SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.
192

CRETACEOUS REPTILES

OF THE

UNITED STATES.

BY

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PREFACE.

The following Memoir was commenced seven years ago, and, although various circumstances have interfered with its completion until now, the delay has not been unattended with some advantages. During the lapse of time nearly as much new material has been discovered as was originally at the command of the author, and thus our acquaintance has been greatly extended with the subjects of the memoir. In consequence the latter has been repeatedly altered, and portions have been intercalated, which may serve to explain any apparent want of continuity in the work.

The author takes the opportunity of acknowledging his obligations to Prof. George H. Cook, of Rutgers College, New Brunswick, New Jersey, who has given constant and important aid in procuring specimens for examination during his geological explorations of the State. Acknowledgments are also due to W. Parker Foulke, of Philadelphia, through whose especial exertions we are indebted for the discovery of the huge Reptile, *Hadrosaurus*, which forms one of the most interesting and important subjects of description in the succeeding pages. Valuable assistance has also been rendered by others in obtaining specimens for investigation, but more especially by Dr. J. H. Slack, of Philadelphia. The basis of the work has been mainly founded on the rich collection of the Academy of Natural Sciences of Philadelphia.

CONTENTS.

MEMOIR

ON THE

EXTINCT REPTILES OF THE CRETACEOUS FORMATIONS OF THE UNITED STATES.

INTRODUCTION.

The present memoir consists of descriptions of remains of Reptiles discovered in the Cretaceous Formations of the United States. It was the author's intention to include an account of the fossil Fishes, of which he had the opportunity of examining numerous specimens, so as to form a monograph of the extinct Vertebrata of the Cretaceous period. These specimens are, however, in so many instances mingled with others derived from Tertiary deposits that he has been led to defer an account of them until he has the opportunity of ascertaining and separating those which belong to the different formations. Other Vertebrata, Bird or Mammal, have not been detected in the Cretaceous deposits of any part of America.[1]

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[1] I formerly attributed two species of Cetaceans to the Green-sand of the Cretaceous era of New Jersey, which I now believe to be erroneous, and regret the more as I have been quoted in the excellent works of Lyell (Princip. Geol. 9th ed. 145; Man. Elem. Geol. 5th ed. 254) and Dana (Man. Geol. 473, 478) in proof of the existence of such animals during the Cretaceous epoch.

Dr. Harlan described a vertebra (Journ. Acad. Nat. Sci. Phila. VI, 232, Plate xiv, Fig. 1; Med. and Phys. Researches, 282, Fig. 1), from Mullica Hill, N. J., which he considered to belong to a species of *Plesiosaurus*. Having accidentally noticed the specimen in the museum of the Academy, I recognized its cetacean character and referred it to a species with the name of *Priscodelphinus Harlani* (Proc. Acad. Nat. Sci. V, 327). As the formation at Mullica Hill belongs to the Cretaceous epoch, it thus appeared as if evidence was obtained proving the existence of a Cetacean at that age. Several other vertebræ, from the Marl of New Jersey, were at the same time referred to *Priscodelphinus grandaevus* (Ibidem). The latter specimens have since been ascertained to have been derived from a Miocene Tertiary deposit of Shiloh, Cumberland County.

I have since had the opportunity of examining many Cetacean remains from the Miocene deposits of New Jersey, and have been led to the conclusion that the vertebra of *Priscodelphinus Harlani* is a Miocene fossil which had become an accidental occupant of the Green-sand in which it was found.

Not only have Miocene fossils occasionally found their way into the Green-sand of New Jersey, but also the remains of more recent animals. The museum of the Academy contains remains of Mastodon, Beaver, Reindeer, Deer, and Muskrat, from the Green-sand of Burlington and Camden Counties.

The tooth of a Seal, reputed to have been found in the Green-sand near Burlington, New Jersey, Most of the fossil remains which form the subject of the memoir were obtained in New Jersey, and are contained in the museum of the Academy of Natural Sciences of Philadelphia. Very many of them were found in the Green-sand, which, under the name of Marl, is largely excavated for agricultural purposes; others were obtained from limestone. Many specimens have been derived from Maryland, Delaware, North Carolina, Georgia, Alabama, Mississippi, and Nebraska.

The Cretaceous formations compose a large tract extending through the States of New Jersey, Maryland, and Delaware. They also appear in isolated patches in North and South Carolina, and Georgia. More extensively developed in the western portion of the latter State, they curve in a wide crescentoid tract through Alabama, Mississippi, and Tennessee to the mouth of the Ohio River. Thence passing in a narrow band through Arkansas, they afterwards expand to an enormous extent and occupy a great portion of the region between the Mississippi River and the Rocky Mountains, reaching north into the British possessions, and south into Mexico.

When we consider the great development of the Cretaceous formations in the western and southern portions of the United States in comparison with those on the eastern border, from which nearly all our fossils have been obtained, we may anticipate many additions. These will not only increase the number of species and genera, but will serve to clear up many of the obscurities concerning those already in our possession.

According to Messrs. Meek and Hayden,[1] the Cretaceous formations in the region of the Upper Missouri, in section, present the following constitution:—

Earlier Cretaceous—

No. 1. Yellowish, reddish, and whitish sandstones and clays, with lignite and fossil angiospermous leaves, 400 feet in thickness. Located near Dakota, and reaching southward into northeastern Kansas.

No. 2. Gray laminated clays, with some limestone, 800 feet in thickness. Located near Fort Benton, on the Upper Missouri, also below the Great Bend. Characteristic fossils of this division are *Inoceramus problematicus*, *I. tenuirostris*, *I. fragilis*, *Ostrea congesta*, *Venilia Mortoni*, *Pholadomya papyracea*, *Ammonites Mullani*, *A. vespertinus*, *Scaphites Warreni*, &c.

No. 3. Grayish calcareous marl, 200 feet in thickness. Location: Bluffs on the Missouri, below the Great Bend. Characteristic fossils consist of *Inoceramus problematicus*, *I. pseudomytiloides*, *I. aviculoides*, *Ostrea congesta*, &c.

Later Cretaceous—

No. 4. Plastic clays, 700 feet in thickness: the middle portion barren of fossils. Located on the Missouri near Great Bend, about Fort Pierre, extending to the Bad Lands, on Sage Creek, Cheyenne River, and White River above the Bad Lands. Characteristic fossils are *Nautilus Dekayi*, *Ammonites placenta*, *A. complexus*, *Baculites ovatus*, *B. com-*

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and referred to *Stenorhynchus vetus* (Proc. Acad. Nat. Sci. VI, 377), I also believe to be a Miocene fossil.

Dr. Harlan described the fragment of the femur of a Snipe (*Scolopax*), from the Marl of New Jersey (Med. and Phys. Res., 282), which has been accepted by authors as an ornithic fossil of the Cretaceous period. The specimen, preserved in the museum of the Academy, is of recent origin.

[1] Dana, Manual of Geology, 1863, 469; Proc. Acad. Nat. Sci. 1861, 419.

pressus, Scaphites nodosus, Helicoceras Mortoni, H. tortum, H. umbilicatum, Ptychoceras Mortoni, Fusus vinculum, Anisomyon borealis, Amauropsis paludiniformis, Dentalium gracile, Crassatella Evansi, Cucullæa Nebrascensis, Inoceramus sublævus, I. tenuilineatus, I. Nebrascensis, I. Vanuxemi, bones of *Mosasaurus,* &c.

No. 5. Gray ferruginous and yellowish sandstones and arenaceous clays, 500 feet in thickness. Location: Fox Hills near Moreau River, above Fort Pierre near Long Lake, and along the base of Big Horn Mountains. Characteristic fossils are *Belemnitella bulbosa, Nautilus Dekayi, Ammonites placenta, A. lobatus, Scaphites Conradi, S. Nicolleti, Baculites grandis, Busycon Bairdii, Fusus Culbertsoni,* bones of *Mosasaurus,* &c.

A section of the New Jersey Cretaceous deposits, according to Messrs. Meek and Hayden,[1] as compiled from the observations of Prof. Geo. H. Cook, exhibits the following structure:—

Earlier Cretaceous—

No. 1. Dark blue, ash colored and whitish clays and micaceous sand, with thin seams of *lignite.* Great quantities of sulphuret of iron. Fossil wood in some of the layers in large quantities, and angiospermous leaves. 130 feet or more in thickness.

Later Cretaceous—

No. 4. Dark clays, with occasional streaks and spots of Green-sand, containing *Ammonites Delawarensis, A. placenta, Baculites ovatus,* etc. 130 feet in thickness.

First or lower bed of Green-sand, containing *Nautilus Dekayi, Baculites ovatus, Belemnitella mucronata, Terebratula Sayi, Ostrea larva, Exogyra costata, Gryphæa vesicularis,* etc. 50 feet in thickness.

Quartzose sand, highly ferruginous; argillaceous in its upper part, containing *Belemnitella mucronata, Ostrea larva, Exogyra costata, Neithea Mortoni,* etc. From 65 to 70 feet in thickness.

No. 5. Second bed of Green-sand. This includes the yellow limestone of Timber Creek, containing *Montivaltia Atlantica, Nucleolites crucifer, Ananchytes cinctus,* etc. Also a bed of nearly unchanged shells, among which are *Terebratula Harlani, Gryphæa lateralis, G. convexa,* etc. Lastly, Green-sand, etc., containing *Scaphites Conradi, Baculites ovatus, Ammonites placenta, Cucullæa vulgaris,* etc. From 45 to 50 feet in thickness.

Tertiary—

Quartzose sand resembling ordinary beach sand, and destitute of fossils. From 45 to 50 feet in thickness.

Third, or upper bed of Green-sand. 60 feet in thickness.

In Alabama, according to Prof. Winchell, as communicated by Messrs. Meek and Hayden,[2] the Cretaceous formations are as follows:—

Earlier Cretaceous—

No. 1. Dark blue and mottled shales or clay, with vegetable remains. 300 feet or more in thickness.

Later Cretaceous—

No. 4. Grayish and yellowish sand, with fossil wood and *Teredo tibialis;* 15 feet.

Gray sand with *Ammonites placenta, A. Delawarensis, Gryphæa vesicularis, Exogyra costata, Inoceramus biformis, Pecten quinquecostatus,* etc.; 6 feet.

Soft white limestone ("Rotten limestone"), with *Nautilus Dekayi, Ammonites Delawarensis, Baculites ovatus,* etc.; 150 feet or more.

Loose white sand, with *Ostrea larva, Pecten quinquecostatus, Gryphæa vomer,* etc.; 45 feet.

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[1] Proc. Acad. Nat. Sci. 1857, 127; 1861, 426. [2] Ibidem 1857, 126.

No. 5. Soft white limestone, with *Nautilus Dekayi, Baculites ovatus, Scaphites Conradi, Gryphæa vesicularis, Exogyra costata,* etc.; 6 feet.
Dark limestone, with obscure casts of shells; 4 feet.

In Texas the formations consist mainly of compact limestone. Dr. Shumard[1] gives the following section:—

EARLIER CRETACEOUS—

No. 1. Marly clay, with *Ammonites Swallovii, A. Meekianus, Ancyloceras annulatus, Scaphites vermiculus, Baculites gracilis, Inoceramus capulus,* etc.; 150 feet in thickness.
Arenaceous beds, with *Ostrea bellarugosa,* remains of fishes, etc.; 80 feet.

No. 2. Caprotina limestone, with *Orbitolina Texana,* etc.; 55 feet.
Blue marl, with *Inoceramus problematicus,* etc.; 50 feet.

No. 3. Washita limestone, with *Gryphæa Pitcheri, Inoceramus problematicus, Hamites Fremonti,* etc.; 100 to 120 feet.
Indurated blue marl, with *Exogyra arietina,* etc.; 60 feet.

LATER CRETACEOUS—

No. 4. Austin limestone, with *Gryphæa vesicularis, Exogyra costata, Nautilus Dekayi, Baculites anceps,* remains of fishes, etc.; 100 to 120 feet.
Comanche Peak Group, with *Exogyra Texana, Gryphæa Pitcheri, Cardium multistriatum, Ammonites Pedernalis, Heteraster Texanus, Diadema Texana,* etc.; 300 to 400 feet.
Caprina limestone, with undetermined species of shells; 60 feet.

Other localities[2] of Cretaceous formations of the different subdivisions are as follows:—

No. 1. At different points in New Mexico. (Newberry.)

No. 2. On the north branch of the Saskatchewan, west of Fort à la Corne, lat. 54° N., in New Mexico. (Meek.)

