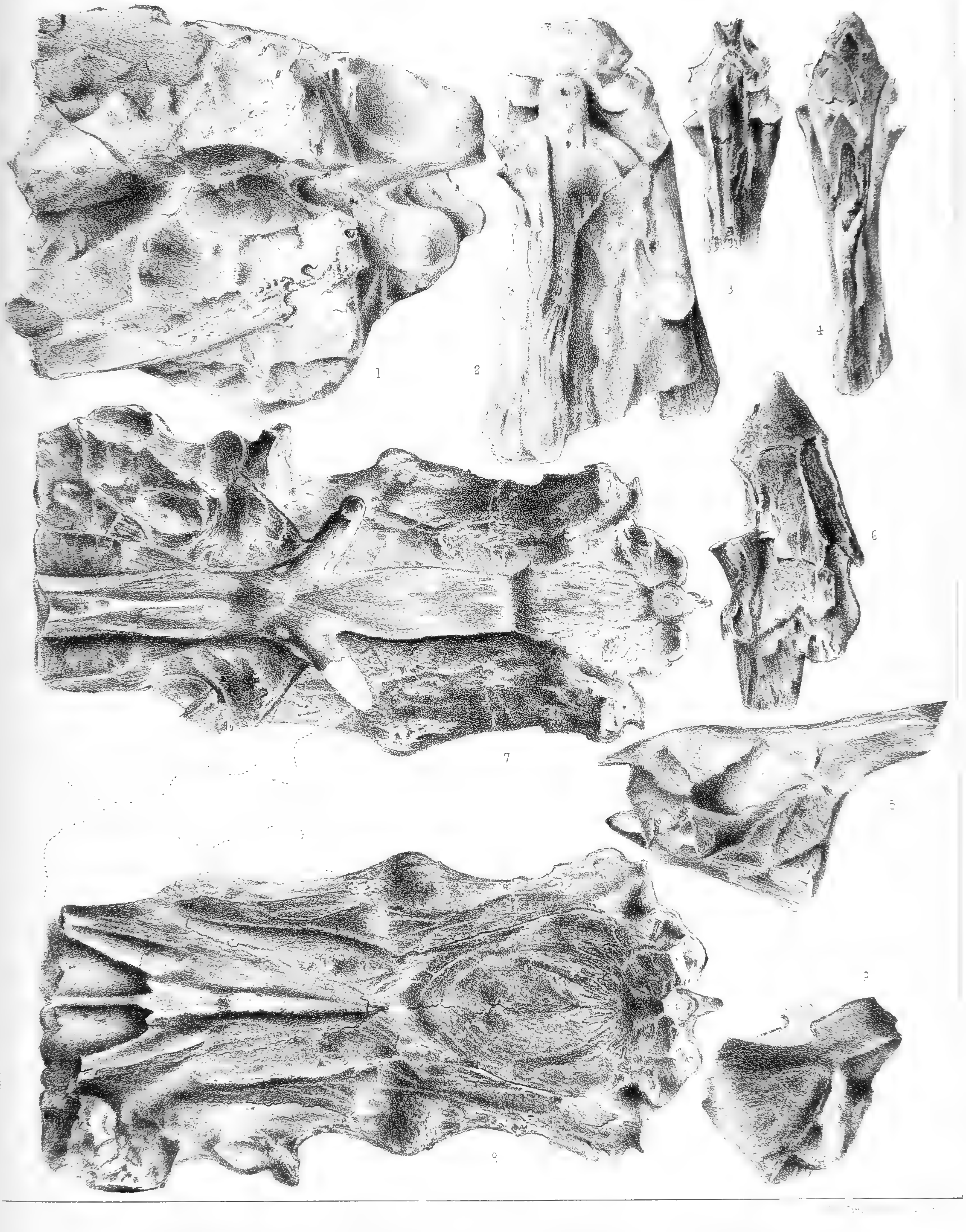


1-4. ICHTHYODECTES CTENODON. 5. I. HAMATUS. 6-10. I. PROGNATHUS.
11. PACHYRHIZODUS KINGII. 12. ANOGMIUS.

EXPLANATION OF PLATE XLVII.

Muzzles and crania of *Saurodontidæ*, natural size.

FIG. 1. Inferior view of vomer and ethmoid bones of *Portheus lestrio*, Cope, obliquely depressed, displaying cotyli for the maxillary and premaxillary condyles.
2. Inferior view of vomer and ethmoid of an unknown species, not distorted.
3. The same view of *Daptinus phlebotomus*.
4. Superior view of the same specimen.
5. Profile of an unknown Saurodont.
6. Superior view of ethmoid of *Daptinus phlebotomus*, Cope.
7. Inferior view of cranium of *Portheus ? arcuatus*.
8. Superior view of the same cranium.
9. Palatine bone, with malleolar body, of *Portheus arcuatus*, from the outer side.



1-2 PORTHEUS LESTRIO. 3-6 ? DAPTINUS PHLEBOTOMUS.
7-9 ? PORTHEUS ARCUATUS.

EXPLANATION OF PLATE XLVIII.

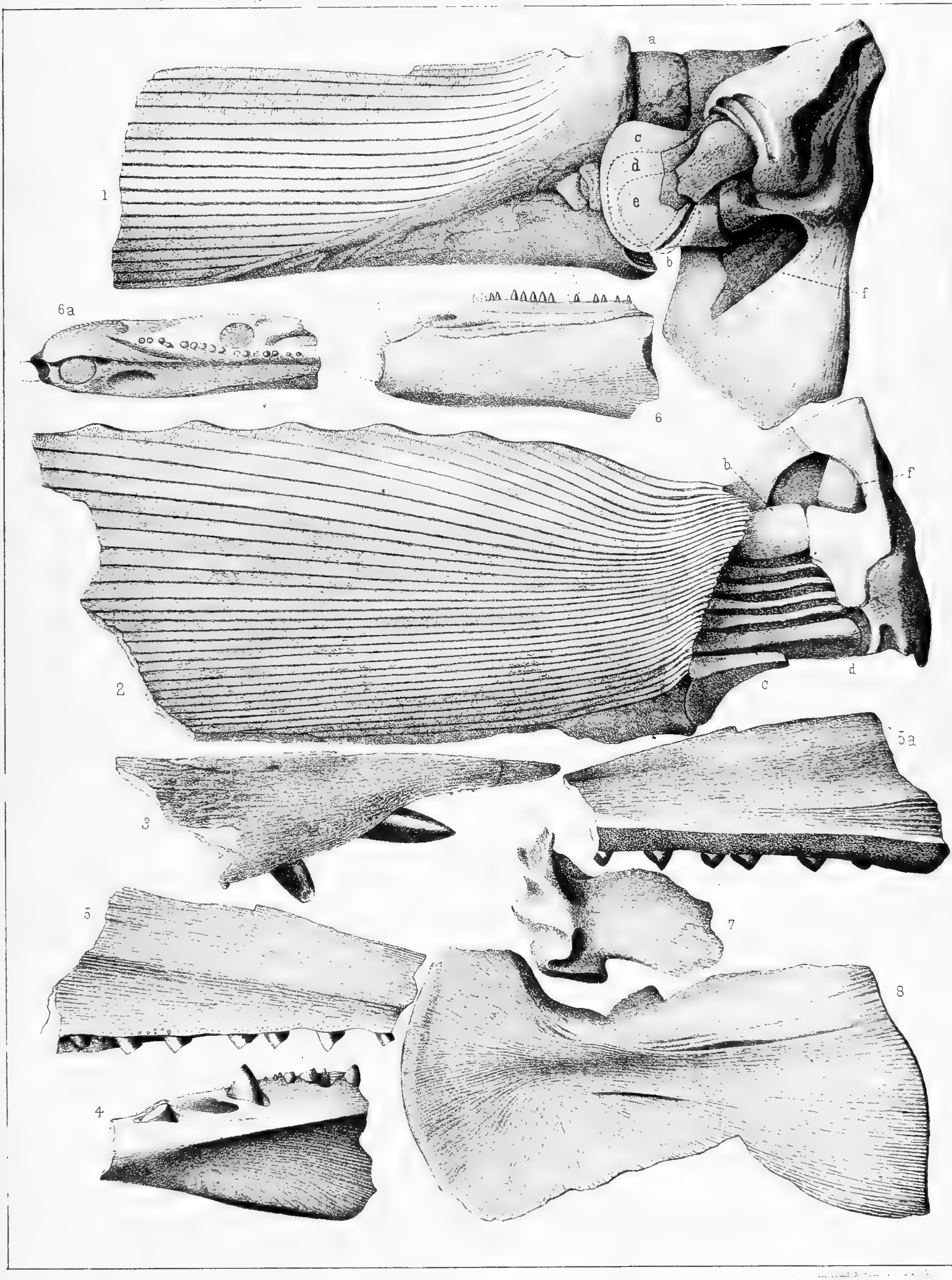
FIG. 1. Base of pectoral spine of *Pelecopterus chirurgus*, displaying the stout (*a*, *b*) and slender (*c*, *d*, *e*) basilar bones, with fossæ for the inner ones; *f*, coraco-clavicular foramen.

2. Base of pectoral spine of *Pelecopterus perniciosus*; lettering as in the preceding figure.

FIGS. 3–8. *Erisichthe nitida*, Cope, probable maxillary, premaxillary, and other bones.

FIG. 6. Distal end of dentary bone, from outside; *a*, from above.

7. ? Hyomandibular bone.



3-8. ERISICHTHE NITIDA.

EXPLANATION OF PLATE XLIX.

FIGS. 1–4. *Daptinus phlebotomus*, Cope, natural size.

FIG. 1. The mandibular and palatine bones compressed in one mass, viewed from above; 1 *a*, the same from below.

2. Maxillary and superior lamina of premaxillary bones of the left side, from without; 2 *a*, the same, from the inner side. The longitudinal lines represent fractures only.

3. Right dentary bone against the palatine; the latter with malleolar process broken off.

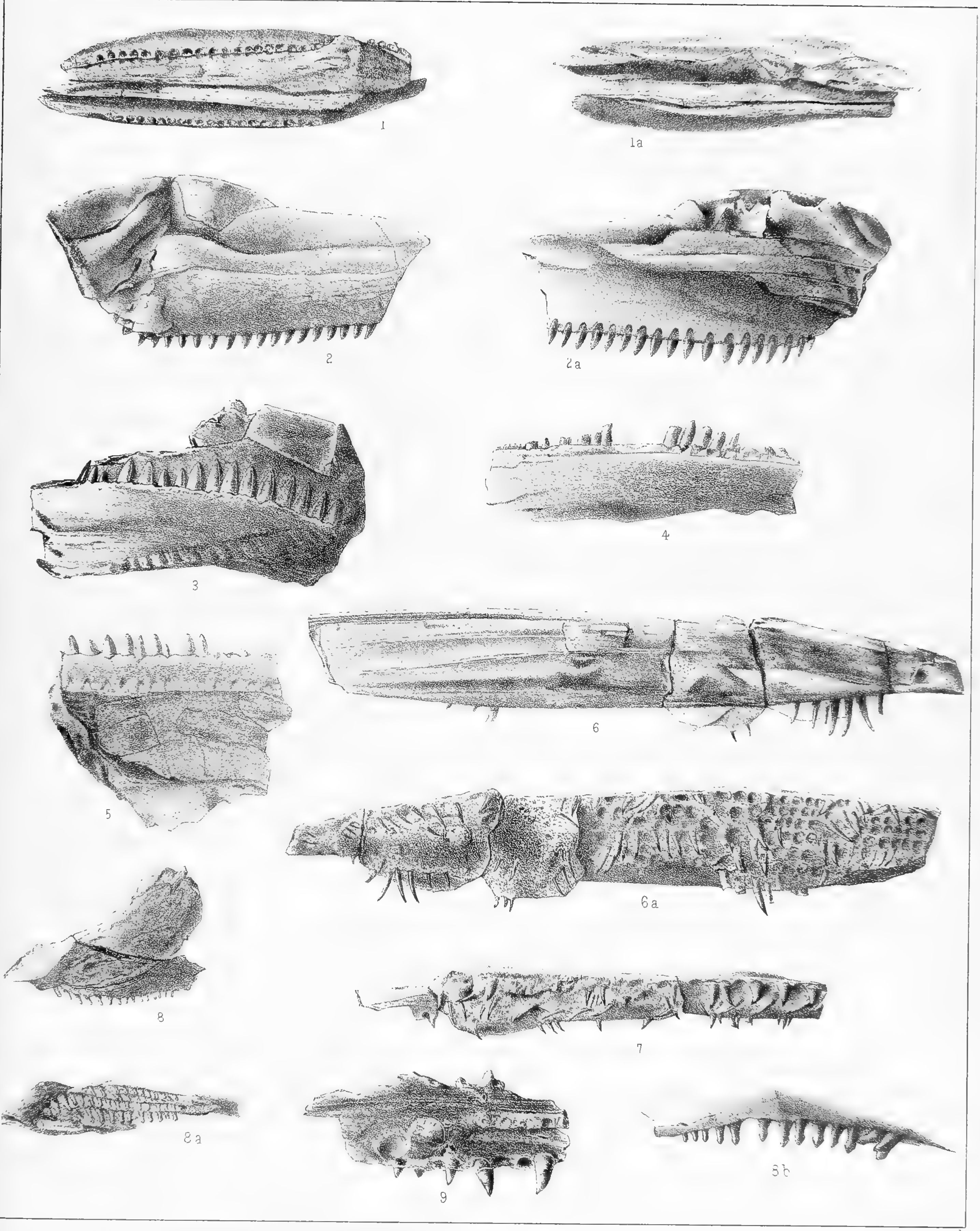
4. Left dentary.

5. Part of maxillary bone of *Saurocephalus arapahovius*, Cope, natural size; inverted by artist.

6. Palatine bone of *Stratodus apicalis*, Cope, outer aspect, natural size; 6 *a*, same, inner side.

8. Premaxillary and part of maxillary bones of the same, natural size; 8 *a*, same, from below; 8 *b*, teeth of the same, enlarged.

9. Distal extremity of premaxillary bone of *Empo nepæolica*, Cope; type-specimen.



[illegible] AUROCEPHALUS ARAPAHOVIUS.
[illegible] ATODUS APICALIS. 9. EMPO NEPAEOLICA.

EXPLANATION OF PLATE L.

FIGS. 1–4. *Pachyrhizodus caninus*, Cope, natural size.

FIG. 1. The mandibular rami, the right one with the angular bone entire behind, and broken in front; the left with the angular process broken off.