No. 3. Over the region from Kansas through Arkansas to Texas; Pyramid Mountain, N. Mexico.

No. 4. In British America, on the Saskatchewan and Assiniboine; on Vancouver Island; Sucia Islands, in the Gulf of Georgia.

No. 5. At Deer Creek, on the North Platte, and not identified south of this. (Meek and Hayden.)

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[1] Transac. Acad. of Sciences of St. Louis, I, 583.
[2] Dana, Manual of Geology, 470.

SAURIA.

THORACOSAURUS.

Thoracosaurus neocesariensis.

New Jersey Gavial, De Kay, Ann. Lyc. Nat. Hist. N. Y. III, 1833, 156, pl. iii, figs. 7–10.
Gavialis neocesariensis, De Kay, Zool. New York, 1842, part III, 28, pl. 22, fig. 59.
Crocodilus s. Gavialis clavirostris, Morton, Proc. Acad. Nat. Sci. Phila. III, 1844, 82.—Giebel, Fauna d. Vorwelt, 1847, 122.
Crocodilus basifissus, Owen, Jour. Geol. Soc. Lond. V, 1849, 381, pl. x, figs. 1, 2; Palæontology, 1860, 277.—Pictet, Traité de Palæont. I, 1853, 482.
Sphenosaurus, Agassiz, Proc. Acad. Nat. Sci. Phila. IV, 1849, 169.
Thoracosaurus grandis, Leidy, Proc. Acad. Nat. Sci. Phila. VI, 1852, 35.

The most characteristic of the Crocodilian remains, obtained from the strata of the Cretaceous period in the United States, consists of a nearly entire skull, which was discovered in limestone, overlying the ferruginous Marl, on the farm of Gen. William Irick, near Vincenttown, Burlington County, N. J. The specimen was presented by that gentleman, and Mr. Wm. Whitman, of this city, to the Academy of Natural Sciences, in the cabinet of which it is now contained. This finely preserved fossil consists of the skull, without the lower jaw. It has lost the anterior extremity of the muzzle, estimated to have been equal to half its original length. The teeth are also broken away, but sockets with the remains of fangs for fourteen of the back teeth exist on each side of the fossil. The zygomatic arches, as formed by the squamosals, are broken away, as is also the case with the articular ends of the tympanics and the lower or outer conjoined extremities of the ecto- and entopterygoids.

The matrix, in which the fossil was imbedded, for the most part has been chiselled away. Portions still adherent and occupying one orbit and palatine orifice, besides the interior of the cranium and nasal passages, consist of a moderately hard, gray arenaceous limestone. The bones of the fossil are brown and friable.

In general shape and construction the fossil skull exhibits more resemblance to that of the existing Gavial of the Ganges (*Gavialis Gangeticus*) than of any other of the living crocodilian Reptiles, though from the non-eversion of the orbits and the more gradual prolongation of the muzzle it also presents a relationship to the genus *Mecistops*, of Western Africa. Of all known forms, however, it bears most resemblance to the skull of the extinct *Gavialis macrorhynchus*, of the Cretaceous formations of Europe.

In consequence of the anterior extremity of the muzzle being lost in the New Jersey specimen, we have no positive means of ascertaining the length of the skull. Supposing it, however, to have held the same relation of length to breadth as in the recent Gavial, in its perfect condition it would have measured about three and three-quarter feet in length and one and a-half feet in breadth. The relation of length to breadth in the *Gavialis macrorhynchus*, with which the New Jersey species appears to be most closely allied, is rather less, and would have made our fossil head about three and a-half feet in length. If we allow as many vertebræ to the New Jersey Gavial as are possessed by the existing species, or the same proportionate length of body to the head, the former animal in its entire condition would measure twenty feet in length.

The upper view of the fossil skull, represented in Fig. 1, Plate I, bears a strong resemblance to that of the living Gavial, except that the boundaries of the orbits are not conspicuously everted as in the latter, and the muzzle is not so abruptly narrowed forward. In the characters just mentioned the fossil appears intermediate to the Gavial and *Mecistops*, and resembles the Teleosauri of the Liassic formations of Europe, but most closely the Cretaceous *Gavialis macrorhynchus*. The posterior and lateral outlines of the cranium are the same in both the New Jersey and living Gavials, as is also the form of the large temporal foramina. The space separating the latter in our fossil, formed by the symmetrical parietal, is both relatively and absolutely narrower than in the living Gavial. The forehead, as formed by the frontal and pre-frontals, has almost the same proportionate breadth as in the latter, but is only slightly concave in consequence of the non-eversion of the orbital borders. The frontal in the fossil, as is also the case in the *Gavialis macrorhynchus*, is prolonged considerably more posteriorly to join the parietal than in the recent Gavial or *Mecistops*. The orifices of the orbits, when perfect, appear to have had nearly the same proportionate size and form as in the living Gavial, but their borders in no position are everted, not even so much as in *Mecistops*, or the Alligator, *A. Mississipiensis*.

The post-frontals, separating the orbits from the temporal foramina, are proportionately narrower than in the recent Gavial; while the post-orbital arches, formed through conjunction of the post-frontals with the malars, are broader.

As in the extinct *Gavialis macrorhynchus*, the face in advance of the forehead and orbits in the New Jersey fossil slopes with a gentle curve forward to the broken end of the muzzle.

The malar and lachrymal are more prolonged upon the face or muzzle than in the recent Gavial. Thus in the latter, the anterior border of the malar reaches as far forward as the position of the fourth tooth, counting from behind, and the lachrymal advances as far as the sixth tooth. In the fossil the malar extends as far forward as the seventh tooth, and the lachrymal reaches beyond the position of the ninth tooth.

The posterior extremities of the nasals are angular, and extend back on a line with the anterior orbital margins. They widen forward to the anterior ends of the pre-frontals, then very gradually narrow forward a short distance beyond the lachrymals, and finally narrow abruptly into a pair of linear prolongations extending to the broken end of the fossil. A similar condition of the nasal bones is observed to exist in the *Gavialis macrorhynchus*.

The surface of the cranium, as formed by the parietal, mastoids, frontals, pre- and post-frontals, is less foveated than in the full-grown Gavial of the Ganges; and the surface of the muzzle is likewise rather less roughened, though perforated by as many vasculo-neural foramina.

On both sides of the face, in the fossil, there is a large hole, situated between the lachrymals and pre-frontals, a short distance in advance of the inner part of the orbits, which, though perhaps accidental, reminds one of the unossified spaces noticed in a somewhat similar position in the Deer among Mammals, and corresponding with the orifices represented as existing in the *Teleosaurus* or *Pelagosaurus typus*,[1] between the lachrymals and nasals.

The lateral view of the fossil skull, represented in Fig. 2, Plate I, is nearly repeated by that of the corresponding portion of the skull of the recent Gavial, except that the face in the former presents a more gradual slope from the position of the orbit.

The occipital view of the fossil also bears a near resemblance to that of the recent Gavial; its upper outline, however, is more nearly horizontal, and is not prominent at the middle. The supra-occipital is much broader in relation with its height than in the recent Gavial, or the Alligator. Its upper extremity forms a square plate, with everted edges, over an inch in breadth, articulating by transverse suture on the top of the cranium with the parietal.

The exoccipitals, the occipital condyle, and the occipital foramen present nothing peculiar. The latter is an inch and a half in breadth and ten lines in height.

The inferior view of the fossil skull, represented in Fig. 1, Plate II, though presenting the same general outline of form and construction as in the recent Gavial, nevertheless exhibits a number of important peculiarities. The palatine foramina, as in *Gavialis macrorhynchus*, are much larger than in the recent Gavial. They are ovoidal, with their narrow extremity forward and their inner sides nearly parallel. They extend from the ento-pterygoids as far forward as the position of the seventh tooth, counting from behind. The part of the skull corresponding with the position of the foramina and the intervening palatines rises even more than in *Mecistops*. The anterior extremities of the palatines reach as far forward as the position of the ninth tooth from behind. In advance of the palatines the surface of the muzzle is flat.

Neither the palatines nor the ento-pterygoids present capsular osseous dilatations, such as exist in the recent Gavial.

The posterior nares are large, and, as in the Alligator and the extinct *Gavialis macrorhynchus*, are divided by an osseous septum of the ento-pterygoids. The lower border of this septum forms a stout ridge expanding behind upon the basisphenoidal. The latter includes a large, transversely oval pit, communicating with a canal piercing the bone as in other Crocodilians.

The under surface of the tympanics, as observed in this view of the skull, exhibits a deep and wide gutter or concave fossa, of which only a superficial trace is present in the recent Gavial.

The remaining portions of the maxillæ in the fossil, on each side, contain the sockets and portions of the fangs of fourteen teeth, occupying a space sixteen and a half inches in length.

Compared with the skull of *Gavialis macrorhynchus*, as represented by the figures

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[1] See Fig. 7, Plate XXV, of the Atlas to Pictet's Traité de Paléontologie, 2d ed.

of De Blainville[1] and Gervais,[2] that of the extinct Gavial of New Jersey was more than one-third larger. These two Cretaceous Crocodilians present characters in common, so peculiar in comparison with other known forms, recent and extinct, that they may be considered as belonging to a distinct genus, for which the name of *Thoracosaurus* has already been proposed for one of the species, and may equally apply to the other.

Measurements of the Skull of THORACOSAURUS NEOCESARIENSIS.

	Inches.	Lines.
Estimated length of skull . . . . . from 42 inches to	45	
Breadth at condyles of tympanics or articulation of the lower jaw .	17	
Breadth of face at the last teeth	12	
Breadth of face at the fourteenth teeth, counting from behind . .	3	7
Height of cranium at the occiput	6	3
Breadth of cranium at the posterior border of the orbits crossing the parietal and mastoids	12	6
Distance from summit of the occiput to anterior extremity of the frontal	11	
Length of alveolar border from back end of maxilla to the fourteenth alveolus, or broken end of the fossil	17	
Length of palatines in the median suture	9	6
Breadth of palatines together at the middle	2	9
Length of palatine foramina	8	
Breadth of palatine foramina	3	6
Distance from occipital condyle to broken end of the muzzle, corresponding with the fourteenth tooth, counting from behind . . .	29	
Breadth of muzzle at anterior extremity of the palatine foramina .	8	
Breadth of cranium at middle of the temporal foramina . . .	3	
Transverse and antero-posterior diameters of the temporal foramina .	4	3
Transverse and antero-posterior diameters of the orbits . . .	3	3
Distance apart of orbits where nearest	4	3
Distance apart of temporal fossæ		6½
Length of frontal	7	
Breadth of frontal between post-frontals	5	6
Length of parietal	4	
Breadth of parietal posteriorly	4	5
Distance between anterior ends of malars	4	10
Breadth of nasals between anterior ends of pre-frontals . . .	3	1
Breadth of nasals between anterior ends of lachrymals . . .	1	9
Diameter of posterior nares	1	8
Thickness of border of septum between the latter		5

A small fragment of the lower jaw of an extinct Gavial from the ferruginous sandstone, of the Cretaceous era, of the Highlands of Navesink, New Jersey, was described by Dr. J. E. De Kay, in 1833, in the third volume of the Annals of the Lyceum of Natural History of New York, page 158. The fragment, now more mutilated than formerly, I have had the opportunity of inspecting, through the kindness of Prof. E. Emmons, of Albany. The specimen is about six inches in

[1] Osteographie; Reptiles, Plate 6, Crocodilus macrorhynchus.
[2] Zoologie et Paléontologie Francaises, Plate 59, fig. 18.

length and corresponds with that part of the jaw just in advance of the divergence of the rami, and consists of portions of both dentals and splenials. The right dental contains remains of four alveoli with portions of their teeth, of which one incloses the entire crown of a successional tooth.

This fossil fragment of the lower jaw I suspect to belong to the same species as the Vincenttown skull, but to a smaller or younger individual. The symphysis of the splenials, preserved at the posterior part, in the perfect condition, is estimated to have been about seven inches in length. The breadth of the jaw at the back extremity of the symphysis of the splenials is estimated to have been about four and a quarter inches; and at the fore extremity two and three-quarter inches. The oral surface of the splenials and dentals presents about the same degree of convexity as in the recent Gavial.

The cabinet of the Academy contains a fragment of the left upper maxilla, apparently belonging to the same Gavial as the fossil skull just described, which is of especial interest from its retaining several entire and well-preserved teeth. The specimen, together with some small fragments of the jaw and teeth of the same individual, were obtained by Dr. J. L. Burtt, from the Cretaceous limestone, near Blackwoodtown, Camden County, N. J. The fragment to which we especially refer, represented in Fig. 2, Plate II, is about eight inches long, and corresponds with that portion of the left maxilla in the fossil skull which contains the back six teeth with the exception of the one or two last ones. It has a portion of the malar attached, and belonged to a rather larger individual than the Vincenttown skull, for it contains one tooth less in the space occupied by seven in the latter.