2. The right angular, viewed from the outer side.

3. The right premaxillary bone, inferior aspect; 3 *a*, viewed from the outer side.

4. Right maxillary, inner side; 4 *a*, same, from above.

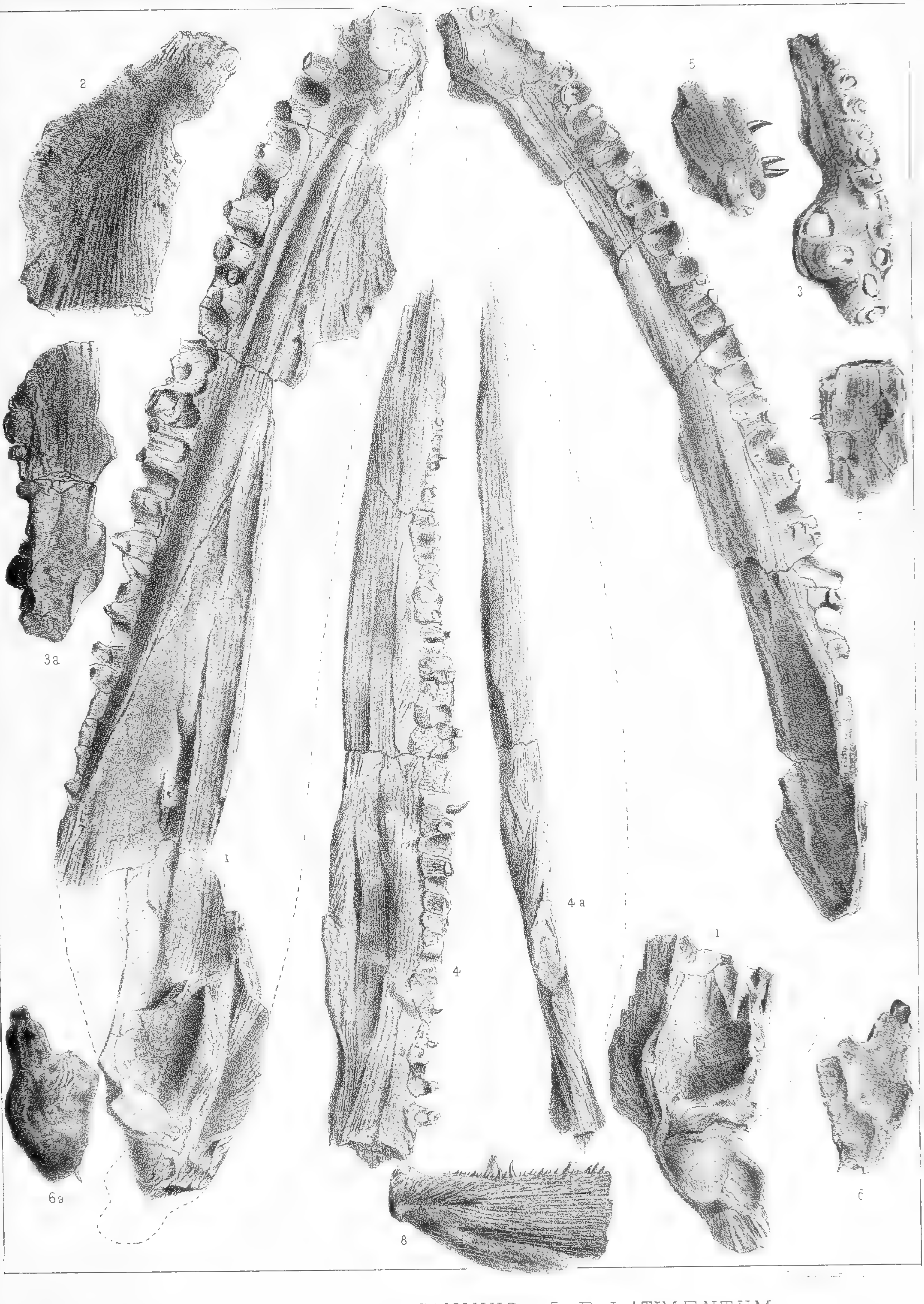
5. Distal part of dentary bone of *Pachyrhizodus latimentum*, Cope, from outer side.

6. Premaxillary bone of *Ichthyodectes multidentatus*, Cope, from within; 6 *a*, same, from without.

7. Part of the maxillary bone of the same.

8. End of dentary bone of *Empo nepæolica*, Cope.

All the figures on this plate are of the natural size.



1-4. PACHYRHIZODUS CANINUS. 5. P. LATIMENTUM.
6-7. ICHTHYODECTES MULTIDENTATUS. 8. EMPO NEPAEOLICA.

EXPLANATION OF PLATE LI.

FIGS. 1-7. *Pachyrhizodus latimentum*, Cope, three-fourths of natural size.

FIG. 1. Both mandibular rami, the upper without articulo-angular bone; the lower with the upper edge downward, and the distal end of the dentary wanting; 1 *a*, symphyseal extremity of the left dentary; 1 *b*, probable accessory maxillary bone.

2. Supposed preörbital bone.
3. Element of uncertain position.
4. Supposed hyomandibular; on the same block as the next — fig.
5. Supposed interoperculum.
6. Uncertain piece, perhaps symplectic.
7. Lateral view of a vertebra accompanying the same.
8. *Pachyrhizodus leptopsis*, Cope, mandibular ramus, natural size: *a*, distal half of dentary bone, from within; *b*, proximal part of the same bone; *c*, view of distal or symphyseal end of the same.

1-7. PACHYRHIZODUS LATIMENTUM. 8. P. LEPTOPSIS.

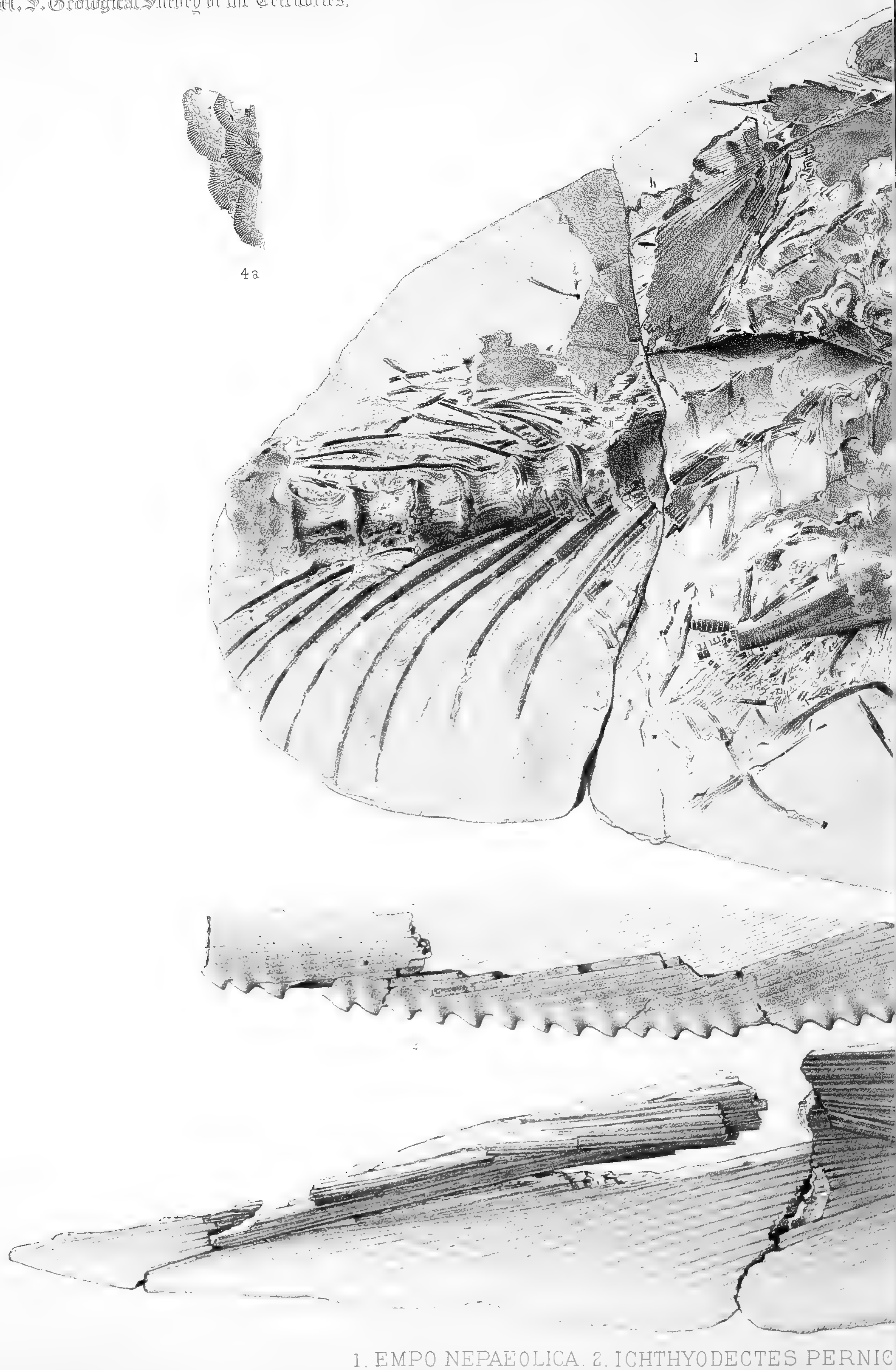
EXPLANATION OF PLATE LII.

FIG. 1. *Empo nepæolica,* Cope, head and anterior part of the body, on a block of the chalk of the Niobrara beds, from Professor Merrill's collection: *a, b,* right premaxillary and dentary bones; *c, d,* left premaxillary and dentary bones; *e,* frontal bones; *f,* ectopterygoid; *g,* quadrate; *h,* dermal scuta; *i,* pectoral fin; one-half natural size.