The crowns of the teeth protruding from the specimen are curved conical as in the recent Gavial, but are more robust in proportion with their length. The ridges separating their outer and inner surfaces are also less prominent than in the living Gavial. The more anterior of the teeth, towards the base of the crown, internally exhibit a slightly fluted disposition. The enamel, which is jet black, is closely striated longitudinally with fine linear ridges, and also presents a feeble annular disposition towards the summits of the crowns.

The measurements of the teeth, counting them from behind forward, are as follows:—

	Lines.
Length of crown of third tooth	$7\frac{3}{4}$
Diameter of base from without inwardly	$5\frac{1}{2}$
Length of crown of fourth tooth	10
Diameter of base from without inwardly	$6\frac{1}{4}$
Diameter of base at the divisional ridges	$7\frac{1}{2}$
Length of crown of sixth tooth	$13\frac{1}{2}$
Diameter of base from without inwardly	8
Diameter of base at the divisional ridges	$9\frac{1}{2}$
Length of sixth tooth to bottom of alveolus	39
Diameter of base of eighth tooth from without inwardly	$9\frac{1}{2}$
Diameter of base of eighth tooth at divisional ridges	10

A detached tooth, represented in Fig. 4, Plate I, from the same individual as the fossil fragment of jaw just described, presents the same characters as those contained in the latter.

Two isolated teeth, obtained by Dr. Burtt from the same formation as the preceding specimens, exhibit identical characters with those above described.

The crowns of two additional teeth from the Green-sand, near Blackwoodtown, Camden County, N. J., presented by Dr. Burtt to the Academy, probably belong to the same species as the foregoing. They are narrower in proportion to their length than those in the fragment of jaw, but may have occupied a more anterior position in the series.

The successional tooth, alluded to in the jaw fragment described by Dr. De Kay, resembles the larger of the two just indicated.

The summits unworn of two successional teeth, seen protruding from within the fangs of broken functional teeth, in the Vincenttown skull, in the corrugated appearance of their enamel and in other characters, are identical with those of the teeth described.

The cabinet of the Academy also contains several small fragments of jaws, with entire teeth, from the Cretaceous limestone of Big Timber Creek, Gloucester Co., N. J., presented by Messrs. R. Haines, J. P. Smith, T. McEuen, and S. G. Morton. The teeth, of which the most perfect is represented in Fig. 6, Plate I, correspond in size, form, and proportions, with those contained in the fragment of jaw presented by Dr. Burtt.

Of five specimens, consisting of crowns of teeth, and probably referable to the same species as the preceding, from the Green-sand of Burlington County, N. J., presented to the Academy by Lewis T. Germain, the more perfect are represented in Figs. 3 and 5, Plate I. One of these corresponds in its proportions with the teeth in Dr. Burtt's fossil, and in the fragments from Big Timber Creek. The other is much longer in relation with its diameter, and probably belonged to the anterior part of the jaw.

Accompanying the teeth, presented by Mr. Germain, there is a mutilated specimen of a posterior caudal vertebra, the body of which is a little over three inches in length, and is eleven lines in transverse diameter at its middle.

Of other fossils referable to the extinct Gavial of New Jersey, contained in the cabinet of the Academy, there is a coherent mass of much mutilated bone fragments, obtained from the Green-sand, and presented by Daniel Brinton. The fragments are exceedingly friable, and are cemented together by a portion of the Green-sand matrix. One of them consists of a portion of the left maxilla, and possesses the same size and form as the corresponding portion of the jaw of the Vincenttown skull just in advance of the palatine foramen. The outer part of the alveoli is destroyed and all traces of the teeth have disappeared. The best preserved of the fragments consists of the greater part of a fourth or fifth cervical vertebra, represented in Figs. 5, 6, Plate III. It is identical in character with the vertebra from the New Jersey Green-sand, described and figured by Prof. Owen, as indicating a species of Crocodile or Alligator, for which he proposed the name of *Crocodilus basifissus*.[1] The specific term was given in consequence of the cleft condition of the process or hypapophysis beneath the fore part of the vertebral body. The cervical

[1] Journ. Geol. Soc. London, V, 381, pl. x, figs. 1, 2.

vertebræ of the *Gavialis*, or, as we may call it, *Thoracosaurus macrorhynchus*, appear also to have possessed the same discriminating character, as represented by Fig. 22, Plate 59, of the Atlas to Gervais' Paléontologie.

Other fragments adherent to the mass consist of a portion of another cervical vertebra, a much mutilated posterior caudal vertebra corresponding in its proportions with the one above indicated, an uncharacteristic piece of an ulna, and a mutilated upper extremity of a humerus.

A dermal plate and part of another, presented to the Academy by Dr. S. G. Morton, and obtained from the Green-sand of Mount Holly, Burlington Co., N. J., is probably referable to the same species. The specimens are black, dense, and heavy from the infiltration of ferruginous matters. They are deeply foveated on their free surface, and are devoid of any trace of a carina. The more perfect specimen, represented in Fig. 3, Plate II, is nearly oblong square, and measures three and a half by three inches in breadth, and is half an inch in thickness along the middle. Upon these dermal plates I formerly proposed the name of *Thoracosaurus grandis*.[1]

Since writing the preceding, I have received for examination a collection of crocodilian fossils from Prof. Cook, of Rutger's College, New Brunswick, N. J., which are referable to the *Thoracosaurus Neocesariensis*. The fossils were obtained from the Green-sand of Monmouth County, N. J., and are black, dense, and in a good state of preservation. They consist of ten vertebræ, and a fragment of a dermal plate resembling those above described, all apparently from the same individual, which had reached maturity.

Of the vertebræ, one, represented in Fig. 7, Plate III, appears to be the sixth cervical, and has lost its spinous and articular processes. It agrees in size and details with the specimen of a fourth or fifth cervical vertebra above described, and with that described by Prof. Owen as characteristic of the *Crocodilus basifissus*, excepting that its hypapophysis exhibits a mere trace of fission; a condition, however, which indicates its more posterior position in the cervical series.

Two other vertebræ, preserved nearly entire, are the first and third dorsal, of which the latter is represented in Fig. 8, Plate III. The former has lost its hypapophysis, but otherwise both specimens resemble in the details of form the corresponding bones of the Mississippi Alligator.

The remaining specimens consist of the series apparently unbroken, from the eighth dorsal to the second lumbar, inclusive. The eighth and ninth dorsals, Fig. 9, Plate III, have lost all the processes from their vertebral arches, and their bodies are coossified by a huge exostosis. The tenth dorsal, Fig. 10, retains its spinous process, and is five and three-quarter inches high posteriorly. The last pair of dorsals and the two lumbars, of which the first is represented in Fig. 11, have lost their vertebral arches. In form and proportions all the specimens agree with the corresponding bones of the Mississippi Alligator.

Measurements of the specimens are as follows:—

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[1] Proc. Acad. Nat. Sci. Phila. VI, 1852, 35.

	Lines.
Length of sixth cervical vertebra at the lower part of the body	28
Breadth of body anteriorly	25
Height of body anteriorly	23
Height of vertebral canal anteriorly	7
Width of vertebral canal anteriorly	11
Length of body of first dorsal laterally	24
Breadth of body of first dorsal anteriorly	26
Height from lower part of body posteriorly to summit of spinous process	68
Height of vertebral canal anteriorly	7
Width of vertebral canal anteriorly	12
Length of body of third dorsal inferiorly	26
Length of body of third dorsal laterally	24
Length of hypapophysis	9
Width of hypapophysis at middle	10
Height from end of hypapophysis to summit of spinous process	88
Height of body anteriorly	25
Width of body anteriorly	27
Height anteriorly from lower edge of body to summit of spinous process	75
Length of spinous process anteriorly from edge of vertebral canal	43
Height of vertebral canal anteriorly	9
Width of vertebral canal anteriorly	11
Length of transverse process above	24
Length of coossified eighth and ninth dorsal bodies laterally	58
Height of body of eighth dorsal anteriorly	27
Width of body of eighth dorsal anteriorly	25
Height of vertebral canal anteriorly	8
Width of vertebral canal anteriorly	7
Length of body of tenth dorsal inferiorly	30
Length of body of tenth dorsal laterally	29
Height of body anteriorly	26
Width of body anteriorly	27
Height of vertebral canal anteriorly	8
Width of vertebral canal anteriorly	7
Height of spinous process anteriorly	34
Width of spinous process at middle	18
Length of body of eleventh dorsal laterally	28
Length of body of twelfth dorsal laterally	30
Length of bodies of first and second lumbars laterally	32
Height of body of first lumbar anteriorly	24
Width of body of first lumbar anteriorly	29

BOTTOSAURUS.

Bottosaurus Harlani.

Extinct species of Crocodile, Harlan, Journ. Acad. Nat. Sci. Phila. IV, 1824, 15, pl. 1.
Crocodilus Harlani, Meyer, Palæologica, 1832, 108.
Crocodilus macrorhynchus, Harlan, Med. and Phys. Researches, 1835, 369; Trans. Geolog. Soc. Penn. I, 1835, 76; Edinb. New Phil. Journ. XVIII, 1835, 28; Jahrb. f. Miner. 1836, 105.—Giebel, Fauna d. Vorwelt, 1847, 122.
Bottosaurus, Agassiz, Proc. Acad. Nat. Sci. Phila. IV, 1849, 169.
Crocodilus basitruncatus, Owen, Jour. Geol. Soc. Lond. V, 1849, 380; Palæontology, 1860, 277.—Pictet, Traité de Paléont. I, 1853, 482.

In the fourth volume of the Journal of the Academy of Natural Sciences, 1824, Dr. Harlan described the fragment of a lower jaw, obtained from the Green Sand, and presented to the Academy by Samuel Wetherill, of Burlington, N. J. The specimen was referred to an extinct species of Crocodile, which, in 1832, was indicated in the Palæologica of Meyer, as *Crocodilus Harlani.* Subsequently, Dr. Harlan, in his Medical and Physical Researches, published in 1835, named the species *Crocodilus macrorhynchus*, by which name it is generally indicated by systematic writers.

The fragment consists of the greater portion of the right dental bone, and is accompanied by a portion of the corresponding angular bone, apparently from the same jaw. The specimens are black and heavy, and like many other of the Greensand fossils are infiltrated with sulphuret of iron, in consequence of the decomposition of which they are in a less well preserved condition than formerly.

The fragment of the dental bone, represented in Figs. 19, 20, Plate IV, is about fifteen inches in length, and in this extent contains the remains of eleven alveoli, which perhaps comprise the whole number except three or four. It corresponds nearly in form and proportions with the homologous portion of the jaw of the Crocodile or Alligator. The posterior portion of the symphysis is preserved; and reaching quite to it, along the inner side of the bone, is the sutural surface of the splenial. The enlargements of the dental bone for the accommodation of the canine and posterior largest teeth occupy nearly the same relative position as in the Crocodile (*C. palustris*), and are separated as in the latter by a cylindroid portion of the jaw, which in the specimen measures two and a half inches in diameter transversely, and about the same extent of depth. The outer surface of the bone is abundantly supplied with unusually large vasculo-neural foramina. The remains of the alveoli, so far as one can judge in their mutilated condition, appear to indicate a succession of teeth related to one another in size nearly as in the series of the Crocodile or Alligator.

The fragment of the angular bone, represented in Fig. 21, Plate IV, is a portion intermediate to the oval angulo-dental foramina and its posterior prolongation. Its outer surface is vertical, and foveated, and its base or under border is convex, and measures two and a quarter inches in thickness.

Of three teeth which accompanied the fragments above described two are much mutilated, one only having an entire crown. One of the mutilated specimens appears to have occupied the third alveolus, back of the canine, and was comparatively small. The other, represented by Fig. 8, Plate 9 of Dr. Harlan's memoir, apparently occupied the eighth or ninth alveolus back of the canine. It possessed a mammiliform crown, from which the enamel is destroyed, and has a gibbous fang. The third specimen is the penultimate or last tooth, represented in Figs. 11, 12, Plate XVIII, and closely resembles the corresponding teeth of living Crocodiles. The fang was gibbous; and the crown is laterally compressed mammiliform, with its outer and inner surfaces separated by a prominent ridge, and its enamel strongly corrugated. The crown is six lines high, eight lines and a half antero-posteriorly, and six lines transversely.