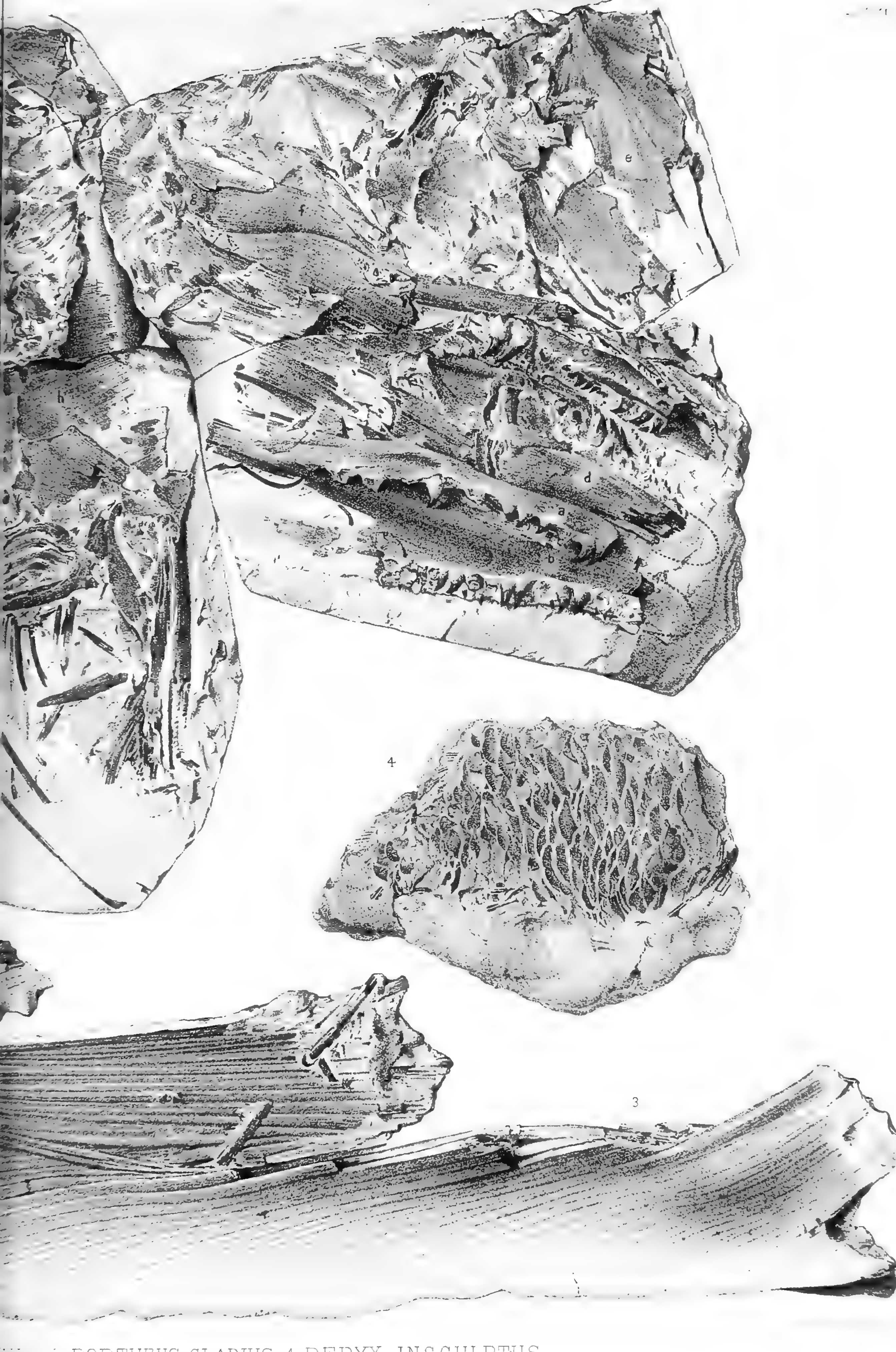
2. *Pelecopterus perniciosus,* Cope, spine of pectoral fin, one-half natural size.

3. Pectoral spine of *Pelecopterus gladius,* Cope, one-half natural size; from Professor Mudge's collection.

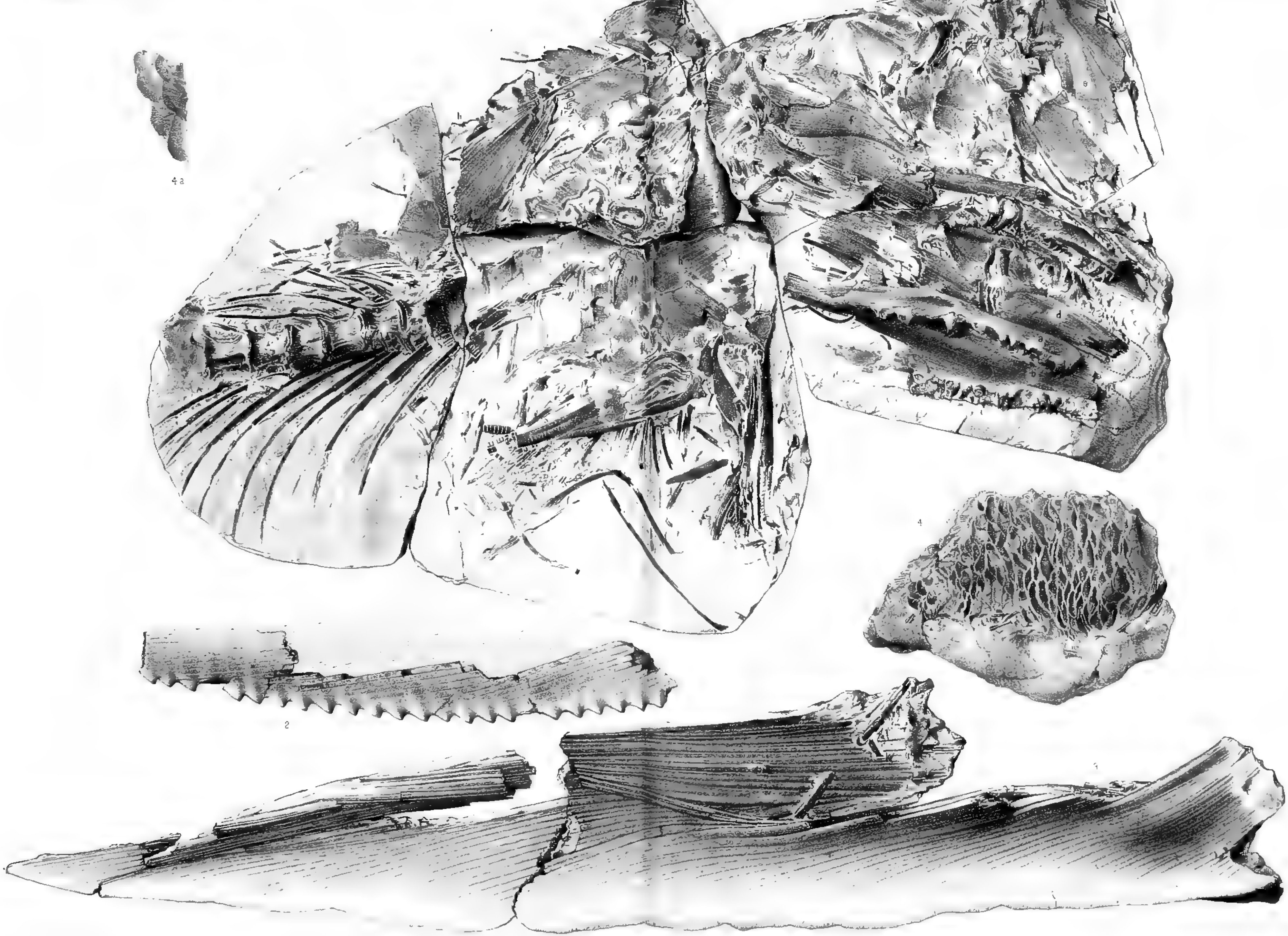
4. *Beryx insculptus,* Cope, from Dr. Lockwood's collection, one-half natural size; *a,* scales, natural size.



1. EMPO NEPAEOLICA. 2. ICHTHYODECTES PERNIC



PORTHEUS GLADIUS 4. BERYX INSCULPTUS



1. EMPO NEPAEOLICA 2. ICHTHYODECTES PERNICIOSUS 3. PORTHEUS GLADIUS 4 BERYX INSCULPTUS

EXPLANATION OF PLATE LIII.

FIG. 1. Vertebral column, with pectoral fin, and impression of opercula of *Empo semianceps*, Cope, one-half natural size; an interruption between the dorsal and caudal series is not filled by the specimens: 1 *a*, obverse of the piece containing last dorsals, showing dermal bones.

2. Opercular, hyomandibular, quadrate, and angular bones of another specimen of *Empo semianceps* one-half natural size.

FIGS. 3–5. Parts of a single specimen of *Empo nepæolica*.

FIG. 3. The mandibular ramus, natural size, from the inner side; 3 *a*, the same, from the outer side; 3 *b*, the angle and cotylus, from behind.