Upon the fossils above described, Prof. Agassiz infers Harlan's Crocodile to belong to a different genus from any previously known, for which he proposes the name of *Bottosaurus*.[1]

[1] Proc. Acad. Nat. Sci. Phila. IV, 169.

I have not had the opportunity of inspecting other fossil remains which may positively be referred to the *Bottosaurus Harlani.*

Among the fossils from the New Jersey Green Sand, described by Mr. Owen, in the Journal of the Geological Society, Vol. V. p. 380, before mentioned, there was a cervical vertebra of a crocodilian different from that upon which he proposed the name of *Crocodilus basifissus.* This second vertebra, from its having the inferior apophysis of the body, or the hypapophysis, short and flattened, he views as indicating a species, for which he has proposed the name of *Crocodilus basitruncatus.* The vertebra, supposed to characterize the latter, is of a size which relates to that of the individual to which the jaw fragments above described belong, and probably also appertained to Harlan's Crocodile.

Since writing the above there have been presented to the Academy, by Horatio C. Wood, a number of small fragments of the lower jaw of *Bottosaurus Harlani,* from Burlington County, N. J. The specimens, however, present no further characters in relation to the species. Accompanying them there is a tooth, represented in Fig. 14, Plate XVIII, which is a reduced one of the same form as that already described.

I have also recently received for examination, from the Burlington Co. Lyceum of Natural History, several small fragments of a jaw, two teeth, and a large costal rib, probably belonging to the same species.

The fragments of a jaw are uncharacteristic. One of the teeth has a quadrilateral fang two and a half inches in circumference. The crown is quadrate mammiliform, but has lost the greater part of its enamel. The other tooth is represented in Fig. 13, Plate XVIII. It has a compressed cylindrical fang a little less in circumference than the preceding. The crown is compressed mammiliform, strongly rugose, and has its inner and outer faces defined by prominent carina-like ridges. It measures eight and a half lines long, ten lines wide at base, and seven and a half lines from without inwardly.

Undetermined Species of Crocodiles.

Of other remains of Crocodiles, with vertebræ constructed on the same plan as the living representatives of the family, I have seen a number of specimens from the Green-sand of New Jersey apparently indicating several species different from the preceding. Among these is a collection of bones belonging to the same individual, from Timber Creek, Gloucester County, N, J., presented to the Academy by W. P. Foulke. They consist of two cervical, a dorsal, the sacral, and two caudal vertebræ, and portions of both humeri. The vertebræ indicate an adult animal, as the arches are completely united with their respective bodies, and those of the sacrum are firmly coosified. Their comparatively small size renders it improbable that they should belong to either of the species previously indicated.

The bones are black, heavy, and firm, but unfortunately the vertebræ have had most of their processes broken off since their discovery.

The least mutilated of the cervical vertebræ, apparently the sixth, represented in Fig. 12, Plate III, is rather less than two inches in length, independent of the articular convexity of its body. Inferiorly, the latter is divided by a median carina expanding in front into a broad flat space without a distinct hypapophysis, otherwise the specimen presents nothing remarkable by which to characterize it. The other vertebra of the neck, apparently a fourth or fifth, has the inferior carina of the body almost obsolete—commencing in a small tubercle behind, and fading away as it approaches a concavity extending between the parapophyses or inferior transverse processes. The latter are more robust than in the former specimen, and appear to have been conjoined by a ridge-like hypapophysis, though this is too much broken to judge of its true character.

The dorsal vertebra, Fig. 13, Plate III, the fifth of the series, has about the same length as those of the neck, and is nearly as broad anteriorly as it is long. Its hypapophysis is a robust mammillary tubercle, but it is otherwise like the corresponding bone of the common Alligator.

The conjoined bodies of the sacral vertebræ, represented in Fig. 14, Plate III, relate in size with the preceding, and differ in no important point with the homologous parts of the Alligator.

Of the caudal vertebræ, one is the first of the series, distinguished by the double articular convexity of the body, as seen in Fig. 15, Plate III. Unlike that of the Alligator, it is broad and flattened beneath, resembling in this respect more the condition of the bodies of the sacral vertebræ. The second specimen, from near the middle of the tail, is much mutilated. It measures rather more than two inches in length, and appears to have had the same form as in the Alligator.

Of the fragments of humeri, one consists of a portion of the shaft of that of the right side, and measures three inches in circumference; the other is the proximal extremity of the left humerus, and does not differ from the corresponding part in the Alligator. Its head measures rather more than two inches in its greater diameter, and a little more than one inch in its lesser diameter.

Recently Prof. Cook has sent to me for examination a small collection of Crocodile bones belonging to the collection of Rutger's College. The specimens were obtained from near Barnsboro', Gloucester County, N. J., and consist of four vertebræ, the shaft of a femur, and four broken dermal bones, apparently all from the same individual.

The vertebræ have had their arches fully coosified with the bodies, so that they may be considered as having belonged to an animal of mature age. They belonged to a smaller individual than the specimens above described, and perhaps to a different species, for several present some peculiarities of form.

Two of the vertebræ, Figs. 4, 5, Plate II, belonged in the cervical series between the fourth and last, and are probably the fourth and fifth. The bodies measure an inch and three-quarters in length, independent of their posterior convexity, and correspond in general form with those of the Alligator. The hypapophysis of the fourth, Fig. 4, is a thick semicircular ridge extending between and below the level of the parapophyses. In the fifth, Fig. 5, it is a longer, straighter, and less well developed ridge, slightly notched in the middle.

The other two vertebræ are the first and fifth dorsal, and have their body about as long as the cervicals. The first dorsal has lost its hypapophysis, spinous process, and portions of the others, but so far as it is preserved it corresponds in form with that of the Alligator. The fifth dorsal has its body more compressed laterally than in the specimen above described from Timber Creek, and the hypapophysis is absolutely very much more robust than in the latter, though the vertebra is smaller. In the Barnsboro' specimen the anterior articular concavity of the body is quadrilateral, whereas it is broadly cordiform in the Timber Creek specimen. In the former the hypapophysis is excavated in front; in the latter it is plane. These differences in two characteristic vertebræ are, perhaps, sufficient to indicate that they belong to two species.

Comparative measurements of the two vertebræ are as follows:—

	Barnsboro' Sp. Lines.	Timber Creek Sp. Lines.
Length of body inferiorly	20	22
Length of body laterally	20	22
Height of body anteriorly	17	18
Width of body anteriorly	16	22
Thickness of body at middle	12	17
Thickness of hypapophysis	9	6
Breadth of vertebral arch laterally	17	20
Width of vertebral canal	6	7
Height of vertebral canal	7	8

The specimen of the shaft of a femur is three inches and a third in circumference, and resembles the corresponding portion of the same bone in the Alligator.

The dermal bones are square, differ in size, and are coarsely foveated. Two of them form a median elevation without being carinated; the others are flat. One of the more perfect measures two inches by twenty lines; another measures two inches eight lines by two inches.

The museum of the Academy contains two mutilated bodies of posterior dorsal or of lumbar vertebræ, of mature age, from Arneytown, Burlington County, N. J., presented by T. A. Conrad. The specimens, excepting in being devoid of the hypapophysis, agree with the bodies of the dorsals above described, and are like those in the living Alligator.

In the same museum there are the bodies of three vertebræ, which have lost their arches at the sutural attachment, from Jobstown, Burlington County, N. J., presented by Dr. E. Hallowell. One of the specimens, represented in Fig. 6, Plate II, apparently of the fifth cervical vertebræ, is much less convex posteriorly than in the specimens above described, and has its parapophysis wider and much less robust. Its hypapophysis is a small longitudinally cleft tubercle. The body is nineteen lines long, sixteen wide anteriorly, and fifteen high. The remaining specimens are the bodies of two posterior dorsals or lumbars, twenty lines long, and resemble the corresponding bones in the living Alligator. In the same collection, and from the same locality and donor, there is another specimen consisting of the body of a posterior dorsal vertebra with the coosified abutments of its arch remaining. The body agrees in its form and proportions with those just described, and measures twenty-one lines in length.

The body of a posterior cervical vertebra, from the Green-sand of St. George's, Delaware, presented to the Academy by T. A. Conrad, is represented in Fig. 7, Plate II. It belonged to a young animal, and has lost its arch at the sutural conjunction. It measures fifteen lines long, and is provided with very robust parapophyses. The hypapophysis is well developed and associates the latter processes, forming together a large crescentoid ridge, deeply notched at the middle. It probably belongs to the same species as the vertebræ above described from Timber Creek.

The museum of the Academy contains a fragment of a left dental bone with a tooth, of a small Crocodile, or of a young individual of a large one, presented by C. C. Abbott. It was found in Monmouth County, N. J., and is represented in Figs. 22, 23, Plate IV. The specimen resembles in form the corresponding portion of the lower jaw of Harlan's Crocodile, of which it may be part of a quite young individual. The suture for the splenial bone, however, does not reach the symphysis as in the fragment characteristic of *Bottosaurus Harlani*—ceasing about one inch short of it. Besides three alveoli, there are preserved portions of five others, and the third behind the symphysis still retains a tooth. The latter has a compressed, conical crown, with its inner and outer surfaces defined by a prominent carina-like ridge. The surfaces are finely rugose longitudinally, and the carinæ are rugose in a divergent manner. The crown measures five lines in length and width, and a line less from without inwardly.

Another specimen belonging to the cabinet of the Academy, represented in Fig. 8, Plate II, is a fragment of a small Gavial skull from the Green-sand of Burlington County, N. J. In construction it bears a resemblance to the corresponding part of the Vincenttown skull, to which I by no means feel sure it does not belong, though it differs in some important points. The forehead, in the fragment, between the position of the post-frontals is quite flat, while it is decidedly concave in the Vincenttown skull. The frontal is less prolonged to meet the parietal than in the latter. The dividing ridge formed by the parietal between the temporal fossæ is even slightly greater than in the Vincenttown skull, while the distance between the orbits at the anterior broken end of the specimen is only two inches. The upper surface of the parietal and frontal is also more strikingly foveated than in the Vincenttown skull.

Four specimens of teeth, from Blackwoodtown, Camden County, N. J., presented to the Academy by Dr. J. L. Burtt, may probably belong to the same species as the fragment of skull just described. The more perfect are represented in Figs. 7, 8, 9, Plate I. They have the form, curvature, and proportions of the teeth of the living *Gavialis Gangeticus*, and are proportionately narrower than those of *Thoracosaurus Neocesariensis*, and are also more finely striated.

Figs. 22, 23, Plate III, represent the mutilated crowns of two teeth of a crocodilian reptile, supposed to have been obtained from a Green-sand deposit of North Carolina, submitted to my examination by Dr. Isaac Lea. One of the specimens, Fig. 22, is straight and conical, circular in transverse section, with an acute ridge in front and behind which defines the inner and outer surfaces. The latter at base are smooth, and apparently have been so at the apex, which is too much broken to determine the fact positively. The intermediate portion of the surfaces is nearly regularly fluted; the ridges separating the concave grooves extending from the dentinal substance. The base of the crown is excavated. The length of the specimen is fourteen lines and a half; its diameter at base, six lines.

The second specimen, Fig. 23, differs from the former in being somewhat curved, elliptical in transverse section, and in the fluting extending to the bottom of the crown. The apex is worn off, and the specimen in its present state is ten lines and a half long, by six lines and a half in diameter antero-posteriorly near the base.

The two teeth differ from those of *Pliogonodon*, probably also from the Green-sand of North Carolina, in which the crown is proportionately longer, and has its surfaces subdivided into narrow planes and provided with a few interrupted vertical plicæ. They differ also from those of *Polygonodon*, in which the crown of the tooth is long and narrow and its surfaces subdivided into planes without folds or striæ.

Dr. Emmons, in his Report of the North Carolina Geological Survey, page 219, fig. 38, has described and figured a large Crocodilian tooth, obtained from a bed of Miocene marl, at Elizabethtown, Bladen County, N. C. The tooth, together with some bones, Dr. Emmons nevertheless thinks originally belonged to the Green-sand formation beneath. It has a conical crown, and a robust cylindrical fang; is hollow, and moderately curved. The crown is described as circular in transverse section, and without carinæ, or acute ridges separating the inner and outer surfaces, the enamel of which is traversed with "irregular rugose ridges." The specimen is referred to the genus *Polyptychodon*, under the name of *P. rugosus*.

Another tooth, found with the preceding, described and figured in the same chapter, page 220, fig. 39, and referred by Dr. Emmons to the same animal, appears rather to have belonged to *Mosasaurus*.

Fig. 12, Plate VIII, represents a dermal plate, which, together with a small fragment of a jaw, and the mutilated crown of a tooth, were submitted to my examinatiom from the Burlington County Lyceum of Natural History. The dermal plate measures two inches by twenty lines, and is without a carina. The fragment of jaw, much mutilated, is two and a half inches long, straight, and contains the much curved fangs of two teeth. It indicates a small species of Gavial, or perhaps belonged to the young of *Thoracosaurus Neocesariensis*. The isolated crown of a tooth closely resembles that of Fig. 7, Plate I, but is rather more curved.

HYPOSAURUS.

Hyposaurus Rogersii.

Hyposaurus Rogersii, OWEN, Quart. Jour. Geol. Soc. Lond. V, 1849, 380, pl. xi, figs. 7–10.
Holcodus acutidens, GIBBES (in part), Mem. on Mosasaurus, &c., Smithsonian Contrib. II, 1850, 9, pl. iii, fig. 13

Among the fossil vertebræ, from the Green-sand formation of New Jersey, described by Prof. Owen, in the Journal of the Geological Society of London, were two specimens with biconcave bodies, which are referred to a genus of the Crocodilian family under the name of *Hyposaurus Rogersii*. Prof. Owen remarks that "the peculiar and distinctive character of these vertebræ is shown in the large size and especially the great antero-posterior extent of the hypapophysis. Its base occupies the whole extent of the median line of the inferior surface between the prominent borders of the anterior and posterior articular ends of the centrum."

Remains of this genus, on several occasions, have come under my notice, but usually in a much mutilated condition.

A small collection of bone fragments, referable to this animal, were found in the Green-sand, near White Horse, Camden County, N. J., and were presented to the Academy of Natural Sciences by W. Parker Foulke. The specimens are exceedingly friable, and consist of portions of several vertebræ, small fragments of a skull together with portions of the supra-angular bones of the lower jaw, fragments of a humerus, portion of a cervical rib, and the crowns of five teeth, all appertaining to a single individual.

One of the vertebral specimens, of the proportions of those referred by Prof. Owen to *Hyposaurus*, from the anterior part of the dorsal series, consists of the fragment of a body retaining one of the sub-concave articular faces, and the remains of the large lamelliform hypapophysis projecting like a keel from the bone inferiorly.

The best of the vertebral specimens consists of the body of a cervical vertebra with one abutment of the arch remaining. Its articular faces are half oval in outline, with the anterior one more deeply concave than the posterior, which is likewise the case in the other vertebral specimens. The length of the body is about two inches and a half, its depth posteriorly twenty lines, and its width above seventeen lines. Its sides are deeply impressed; its surface next the vertebral canal is nearly plane. The transverse processes are of robust proportions, and those below are united by a stout hypapophysis bounding the fore part of the body beneath. Posterior to the hypapophysis, the under surface of the body forms a deep concavity subdivided by a slight median carina ending in an angular apophysis posteriorly.

The supra-angular bone is quite peculiar, and appears to have largely contributed to the articulation of the lower jaw, though this is not certain, as the condition of the specimen is such that I am not positive whether the articular surface preserved in the fragment actually belongs to the supra-angular. Internally to the articular surface there is a large vertical sutural surface, either adapted to a true articular bone, or unlike the arrangement in any other known Crocodilian, it must have joined the splenial bone as in Turtles. Exterior to and in advance of the articulation of the lower jaw, the supra-angular forms a strong projecting ledge which overhangs the exterior surface of the bone and gradually diminishes over the position of the oval foramen.

The fragments of the humerus mentioned are too much injured to derive any character of importance from them.

Of the five crowns of teeth belonging to the collection the two best preserved are represented in Figs. 16, 17, Plate III. The largest resembles the teeth of the Gavial, being curved conical, nearly circular in transverse section, with prominent acute ridges defining the outer and inner surfaces, which are distinctly fluted. The smaller specimen, and such also is the character of those not represented in the plate, differs from the preceding in being compressed from without inwardly, so that its transverse section exhibits an oval outline, and it is less distinctly fluted.

Recently Dr. W. W. Lamb presented to the Academy of Natural Sciences a collection of bones, referable to a single individual of *Hyposaurus*, from the Green-sand in the vicinity of Blackwoodtown, Camden County, N. J. The specimens are very friable, in consequence of which they have been much mutilated since their discovery. They consist of portions of three cervical, as many dorsal, and five caudal vertebræ, a basilar bone, four crowns of teeth, the greater part of the shaft of a femur and fragments of several other long bones and ribs, an astragalus, two phalanges, and portions of four dermal scales.

In all the vertebral specimens the articular faces of the bodies are slightly concave, the anterior being more deeply depressed than the posterior. The cervical vertebræ, the best preserved of which is represented in Fig. 1, Plate IV, have their body nearly two inches and three-quarters long, with the form and proportions corresponding with those of the specimen previously described. The vertebral arch and canal are like the same parts in the Alligator. The spinous process, partially preserved in one specimen, ascends from a base extending the breadth of the arch and rapidly narrows as it rises.

The dorsal vertebræ belong to the posterior division of the series. The best of the specimens, represented in Figs. 4, 5, Plate IV, has the body about two and a quarter inches long, and of slightly greater depth and less width anteriorly.

The caudal vertebræ, Figs. 8, 9, 10, Plate IV, are short in relation with their depth and breadth. Their body is sub-cuboidal, with the articular ends slightly oblique; and they are provided with strong abutments for the articulation of subvertebral arches or chevron bones. The body of the best preserved specimen, Figs. 9, 10, is about two inches and a quarter long, a trifle over two inches in depth posteriorly, and less than two inches in width in the same position.

The isolated basilar bone has its condyle nearly two inches wide at base, and a little over an inch in depth.

The greater part of the shaft of a femur, Fig. 4, Plate III, is rather more than five inches in circumference at the middle, and is pervaded its entire length by a large medullary cavity.

The astragalus measures two inches and a quarter in its long diameter, twenty lines in its short diameter, and is thirteen lines thick.

A last ungual phalanx is nearly two inches in length.

The dermal plates, of which two are represented in Figs. 11, 12, Plate IV, are without carina or tubercle, gradually thin away towards the margins, and are impressed by a comparatively few large and deep foveæ.

The teeth, which accompanied the bones just described, represented in Figs. 18–21, Plate III, are curved conical, compressed from without inwardly, and have their external and internal surfaces defined by an acute ridge. They are not fluted as in the specimens previously described, and were it not for their association might readily have been supposed to belong to a different animal. They are longitudinally wrinkled, especially near the base of the crown, and more internally than externally.

The teeth described and figured by Dr. R. W. Gibbes, in the second volume of the Smithsonian Contributions to knowledge,[1] supposed to be characteristic of a

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[1] Memoir on Mosasaurus and the allied Genera, p. 9.

reptile allied to *Mosasaurus*, and named *Holcodus acutidens*, in part at least, appear rather to belong to *Hyposaurus*. Of the specimens, which Dr. Gibbes has submitted to my inspection, that from New Jersey, I think, undoubtedly belongs to the last mentioned genus. The other specimen, from the Cretaceous formation of Alabama, though agreeing in its form and proportions with the teeth above described, may, nevertheless have belonged to a *Mosasaurus*.

The collection of the Academy contains a dorsal vertebra, represented in Figs. 6, 7, Plate IV, from the Green-sand of Burlington County, N. J., which has the same form and proportions as the corresponding vertebræ above mentioned, but is smaller. The specimen probably occupied a more anterior position in the series; though it may have belonged to a smaller species of the genus. The cabinet of the Academy also contains the body of a dorsal vertebra, from the Green-sand of New-castle County, Del., which has the same form as the Burlington County specimen, but is the fourth of an inch longer.

Since writing the foregoing I have received for examination a small collection of remains of *Hyposaurus*, belonging to Rutger's College, New Brunswick, N. J. The specimens were sent by Prof. Cook, who informs me that they were obtained from a marl pit, at Tinton Falls, Monmouth County, N. J. The specimens have the same friable character as those previously described, and they appear to have belonged to two different individuals: one quite young, the other of maturer age. Those of the young individual consist of several fragments of the occipitals, a cervical rib resembling those of the Mississippi Alligator, and the body of a posterior dorsal two inches long. Those of the maturer animal consist of a posterior cervical and a fourth dorsal vertebra, the bodies of three posterior dorsals, and the shaft of a femur.

The posterior cervical, represented in Fig. 2, Plate IV, corresponds in size, form, and details of structure with those previously described. The length of its body, which is slightly more concave posteriorly than anteriorly, is three inches, and the length of the specimen between the anterior and posterior articular processes is three inches and three-quarters. The hypapophysis, somewhat mutilated, appears not to have been proportionately better developed than the corresponding processes in the cervical series of the Mississippi Alligator.

The fourth dorsal vertebra, Fig. 3, Plate IV, has lost one-half of its vertebral arch with the spinous process, and the other half of the arch is separable at its suture with the body. The latter is two inches and a quarter in length below and two inches and a half at its junction with the arch. The two ends are nearly equally concave, and between them there extends a broad laminar hypapophysis, as represented in the specimens upon which Prof. Owen proposed the genus, but as in these, unluckily the process is broken so that we are unable to determine its length.

The bodies of the three posterior dorsals are rather over two inches in length, and exhibit the sutures from which the vertebral arches have been detached. They are more concave anteriorly than posteriorly, in this and other characters agreeing closely with those previously described.

The shaft of a femur corresponds closely with that already described both in size and form.

DISCOSAURUS.

Discosaurus vetustus.

Discosaurus vetustus, Leidy, Proc. Acad. Nat. Sci. Phila. 1851, 326.

The remains of a large Saurian, apparently nearly related to the *Plesiosaurus* of Europe, discovered in the American Cretaceous deposits, have occasionally come under my notice. Dr. Harlan has described and figured a vertebra, obtained, together with several others, from Mullica Hill, N. J., which he referred to the *Plesiosaurus*.[1] The specimens, upon which this view was founded, are preserved in the museum of the Academy of Natural Sciences, and prove to belong to a Cetacean, of the Dolphin family. Subsequently Dr. DeKay described and figured a fragment apparently of a cervical vertebra, from the Green-sand of New Jersey, evidently belonging to the Saurian to which I allude, and which he recognized as being allied to *Plesiosaurus*.[2]

The collection of the Academy of Natural Sciences contains a few remains of the Saurian indicated from four different localities, as follow:—

1. The mutilated bodies of two caudal vertebræ, as I suppose them to be, from the Cretaceous deposits of Alabama, presented by Prof. Joseph Jones, of Georgia.

The specimens, represented in Figs. 4, 5, 6, Plate V, have the body in the form of a transverse section of a cylinder, compressed from above downward, with the sides and under part slightly narrowed towards the middle. The articular extremities are transversely elliptical and moderately concave, but have prominently convex borders. They are constricted or defined from the rest of the body by a narrow groove, which gives them the appearance of distinct plates or disks applied to and terminating the body. From this peculiar appearance, the name of *Discosaurus* was proposed for the genus to which the vertebræ belong. At the under part of the body, as seen in Fig. 5, the groove is inflected on each side apparently with the view of producing facets for a chevron bone. It is this apparent adaptation of the parts to the articulation of chevron bones which has led me to consider the vertebræ under consideration as caudals, otherwise from their resemblance to the cervical vertebræ of *Plesiosaurus pachyomus*, as represented by Prof. Owen,[3] I should have viewed them as belonging to the cervical series.

Between the position of the inflections to accommodate the chevron bones, the under part of the body forms a pair of feeble ridges, the intervening surface of which presents on one side a single venous foramen communicating by a branching vertical canal with the spinal canal. The latter, in both specimens under examination, is too much broken to judge of its form, and no other information is to be ascertained from the abutments of the vertebral arch other than that they were completely coosified with the body. The side of the body is produced into a large conical protuberance

[1] Journ. Acad. Nat. Sci. Phila. IV, 1824, 232, pl. xiv, fig. 1; Med. Phys. Res. 1835, 382. See note, page 1, of this Memoir.

[2] An. Lyc. Nat. Hist. New York, III, 1828, 165, pl. iii, fig. 11.

[3] British Fossil Reptiles, Enaliosauria, pl. 28.

excavated to its base into a transversely elliptical costal pit, bounded by a prominent acute border. The pit occupies the middle portion of the body from above downward, and extends two-thirds its length, reaching nearer the anterior than the posterior articular surface.