4. Premaxillo-maxillary bone of the same, natural size, viewed from below.

5. Cervical vertebræ and basioccipital bone of the same, from below, one-half natural size.

FIGS. 6–9. Portions of a skeleton of *Empo semianceps*, natural size.

FIG. 6. Dentary bone, from the outside.

7. ? Pharyngeal bone, with dental alveoli.

9. Dermal scuta.

FIGS. 10–13. *Empo merrillii*, Cope, natural size.

11–12. Premaxillary bone, from below.

FIG. 12. Proximal end.

13. Pharyngeal bone, with alveoli.

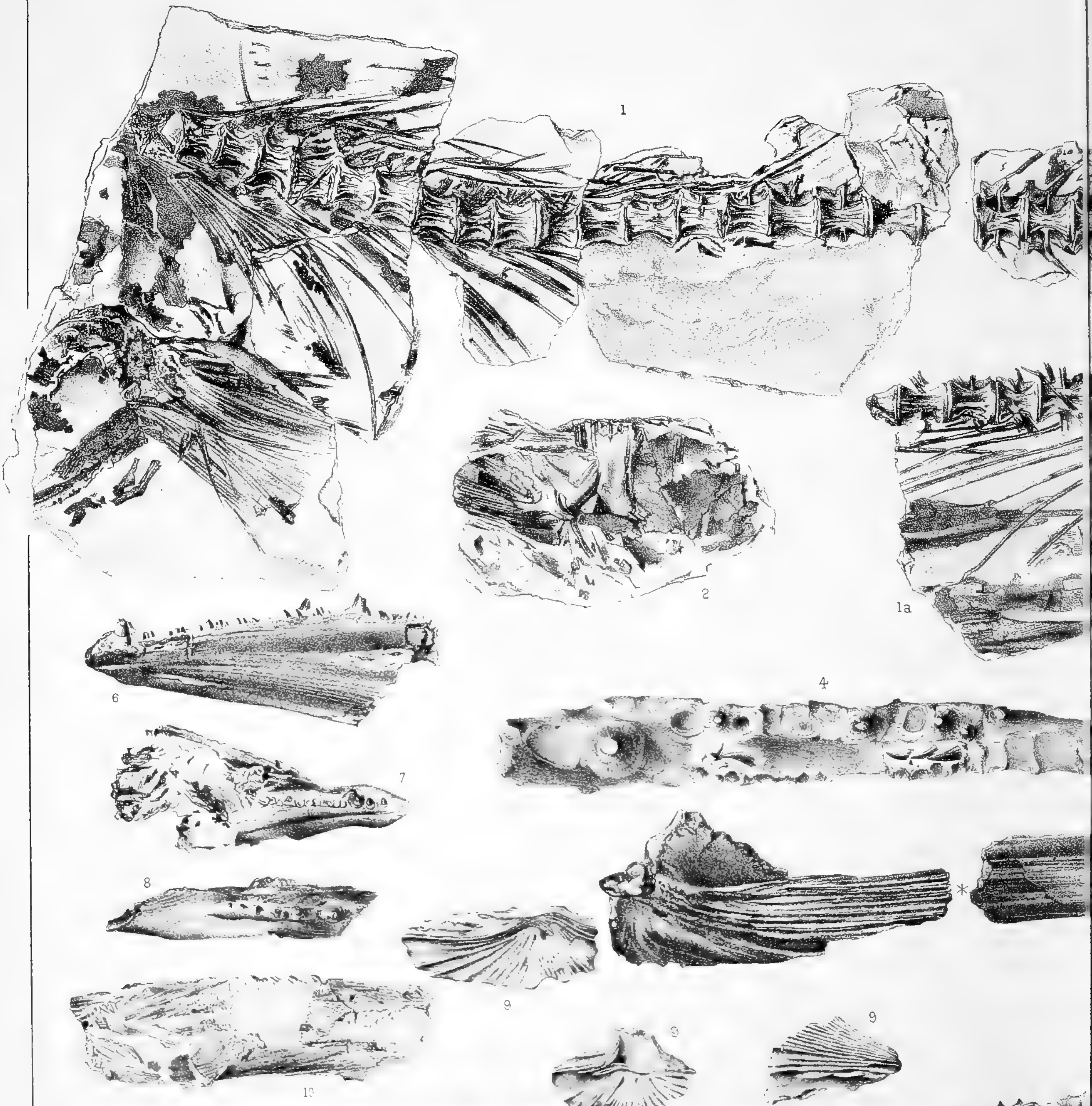
FIGS. 14–17. *Empo contracta*, Cope, natural size.

FIG. 14. Pharyngeal bone, with alveoli.

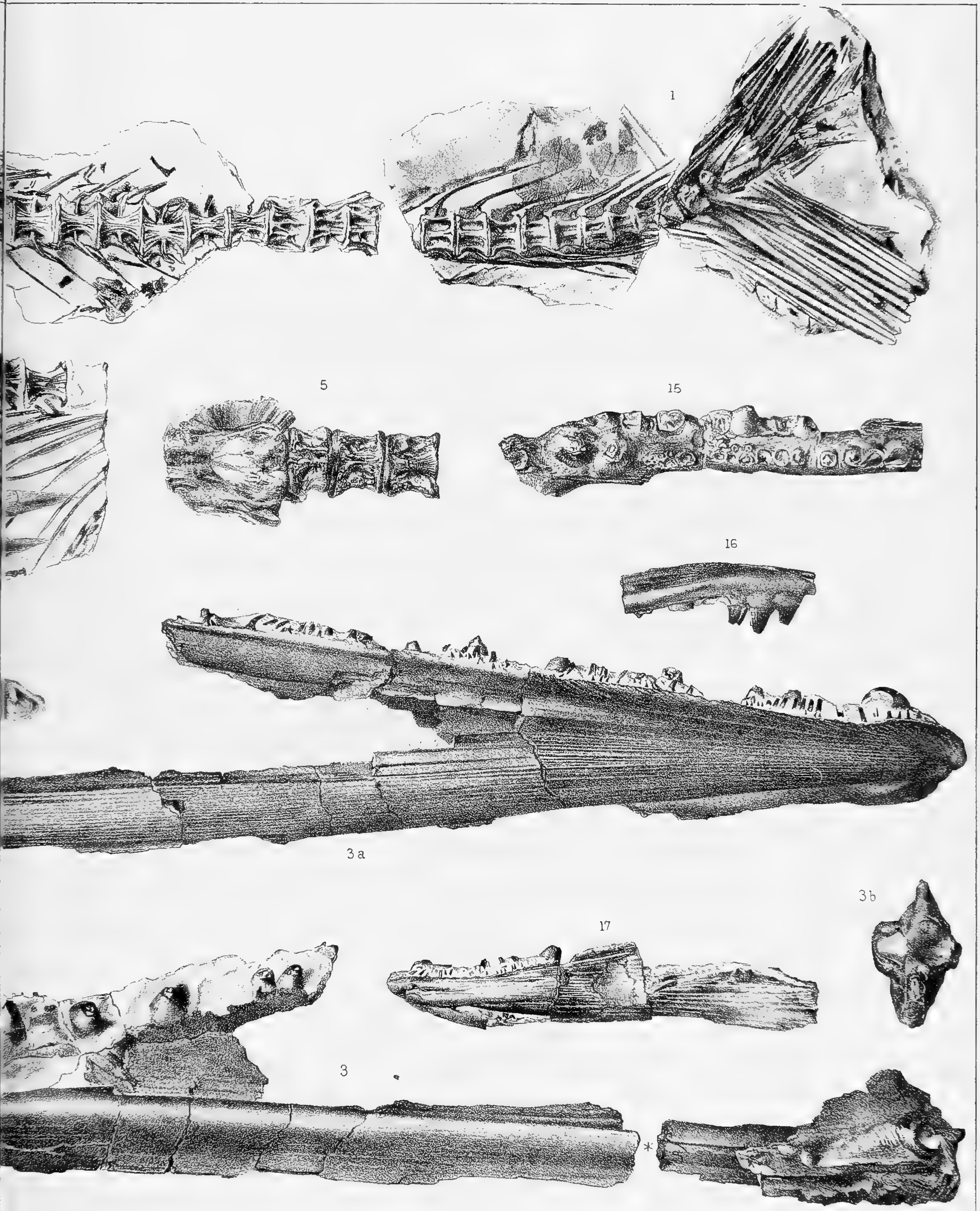
15. Premaxillary and maxillary bones, from below.

16. Proximal side of premaxillary, from the side.

17. Dentary bone, from outer side.



1-2. EMPO SEMIANCEPS. 3-5. EMP
10-13. EMPO MERRILL



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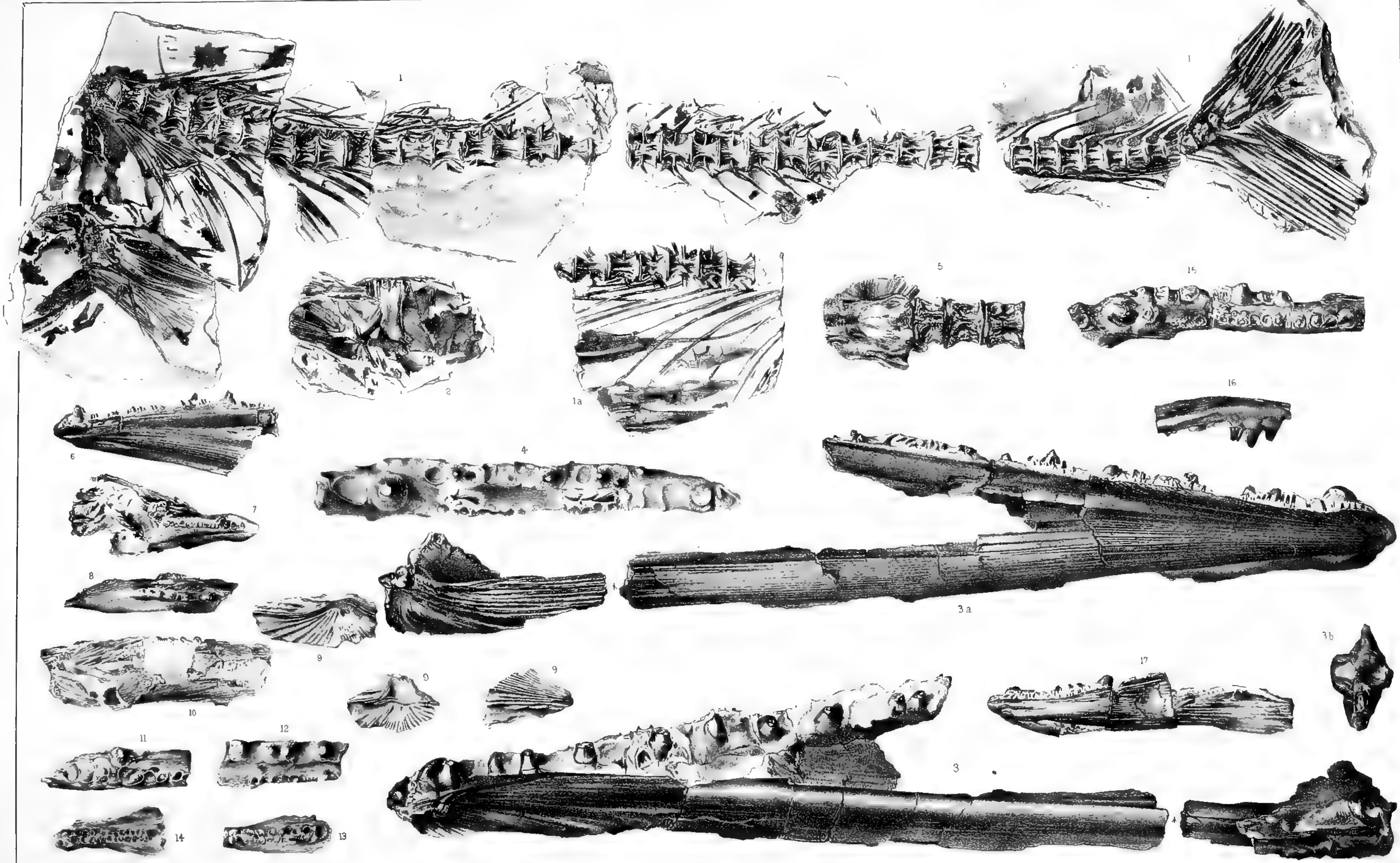
NEPAEOLICA. 6-9. EMPO SEMIANCEPS.
14-17. EMPO CONTRACTA.



Wm Sinclair & Son lith Phila

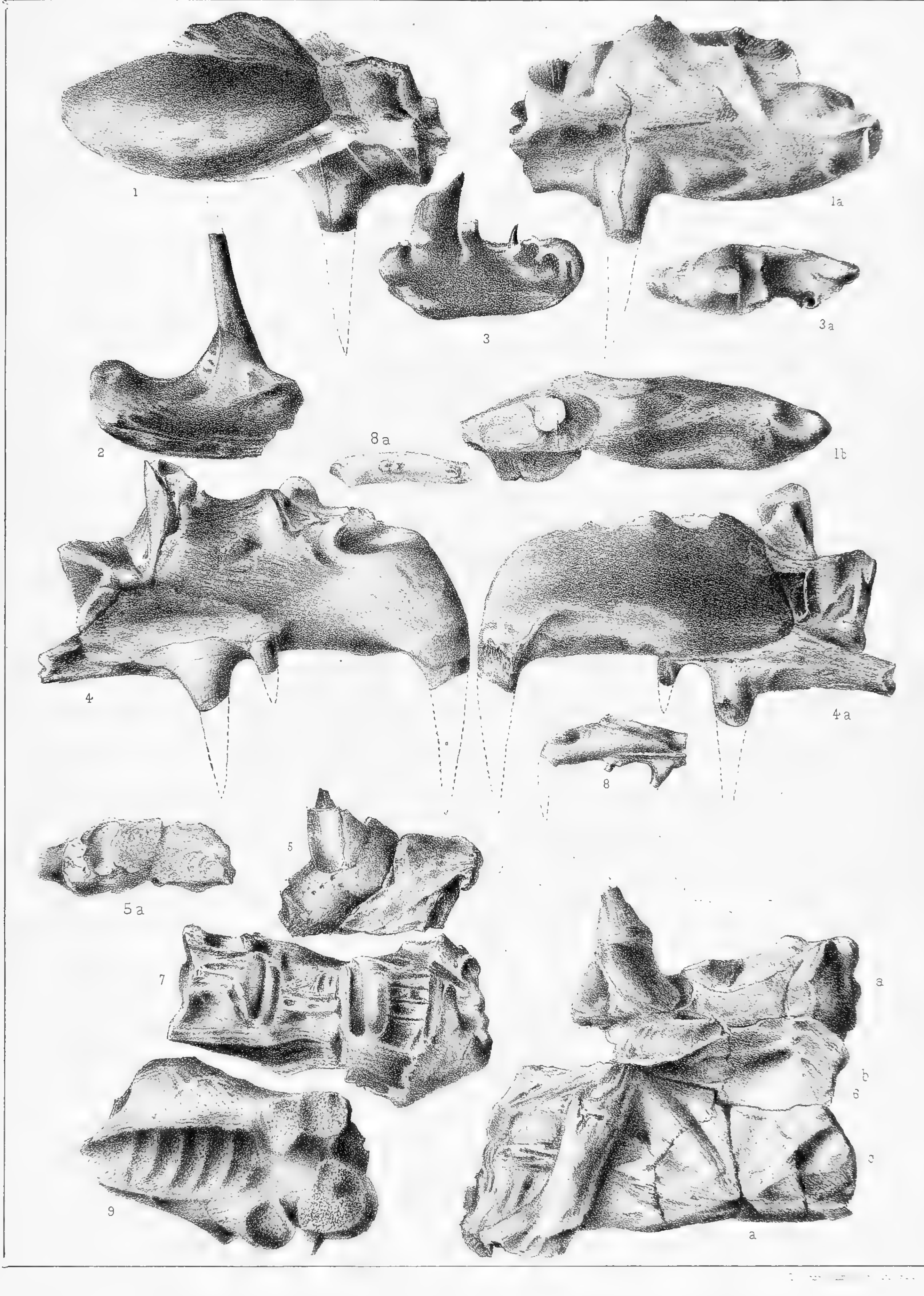
1-2. EMPO SEMIANCEPS. 3-5. EMPO NEPAEOLICA. 6-9. EMPO SEMIANCEPS.
10-13. EMPO MERRILLII. 14-17. EMPO CONTRACTA.