Measurements, derived from the two specimens which are almost identical in size as well as form, are as follows:—

	Lines.
Length of body between the grooves defining the articular extremities	19
Extreme length of body between the prominent margins of the articular extremities	24
Breadth of articular extremities	31
Height of articular extremities	26
Estimated breadth of spinal canal	6
Transverse diameter of costal pits	14
Vertical diameter of costal pits	11

2. A vertebra, represented in Figs. 10, 11, 12, Plate V, rather larger than the preceding, but nearly identical in form, from the lower Cretaceous of Mississippi, presented to the Academy by Prof. M. Tuomey. In this specimen the articular extremities of the body are nearly flat surfaces, being much less depressed towards the centre and much less prominent towards the periphery than in the Alabama specimens. It differs also from the latter in having the articular surfaces terminating in an acute margin and not defined from the rest of the body by a groove. The body beneath, Fig. 10, presents inflections apparently for the articulation of chevron bones, those posterior being large, while those anterior are but slight. The vertebral arch, partly preserved in the specimen, is coosified with the body. It presents no conspicuous mark of its original separation, and a continuous slope extends from the side of the arch upon that of the body to the upper margin of the costal pit.

The measurements of the specimen are as follows:—

	Lines.
Length of the body at the acute margins of the articular extremities	24
Extreme length of the body at the prominent periphery of the articular extremities	26
Breadth of the articular extremities	36
Height of the articular extremities	29
Diameter of spinal canal	7
Transverse diameter of costal pits	15
Vertical diameter of costal pits	9

3. A much mutilated body of a vertebra from Choctaw Bluff, Clarke Co., Alabama, presented by Prof. M. Tuomey to the Academy. The specimen has the same form as that just described, excepting that its articular faces are more concave and it is considerably larger.

Its measurements are as follows:—

	Lines.
Length of body	31
Breadth of articular extremities	44
Height of articular extremities	34
Width of spinal canal	10
Transverse diameter of costal pits	17
Vertical diameter of costal pits	11

4. Two vertebræ, a carpal and two metacarpal bones and a phalanx, apparently all from the same individual. The specimens were found, with others, in Burlington County, N. J.

Of the vertebræ, the one represented in Figs. 7, 8, 9, Plate V, is almost identical in form and size with the first described specimens from Alabama. The articular surfaces of its body present intermediate characters to those of the Alabama specimens and the one from Mississippi. As previously stated, in the former, the articular surfaces are defined by a narrow groove from the rest of the body, of which an acute edge forms one boundary of the groove and the prominent convex periphery of the articular surface the other. In the Mississippi specimen the corresponding groove is nearly obsolete, so that the articular surfaces appear defined from the rest of the body by an acute edge. In the Jersey specimen the acute edge forms a conspicuous linear ridge, and a feeble groove defines this from the articular surfaces. The latter are less depressed towards the centre, and less prominent at the periphery than in the Alabama specimens, but in both characters are more so than in the Mississippi specimen. In the Jersey specimen the inflections for the apparent accommodation of chevron bones are deeper than in the Alabama specimens, and give the under part of the body at its extremities a remarkably festooned appearance, as represented in Fig. 8. The body inferiorly, between the inflections, in front and behind, does not exhibit the ridges so prominently as in the other specimens, but is otherwise the same.

The measurements of the vertebra are as follows:—

	Lines.
Length of the body in the median line inferiorly between the acute edges	22
Length between the lateral inflections of the latter	14
Length of the body laterally between the acute edges	20
Extreme length of the body between the prominent margins of the articular extremities	24
Breadth of the articular extremities	34
Height of the articular extremities	27
Width of spinal canal	6
Transverse diameter of costal pits	13
Vertical diameter of costal pits	10

The other vertebra, represented in Figs. 1, 2, 3, Plate V, much larger than the former, appears to belong to the back part of the cervical series. The body is a transverse section of a cylinder flattened from above downward and moderately narrowed at the sides and underneath towards the middle. The articular extremities are nearly plane surfaces, transversely elliptical, but emarginate above, and are defined from the rest of the body by a sub-acute border. The general level of the posterior surface is slightly depressed, and its periphery is slightly convex. The anterior surface is a little more depressed, but presents a slight central prominence. The under part of the body is less depressed than the sides, and it presents three large venous foramina. The vertebral arch is coosified with its body on a level with the floor of the spinal canal, which is almost a plane surface. The spinal canal is large and ovoid in outline. A portion of the spinous process, preserved in the specimen, proves it to be a strong, broad plate. It is deeply grooved behind at its root for an elastic ligament. The greater portion of a remaining posterior articular process indicates this to be of small size, and it has its facet directed downward and outward.

The side of the body is extended into a large process excavated to its base into a vertical, ear-shaped, concave, costal pit, bounded by an elevated, acute margin. The vertical diameter of the pit is equal to two-thirds that of the body, and its transverse diameter equal to half the length of the latter. The upper extremity of the pit is formed by a trilateral process projecting outwardly from the root of the vertebral arch, and is separated from the rest of the pit by a deep, crescentoid, transverse fissure, remaining as part of the suture through which the arch is united with the body of the vertebra.

The measurements of this vertebra are as follows:—

	Lines.
Length of the body	31
Breadth of the articular extremities	43
Height of the articular extremities	33
Breadth of costal pits	15
Height of costal pits	27
Breadth of spinal canal	11
Height of spinal canal	12

The carpal bone, represented in Figs. 13, 14, Plate IV, resembles those of *Plesiosaurus.* It is a thick hexahedral tablet, with the broad surfaces concave and rugged. The borders are half the width of the broad surfaces, and present parallel rows of nutritious foramina. The bone measures in its greater breadth thirty lines, in its lesser twenty lines, and its thickness ranges between twelve and sixteen lines.

The metacarpal bones, represented in Figs. 15, 16, 17, likewise resemble those of *Plesiosaurus.* They are quadrilateral columnar bones, with the sides concave longitudinally. The extremities are quadrate in outline, and their surfaces exhibit parallel rows of nutritious foramina.

The phalanx, represented in Fig. 18, also resembles those of *Plesiosaurus.* It is a slightly compressed cylindrical column, expanding from the middle towards both extremities.

The carpal, metacarpal, and phalangeal bones indicate that they were articulated by cartilage, and together with the other bones of the extremity formed a paddle like those of *Plesiosaurus.*

It is not improbable that I may have included, in the account of *Discosaurus vetustus*, the remains of more than one species, but the material at command appeared to me insufficient to justify a separation.

CIMOLIASAURUS.

Cimoliasaurus magnus.

Cimoliasaurus magnus, Leidy, Proc. Acad. Nat. Sci. Phila. 1851, 325; 1854, 72, pl. ii, figs. 4, 5, 6.

Vertebræ differing from any of those described in the preceding pages, and belonging to a huge Saurian, are frequently found in the Green-sand deposits of

New Jersey. The vertebræ have slightly biconcave bodies and are usually well preserved, though all the specimens I have had the opportunity of examining have had their arches and processes broken off, apparently after their discovery. Of such vertebræ thirteen specimens, from Burlington County, N. J., were presented to the Academy of Natural Sciences by Dr. S. G. Morton. They appear to have belonged to the same individual, and consist, as I suppose them to be, of two dorsals and eleven lumbars.

The body of the dorsal vertebræ, Figs. 13–16, Plate V, is the transverse section of a cylinder compressed from above downward and contracted towards the middle, resembling in form the body of the cervical vertebra referred to *Discosaurus.* The articular faces are transversely oval, slightly emarginate above, and are more concave than in the cervical vertebra of *Discosaurus.* They present a central prominence, are bevelled off at the border, and are defined by a subacute edge from the rest of the body. A pair of large venous foramina underneath the latter communicate with channels opening by a single large orifice in the spinal canal, which is depressed towards the middle and wide. The vertebral arch has been coosified with the body, but its loss prevents me from ascertaining anything in regard to its form. In one of the specimens, as represented in Figs. 13, 14, 15, there projects from the middle of the side of the body a short, robust, cylindroid transverse process, terminating in a large irregular facet for the articulation of a rib. In the other vertebra, Fig. 16, probably a more anterior one, the transverse process is broken, but its base indicates it to have been of greater vertical extent than in the former specimen, though not quite so wide, nor does it extend so low, but above appears nearly to have reached the abutment of the vertebral arch.

The size of the two specimens is nearly equal, their measurements being as follows:—

	Lines.
Length of the vertebral body	32–33
Breadth of articular surfaces	52
Height	42
Width of spinal canal at the middle	12
Width of spinal canal at the extremities	15
Breadth between articular facets of transverse processes	72

The eleven lumbar vertebræ, of which the largest and smallest specimens are represented in Figs. 17–19, Plate V, and 16–18, Plate VI, do not form an unbroken series, but the specimens successively diminish in size from nearly that of the dorsals just described, to a size rather less than the supposed caudals of *Discosaurus.* They are nearly identical in form throughout. The more anterior have the body absolutely somewhat longer than in the dorsals, though the other diameters are diminished. The articular extremities are also slightly more dished than in the dorsals, and almost devoid of the central prominence. The venous foramina on the under part of the body are nearer together, and the intervening portion of bone appears pinched into a convex ridge. The more posterior specimens, which may be regarded as caudals, have the articular extremities of their body rather more concave, and underneath they do not form so prominent a ridge between the position of the two venous foramina.

In all the lumbar vertebræ the abutments of the vertebral arch are fully coossified with their body, leaving no well-marked trace of the former sutural connection. The spinal canal is wide, and is depressed at the floor towards the middle, where it exhibits one or two large venous foramina. In all the specimens the transverse processes have been broken off, but in all, their remaining bases are seen projecting from the lower part of the side of the body. They spring from nearly the whole width of the body, with which they were completely coossified, though they present the appearance as if they formerly possessed a sutural attachment. They were evidently robust and strong, and were directed obliquely outward and downward.

The sides of the body of the vertebræ form, together with the sides of the vertebral arch and the upper part of the transverse processes, a nearly uniform slope, broken only by a slight elevation formed by the apparent sutural coossification of the transverse process with the body. The under part of the body between the transverse processes nearly forms a level surface, more or less elevated into a ridge between the venous foramina, and depressed along a line with the position of the latter.

Measurements, derived from the largest and the smallest of the series of eleven lumbars, are as follows:—

	LARGEST. Lines.	SMALLEST. Lines.
Length of body	35	24
Breadth of articular surfaces	44	31
Height of articular surfaces	36	22
Width of spinal canal	10	8

The vertebræ, above described, were briefly noticed a few years ago in the Proceedings of the Academy of Natural Sciences, volume V, page 325, and referred to a Reptile under the name of *Cimoliasaurus magnus.*

Fourteen vertebræ of the same Saurian as the preceding have been submitted to my inspection by Mr. O. R. Willis, through Prof. Cook. They all evidently belonged to the same individual, and were obtained from the Green-sand, near Freehold, Monmouth Co., N. J. Six of the specimens are dorsal, the remainder lumbar vertebræ. Of the former, three appear to have had their transverse processes at the conjunction of the vertebral arch and body; the others had them situated successively lower on the sides of the body.

Two of the more anterior dorsals are represented in Figs. 1, 2, 3, 4, Plate VI. They exhibit a slight want of symmetry, which is the case also with another anterior dorsal, but this character is a deformity, or mere individual peculiarity. The body is a little longer and higher, in relation with the breadth, than in the dorsals above described, and hence presents a more cylindrical form. The articular extremities are moderately dished, and have a somewhat prominent annular margin. They are nearly circular, but notched above, and are sharply defined by a subacute ridge from the rest of the body. The bottom and sides of the latter are narrowed towards the middle or are concave longitudinally, and they present a number of foramina, varying in size, which communicate with venous channels opening into the spinal canal. The broken abutments of the vertebral arch are much broader and stronger, in accordance with their being required to sustain the transverse processes, than in the more posterior dorsals. The spinal canal is large and depressed towards the middle of the floor.

The measurements of one of the anterior dorsals, which are nearly of the same size, are as follows:—

	Lines.
Length of the vertebral body	36
Breadth of articular surfaces	51
Height of articular surfaces	45
Width of spinal canal	12

A more posterior dorsal vertebra, represented in Fig. 5, Plate VI, differs from the preceding in the less length and depth of the body and the slightly greater breadth, but chiefly in the lower position of the transverse process, which extends from the vertebral arch to near the middle of the side of the body. The measurements of this specimen are as follows:—

	Lines.
Length of the vertebral body	33
Breadth of the articular surfaces	54
Height of the articular surfaces	43

The remaining two posterior dorsal vertebræ, represented in Figs. 6–9, Plate VI, appear to be from near the termination of the series. They have the same form of body as the Burlington County specimens of posterior dorsals, above described, with which they also nearly agree in size. The transverse processes are short, robust, irregularly cylindroid protuberances, projecting from the lower part of the side of the body and terminating in an articulating facet for a rib. In the foremost of the two vertebræ, Fig. 7, the facets are sub-circular and irregularly convex; in the other, Fig. 9, they are transversely oval and irregularly concave. On the under surface of the body of the former, Fig. 6, there are two large foramina on each side communicating with venous channels opening into the spinal canal; in the latter, Fig. 8, the under part of the body presents two very large venous foramina, between which the bone forms a convex ridge, not existing in the preceding vertebra.

Measurements of the two posterior dorsal vertebræ are as follows:—

	Lines.	Lines.
Length of the body	33	35
Breadth of the body	56	52
Height of the body		40
Width of spinal canal		11
Vertical diameter of facet for the rib	18	16
Transverse diameter of facet for the rib	18	20

The eight lumbar vertebræ, of which the largest and smallest specimens are represented in Figs. 10–15, Plate VI, form a nearly unbroken series, and followed close after the dorsal specimens just described. They correspond in form and constitution with the Burlington County specimens, except that the median part of their body beneath, between the position of the venous foramina, forms a more prominent ridge.

The measurements of the largest and smallest specimens, or the first and last of the series, are as follows:—

	LARGEST. Lines.	SMALLEST. Lines.
Length of the vertebral body	35	31
Breadth of articular extremities	50	41
Height of articular extremities	39	28
Width of spinal canal	9	8

It is probable that the vertebræ, above described as lumbars, may be regarded in part as representing sacrals and caudals. Both dorsals and lumbars bear some resemblance to the corresponding vertebræ of Cetaceans, except that in these the transverse processes project from the middle of the sides of the body of the lumbars instead of the lower part. The long series of vertebræ of *Cimoliasaurus* consisting of lumbars apparently gradually merging into caudals, perhaps indicate the absence of a true sacrum and posterior extremities, as in Cetaceans.

I cannot avoid the suspicion that the specimens referred to *Cimoliasaurus magnus* do not belong to the same great reptile as those considered as characteristic of *Discosaurus vetustus.* The supposed caudals of the latter I have suspected to be anterior cervicals notwithstanding the apparent provision for the articulation of chevron bones. If all the vertebral specimens be viewed as belonging to one animal, they represent cervicals, dorsals, and lumbars of *Discosaurus*, otherwise they represent a cervical and caudals of the latter, and dorsals and lumbars of *Cimoliasaurus.*

The vertebræ described as caudals of *Discosaurus* have almost the same size and nearly the same form as the smaller lumbars or caudals attributed to *Cimoliasaurus.* A rib of proportionate size, coosified with the costal pit in the former, would give them a striking resemblance to the latter, except that in *Cimoliasaurus* the costal or transverse processes project from the lower part of the sides of the body, whereas in *Discosaurus* the costal pits are situated at the middle of the sides of the body. The vertebræ, however, differ in other important particulars. Besides the absence of the conspicuous inflections (supposed to have been intended to accommodate chevron bones) in the caudals of *Cimoliasaurus* the body beneath is nearly level between the transverse processes, while in *Discosaurus* it is strongly convex in the corresponding position.

No portions of the skull nor specimens of teeth have been discovered which, with any probability, could be referred either to *Discosaurus* or *Cimoliasaurus.*

PIRATOSAURUS.

Piratosaurus plicatus.

I recently received from the Smithsonian Institution, for examination, a small collection of fossils, which, in a note accompanying the specimens, are stated to have been obtained from the drift of Red River Settlement, about fifty miles south of Selkirk Settlement, and are further labelled as from the Red River of the North. The specimens consist of a peculiar Crocodilian tooth, and others agreeing in form with those referred to *Otodus appendiculatus*, *Corax appendiculatus*, and *Ptychodus*

Mortoni, which would indicate the fossils as appertaining to the Cretaceous era. The reptilian tooth, and several of those of the fishes, are partially imbedded in hard iron pyrites.

The Crocodilian tooth, represented in Fig. 8, Plate XIX, presents the ordinary form of the teeth of recent Crocodiles and Alligators, being curved conical. The crown, or enamelled portion of the tooth, worn away at the point, in its present state measures seventeen lines long, and the remaining portion of the somewhat gibbous fang is half an inch long. I can detect no appearance of acute ridges separating the inner and outer faces of the crown, though such may have existed. The enamel towards the apex is smooth, but at rather more than the basal half of the crown it is thrown into well-defined, slightly tortuous, longitudinal folds or ridges, reminding one of the appearance of those in the teeth of *Polyptichodon*. Between the folds the surface exhibits shallow punctures. The diameter of the tooth at the base of the crown is eight lines. The interior of the tooth is hollow as in the teeth of living Crocodiles.

MOSASAURUS.

Saurian animal, resembling the famous fossil reptile of Maestricht, MITCHELL, Observ. Geol. N. America, 1818, 384, 385, pl. viii, fig. 4.

Saurian reptile, resembling the Maestricht Monitor, HARLAN, Journ. Acad. Nat. Sci. 1825, Vol. IV, 235, pl. xiv, figs. 2, 3, 4; Med. and Phys. Researches, 1835, 384.

Mosasaurus, DE KAY, Ann. Lyc. Nat. Hist, 1828–36, Vol. III, 135, pl. iii, figs. 1, 2.—MORTON, Am. Jour. Sci. 1830, Vol. XVIII, 246; Synop. Org. Rem. 1834, 27, pl. xi, figs. 7, 9.—HARLAN, Trans. Geol. Soc. 1835, 81; Med. and Phys. Res. 1835, 285.—EMMONS, North Carolina Geol. Survey, 1858, 217.

Geosaurus Mitchelli, DE KAY, An. Lyc. Nat. Hist. 1828–36, Vol. III, 138; Zool. New York, 1842, Part III, 28, pl. 22, figs. 55, 56.—HARLAN, Trans. Geol. Soc. 1835, 82; Med. and Phys. Res. 1835, 285; Edinb. Phil. Journ. 1834, Vol. XVIII, 32.—PICTET, Paléontologie, 1853, Vol. I, 506.

Geosaurus, MORTON, Am. Jour. Sci. 1830, Vol. XVIII, 246; Syn. Org. Rem. 1834, 28.

Ichthyosaurus missouriensis, HARLAN, Trans. Am. Phil. Soc. 1834, Vol. IV, 405, pl. xx, figs. 3–8; Trans. Geol. Soc. 1835, 80; Med. and Phys. Res. 1835, 284, 348, figs. 1–6.

Mosasaurus Dekayi, BRONN, Lethæa Geog. 1838, Vol. II, 760.—GIBBES, Mem. on Mosasaurus; Smithsonian Contributions, 1851, Vol. II, 8, pl. i, figs. 2, 6.

Batrachiosaurus, HARLAN, Lond. and Edinb. Philos. Mag. 1839, Vol. XIX, 302.

Batrachiotherium, HARLAN, Bul. Soc. Geol. 1839, Vol. X, 90.

Mosasaurus major, DE KAY, Zool. New York, 1842, Pt. III, 28, pl. 22, figs. 57, 58.

Mosasaurus occidentalis, MORTON, Proc. Acad. Nat. Sci. 1844, 133.

Batrachiosaurus missouriensis, MEYER, Jahrb. Min. 1845, 312.

Mosasaurus neovidii, MEYER, Jahrb. Min. 1845, 312.

Mosasaurus Maximiliani, GOLDFUSS, Nov. Act. Acad. K. L. C. Nat. Cur. 1845, Vol. XXI, 179, pl. vi, vii, viii, ix, figs. 1–3.—MEYER, Jahrb. Min. 1845, 312; 1847, 122.—OWEN, Jour. Geol. Soc. Lond. 1849, Vol. V, 382, pl. x, fig. 5.—GIBBES, Mem. on Mosasaurus; Smithsonian Contributions, 1851, Vol. II, 6, pl. I, fig. 7.—PICTET, Paléontologie, 1853, Vol. I, 505.—EMMONS, North Carolina Geol. Surv. 1858, 217, figs. 36*a*, 37.

Mosasaurus Camperi, PICTET, in part, Paléontologie, 1845, Vol. II, 64.

Mosasaurus Hofmanni, PICTET, in part, ibidem.

Atlantochelys Mortoni, AGASSIZ, Proc. Acad. Nat. Sci. 1849, 169.

Mosasaurus minor, GIBBES, Mem. on Mos.; Smithsonian Contributions, 1851, Vol. II, 7, pl. i, figs. 3, 4, 5.

Mosasaurus Couperi, GIBBES, ibidem, pl. ii, figs. 4, 5.

Mosasaurus carolinensis, GIBBES, ibidem, 8, pl. ii, figs. 1, 2, 3.

Holcodus acutidens, GIBBES, in part, ibidem, 9, pl. iii, figs. 6–9.

? *Amphorosteus Brumbyi*, GIBBES, ibidem.

Mosasaurus Mitchelli, LEIDY, Proc. Acad. Nat. Sci. 1859, 92.

Mosasaurus missouriensis, LEIDY, ibidem, 1857, 90; 1859, 92.

Elliptonodon compressus, EMMONS, North Carolina Geol. Surv. 1858, 222, figs. 41, 42.

Drepanodon impar, LEIDY, Proc. Acad. Nat. Sci. 1856, 255.—EMMONS, North Carol. Geol. Surv., 1858, 224, figs. 45, 46.

Lesticodus impar, LEIDY, Proc. Amer. Philos. Soc. 1859, VII, 10.

Nearly a century has elapsed since the discovery, in the Cretaceous deposits of Europe, of the aquatic Reptile, the *Mosasaurus*, or Lizard of the Meuse, but even at the present time our knowledge of the skeleton is incomplete. The most important of the remains found in Europe consists of the greater part of an enormous skull, including the jaws, together with the teeth, obtained from the quarries of St. Peter's Mount, near Maestricht. The specimen, to which an unusual degree of historic value is attached, is commonly known as the head of the Maestricht Monitor, and is now preserved in the museum of the Jardin des Plantes, Paris. It has been the subject of representation and description by Buchoz,[2] Faujas-Saint-Fond,[3] Cuvier,[4] Buckland,[5] Gervais,[6] Pictet,[7] Bronn,[8] and others. Series of vertebræ of the *Mosasaurus*, comprising most of those from different parts of the column, found in association with the head just mentioned, have also been described by Cuvier.[9]

In the United States remains of the genus *Mosasaurus*, usually consisting of isolated teeth, small fragments of jaws, and mutilated vertebræ, have been frequently discovered in deposits of the Cretaceous period, and have been indicated

[1] M. Faujas-Saint-Fond, in his Natural History of St. Peter's Mount, gives the following account of the discovery and subsequent destination of the fossil: "In one of the galleries or subterraneous quarries of St. Peter's Mount at Maestricht, at the distance of about five hundred paces from the principal entrance, and at ninety feet below the surface, the quarrymen exposed part of a skull of a large animal imbedded in the stone. They stopped their labors to give notice to Dr. Hoffman, a surgeon at Maestricht, who had for some years been collecting fossils from the quarries, and who had liberally remunerated the laborers for them. Dr. Hoffman, observing the specimen to be the most important that had yet been discovered, took every precaution to secure it entire. After having succeeded in removing a large block of stone containing it, and reducing the mass to a proper condition, it was transported to his home in triumph. But this great prize in natural history, which had given Dr. Hoffman so much pleasure, now became the source of chagrin. A canon of Maestricht, who owned the ground beneath which was the quarry whence the skull was obtained, when the fame of the specimen reached him, laid claim to it under certain feudal rights and applied to law for its recovery. Dr. Hoffman resisted, and the matter becoming serious, the chapter of canons came to the support of their reverend brother, and Dr. Hoffman not only lost the specimen but was obliged to pay the costs of the law-suit. The canon, leaving all feeling of remorse to the judges for their iniquitous decision, became the happy and contented possessor of this unique example of its kind."

M. Faujas-Saint-Fond continues, "Justice, though slow, arrives at last. The specimen was destined again to change its place and possessor. In 1795 the troops of the French Republic, having repulsed the Austrians, laid siege to Maestricht and bombarded Fort St. Peter. The country house of the canon, in which the skull was kept, was near the fort, and the general being informed of the circumstance gave orders that the artillerists should avoid that house. The canon, suspecting the object of this attention, had the skull removed and concealed in a place of safety in the city. After the French took possession of the latter, Freicine, the representative of the people, promised a reward of six hundred bottles of wine for its discovery. The promise had its effect, for the next day a dozen grenadiers brought the specimen in triumph to the house of the representative, and it was subsequently conveyed to the museum of Paris."