EXPLANATION OF PLATE LIV.

Figures natural size, except fig. 9, which is three-fourths nature.

FIG. 1. Premaxillary and part of maxillary bones of *Tetheodus pephredo*, Cope, natural size, from the outer side; *a*, same, from inner side; *b*, same, from lower side.

2. Distal end of left dentary bone of the same, outer side, in natural relation with fig. 1.
3. Distal end of right dentary, from outer side; *a*, from above.
4. Left premaxillary and part of maxillary bone of *Enchodus petrosus*, Cope, from the inner side; *a*, same, from outer side.
5. Distal end of left dentary, from inner side, in relation with fig. 4; *a*, the same, from above.
6. Base of posterior part of cranium of the same: *a*, basiöccipital; *b*, exoccipital; *c*, opisthotic; *d*, pterotic.
7. Premaxillary and part of maxillary bone of *Enchodus dolichus*, Cope, from outer side; *a*, same, from below.
8. Scapula of *Pelecopterus chirurgus*, exhibiting the facets for articulation of the two large and six slender basilar bones.

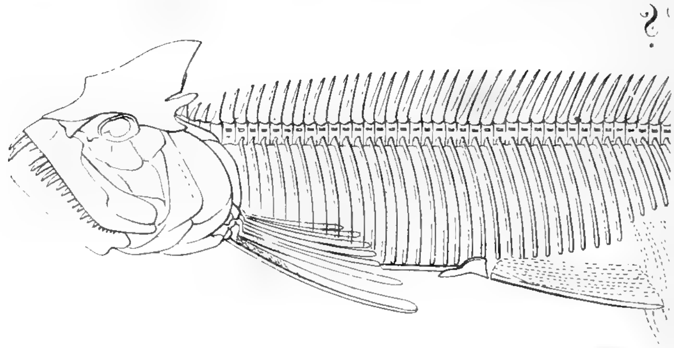


1-3. TETHEODUS PEPHREDO. 4-6. ENCHODUS PETROSUS.
7-8. ENCHODUS DOLICHUS. 9. PELECOPTERUS CHIRURGUS.

EXPLANATION OF PLATE LV.

Restorations.

1. *Portheus*, one-fourteenth natural size.
2. *Clidastes*, one-twentieth natural size.
3. *Platecarpus coryphæus*, outline of the imperfect cranium of the type-specimen.



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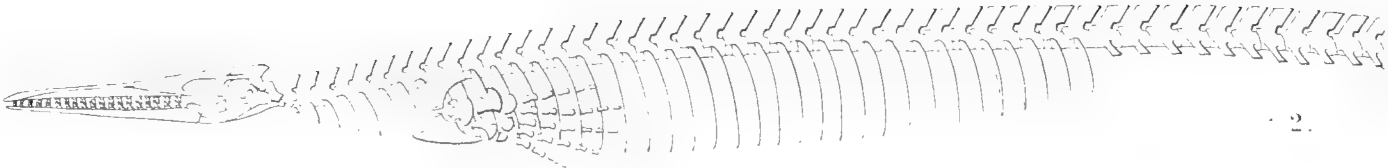

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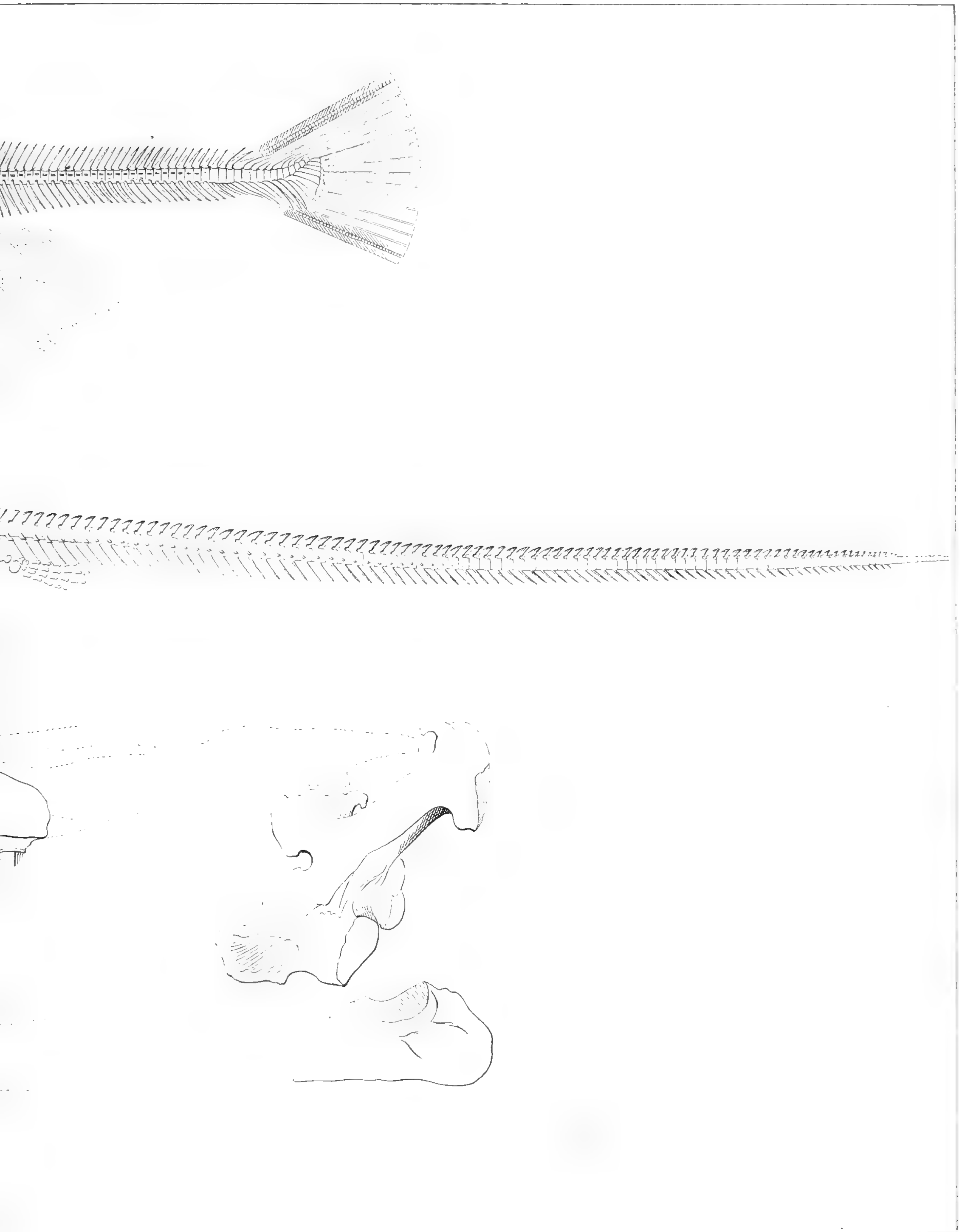
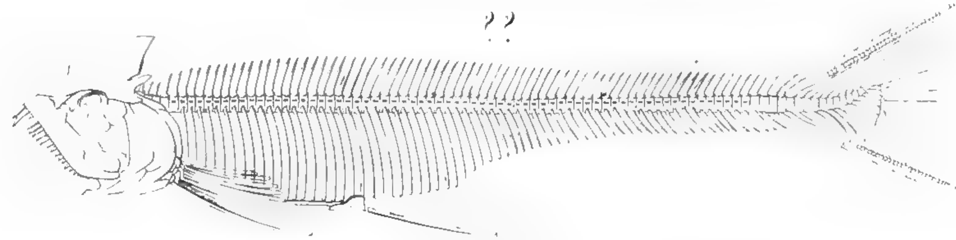
1. PORTHEUS 2. CLIDASTES.



PLATECARPUS CORYPHAEUS.



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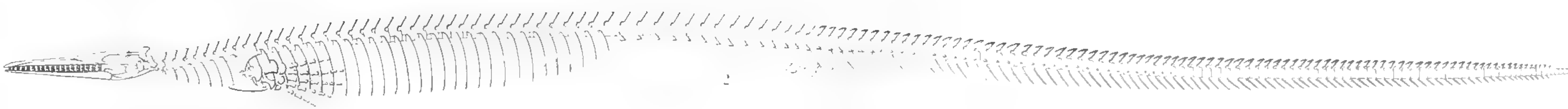

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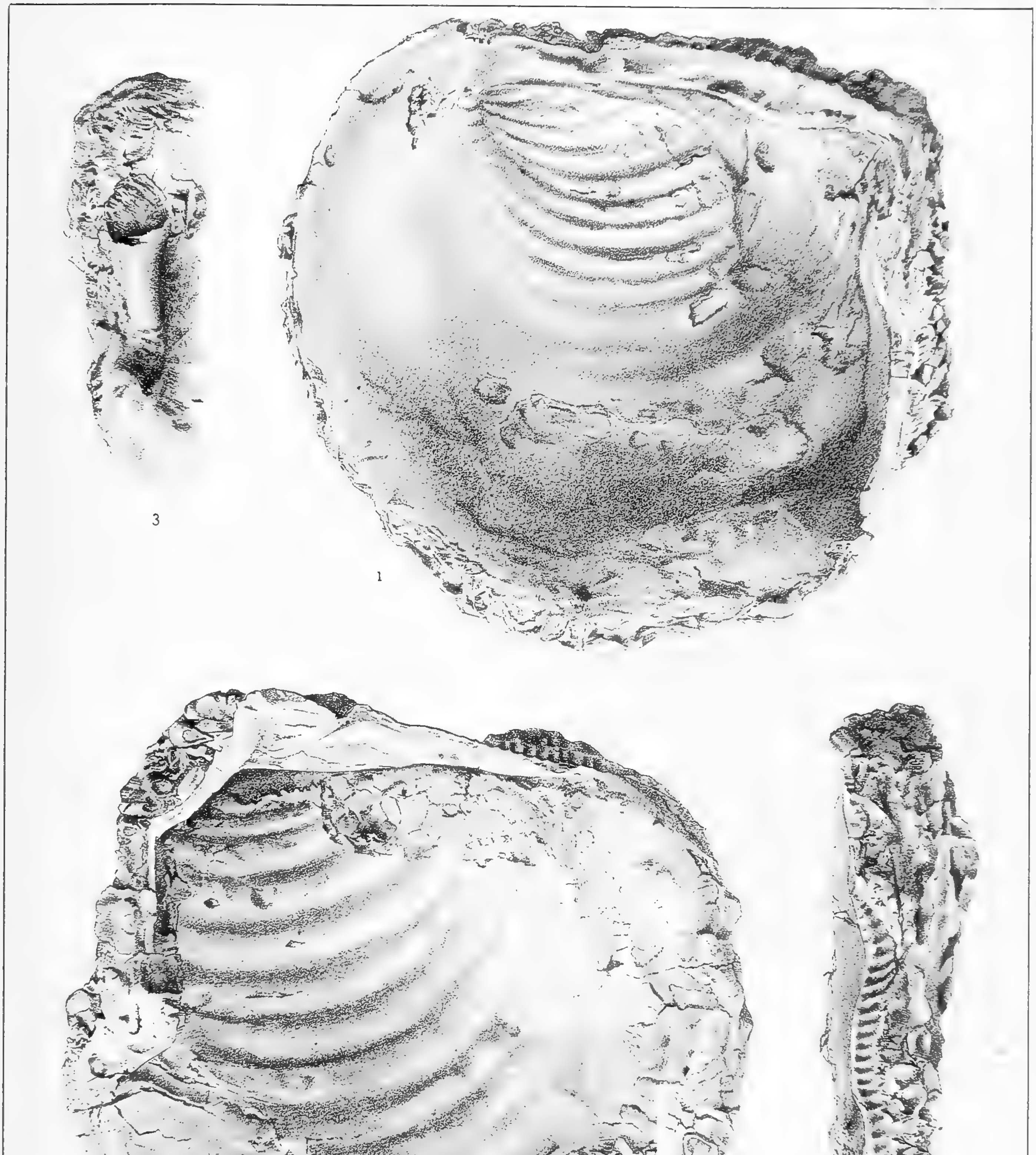
3

1. PORTHEUS 2. CLIDASTES. 3. PLATECARPUS CORYPHAEUS.

EXPLANATION OF PLATE LVI.

Haploscapha grandis, Conrad, one-third the natural size; two specimens (figs. 1 and 2), (see page 23).

FIG. 2 *a.* Cartilage-pits of external dorsal border of No. 2.
3. Hinge of a third specimen, the right-hand end broken o.f.



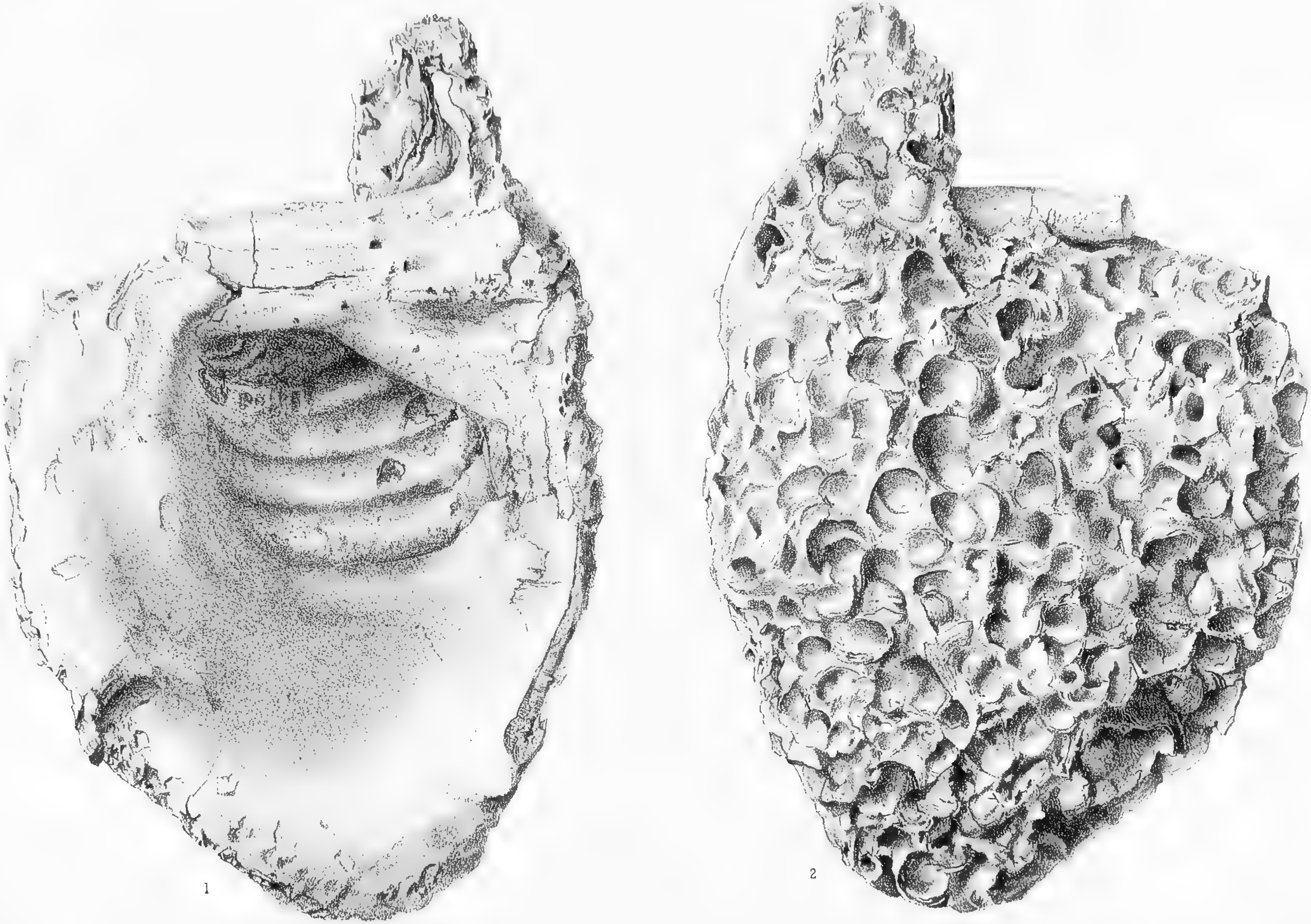
HAPLOSCOPHA GRANDIS.

EXPLANATION OF PLATE LVII.

Haploscapha eccentrica, Conrad, one-third natural size; the extremity of the hinge-border broken off.

FIG. 1. Internal view.

2. Outer side of the same shell, covered with *Ostrea congesta*.



HAPLOSCOPHA ECCENTRICA.