[2] Dons de la Nature, Tab. 68.

[3] Histoire Naturelle de la Montagne de St. Pierre de Maestricht, Pl. IV.

[4] Ossemens Fossiles, Ed. 4, Atlas T. 2, Pl. 246, Fig. 1.

[5] Bridgewater Treatise, Pl. 20.

[6] Zoologie et Paléontologie Françaises, T. III, Pl. 60, Figs. 3–5.

[7] Traité de Paléontologie, Atlas, Pl. XXVI, Fig. 3.

[8] Lethæa Geognostica.

[9] Ossemens Fossiles, Ed. 4, T. 10, p. 151.

or described by Mitchell,[1] De Kay,[2] Harlan,[3] Morton,[4] Gibbes,[5] and Emmons.[6] The

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[1] Observations on the Geology of North America, by Samuel L. Mitchell, published in the American edition of the Essay on the Theory of the Earth, by Cuvier, New York, 1818. Prof. Mitchell was the first to indicate the existence of remains of *Mosasaurus* in the United States. In Plate VIII, Fig. 4, he represents the tooth of a *Mosasaurus* from the foot of Neversink Hills, New Jersey, and refers to it, p. 384, as resembling the teeth of the famous fossil reptile of Maestricht.

[2] Annals Lyceum Nat. Hist. New York, Vol. III, p. 135, Pl. III, Figs. 1, 2. Dr. De Kay, besides describing and figuring a tooth, from Monmouth County, New Jersey, which he refers to *Mosasaurus*, also gives a description and representation of a tooth, p. 138, Pl. III, Figs. 3, 4, which he refers to *Geosaurus*, but which I am inclined to suspect also belongs to the former genus.

[3] Journal Acad. Nat. Sciences, Philadelphia, Vol. IV, p. 235, Pl. XIV, Figs. 2–4. Dr. Harlan represents a tooth from the vicinity of Woodbury, New Jersey, which he says resembles in every respect the teeth of the Maestricht Monitor. In his Med. and Phys. Researches, p. 285, he refers the same specimen to the genus *Mosasaurus*.

[4] Synopsis of Organic Remains, p. 27, 28, Pl. XI, Figs. 7, 9, 10. In this work Dr. Morton simply refers to and reproduces the specimens described by Drs. De Kay and Harlan. In the Proc. Acad. Nat. Sci. Philadelphia, Vol. II, p. 132, Dr. Morton refers to a collection of remains of *Mosasaurus* from New Jersey, forming part of the material of the above memoir. From differences observed in comparison with the European *Mosasaurus*, the author refers them to a distinct species under the name of *M. occidentalis*.

[5] Memoir on Mosasaurus and the allied Genera. By Robert W. Gibbes, M. D. Smithsonian Contributions, Vol. II. The author indicates, describes, and figures a number of specimens, which he refers to several distinct species of *Mosasaurus*. Most of the specimens were found in the Cretaceous deposits, or are readily referred thereto, but several he mentions as having been derived from the Eocene formations of Ashley R., S. C., and Wilmington, N. C., but neither describes nor figures them. I have as yet seen no trace of *Mosasaurus* remains from any of the Tertiary deposits of the United States.

A small vertebra, with an attached portion of another, from the Cretaceous formation of Alabama, together with fragments of two small teeth, from unknown localities of Alabama and Georgia, represented in Pl. I, Figs. 3, 4, 5, are referred by Dr. Gibbes to a species with the name of *Mosasaurus minor*.

Two specimens, the summits of large teeth, represented in Pl. II, Figs. 4, 5, from the Cretaceous formation of the Chattahoochie R., Georgia, are referred to a species under the name of *Mosasaurus Couperi*.

An uncharacteristic fragment of a large jaw, represented in Pl. II, Figs. 1, 2, 3, is referred to a species with the name of *Mosasaurus carolinensis*. The specimen is stated to have been found in association with Cetacean remains in the Pliocene deposit overlying the Cretaceous formation in the vicinity of Darlington, S. C. As observed by the author, "it was most probably derived from the atter formation;" and he adds, "its appearance and the mineralization of its structure render it probable that it came originally from the Cretaceous." The same explanation, I am inclined to believe, would apply to the vertebra which Dr. Gibbes mentions as having been found in the Eocene deposit of Wilmington, N. C.

The allied genera of the memoir are named *Holcodus*, *Conosaurus*, and *Amphorosteus*. The tooth, represented in Pl. III, Fig. 13, from the Cretaceous formation of New Jersey, referred to *Holcodus*, belongs to the Crocodilian *Hyposaurus*. The tooth, represented in Figs. 6–9, from the Cretaceous of Alabama, also referred to *Holcodus*, I suspect belongs to *Mosasaurus*. The teeth, represented in Pl. III, Figs. 1–5, from the Eocene deposit of the Ashley R., S. C., referred to *Conosaurus*, I have proved, through microscopic examination of the structure, to belong to a fish. The vertebræ, represented in Pl. III, Figs. 10–16, from the Cretaceous deposit of Alabama, referred to *Amphorosteus*, may probably prove to be different from those of *Mosasaurus*, but at present I consider the matter doubtful.

[6] Report of the North Carolina Geological Survey, by E. Emmons, p. 217, Figs. 36*a*, 37. The

most important remains, comprising the greater part of a skeleton, consisting of a nearly entire skull and eighty-seven vertebræ, were found, by Major O'Fallon, on the Upper Missouri, in the vicinity of Big Bend, and were presented by him to Maximilian, Prince of Wied, who was then travelling in America. Conveyed to Europe, the remains were presented by the Prince to the Museum of the Academy of Naturalists of Bonn, and were described in the Transactions of the Academy by Dr. August Goldfuss.[1]

Cuvier views the skull of the great Maestricht *Mosasaurus* as intermediate in anatomical characters to that of the existing *Monitor* and *Iguana*.[2] The length of the lower jaw he gives as three feet nine inches,[3] and estimates the skull to have been nearly four feet.[4] On each side of the lower jaw there are fourteen teeth;[5] to the upper maxillary bone eleven teeth, and as it is estimated that there may have been three additional teeth to each side of the inter-maxillary bone, the number would be the same in the upper as in the lower jaw.[6] The pterygoids, as in the *Iguana*, also possess teeth, of which Cuvier states there were eight to each bone.[7]

The skull of the Missouri *Mosasaurus* is about half the length of that of the Maestricht *Mosasaurus*, but Dr. Goldfuss assumes too much when he says the complete ossification of all parts, as well as the frequently perceptible solidification of the teeth, prove that the individual had reached maturity,[8] for the skull and teeth of Saurians exhibit the same characters of ossification and development from youth to extreme age. As remarked by Owen, "the characters of immaturity are not manifested by the cold-blooded animals in their osseous and dental systems as they are in the warm-blooded and higher organized mammalia."[9]

In the jaws of the Missouri *Mosasaurus* there are the remains of eleven teeth above and below, and supposing three more to have existed in the anterior extremities of the jaws, which were lost, the number would be equal to that of the Maestricht *Mosasaurus*. The pterygoid bones, according to Dr. Goldfuss, are each occupied with the remains of ten teeth, being two more than the number mentioned by Cuvier as existing in the Maestricht skull.

The vertebræ of *Mosasaurus* have their bodies concave in front and convex behind. Cuvier[10] estimates the number to have been about one hundred and thirty-three. These he divides as follows: The atlas and axis; eleven vertebræ of the neck and thorax distinguished by the presence of an inferior apophysis or hypapophysis together with articular and transverse processes; five similar vertebræ without the

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vertebra, represented in Fig. 34*a*, referred to *Macrosaurus*, the tooth, represented in Fig. 39, referred to *Polyptychodon rugosus*, and that represented in Figs. 45, 46, which I referred to a reptile of unknown relation with the name of *Drepanodon impar*, I also suspect to belong to *Mosasaurus*.

1 Schädelbau des Mosasaurus. Nov. Act. Acad. C. L. C. Nat. Cur., Vol. XXI, p. 173.

2 Ossem. Foss., Ed. 4, T. 10, p. 150. 3 Ibid., p. 168. 4 Ibid., p. 151.

5 Ibid., p. 139. 6 Ibid., p. 143. 7 Ibid., p. 148.

8 "Die vollständige Verknöcherung aller Theile, so wie die häufig bemerkbare Ausfüllung der Zähne beweisen, dass das Individuum seine vollständige Ausbildung erreicht hatte." Schädelbau des Mosasaurus, Nov. Act. Acad. C. L. C. Nat. Cur., Vol. XXI, p. 177.

9 British Fossil Reptiles, p. 187. 10 Ossem. Foss., T. 10, p. 165.

hypapophysis; thirty-eight without articular processes, but retaining transverse processes; twenty-six having the latter, and in addition, facets for chevron bones; forty-four without transverse processes, and possessing coossified chevron bones; and seven devoid of processes.

Goldfuss[1] estimates the number of vertebræ at about one hundred and fifty-seven, which he divides as follows: atlas and axis; thirteen vertebræ with a hypapophysis; twenty-six with transverse and articular processes, but no hypapophysis; thirty with transverse, but no articular processes; thirty as in the latter, but in addition, possessing chevron bones; forty-four without transverse processes, but having chevron bones; and twelve without processes.

The ribs articulated by their head alone with the ends of the transverse processes.

The most remarkable character in the anatomy of the vertebral column of the *Mosasaurus*, is the coossification, in the hinder part of the tail, of the chevron bones with the bodies of the vertebræ, a condition previously known only as a peculiarity of Fishes. The superior and inferior vertebral arches, in association with their long spinous processes, and the absence of transverse processes, indicate the tail of *Mosasaurus* to have presented the laterally compressed appearance and great vertical depth seen in many Fishes.

Another remarkable character is the absence, or rather the rudimental state, of the articular processes from about the middle of the vertebral series posteriorly, a condition likewise observed in Cetaceans.

The characters just given indicate *Mosasaurus* to have been eminently aquatic in habit. The tail possessed great freedom of movement in a lateral direction as in Fishes. The absence of articular processes in the posterior half of the vertebral series leads to the suspicion that no vertebræ were coossified so as to constitute a sacrum. Perhaps, also, there were no hinder extremities, though these may have existed, without the presence of a sacrum, adapted to swimming, as in *Plesiosaurus*, with which *Mosasaurus* exhibits other important points of resemblance, as will be seen hereafter.

Most of the remains of *Mosasaurus* which I have had the opportunity of examining have been derived from the Cretaceous Green-sand deposits of New Jersey, in which they are frequently found by those engaged in digging the Green-sand, or Marl as it is commonly called, for agricultural purposes. With the exception of a number of well-preserved teeth, the fossils have usually been submitted to me in such a fragmentary condition that they have served little else than to indicate the genus or family to which they belonged. I have seen no considerable portion of a skull, though I have met with small fragments of many skulls. Vertebræ, though common, are usually deprived of all their processes. Bones of the extremities are almost unknown.

The fossil remains of *Mosasaurus*, from New Jersey, are usually jet black, or iron-gray, more or less brittle, and impregnated with sulphuret of iron. Not unfrequently the pulp cavities of teeth and hollows of bones are occupied by solid accumulations of the latter substance. The decomposition of the sulphuret of iron,

[1] Schädelbau, etc., Nov. Act. Acad., Vol. XXI, p. 194.

after the fossils are exposed to the air, renders them very liable to crack to pieces. Rarely I have seen remains of *Mosasaurus*, from New Jersey, of an ochre color and chalky consistence. Sometimes the fossils, but especially the teeth, are remarkably well preserved, and of very firm texture. Usually the enamel of the teeth is jet black and shining; occasionally gray, with brownish stains.

Besides the New Jersey specimens, I have seen a few others from the Cretaceous formations of the Upper Missouri, collected by Dr. F. V. Hayden, several from a deposit, of the same age, near Columbus, Mississippi, obtained by Dr. William Spillman, and one from near Marion, Alabama.

I have been unable to satisfy myself whether the specimens from the Upper Missouri, described by Dr. Goldfuss, and those submitted to my examination by Dr. Hayden, belong to the same species as the remains of the New Jersey *Mosasaurus*.

The specimens sent to me for inspection by Dr. Spillman consist of a basi-occipital bone, a tympanic bone, the greater portion of a pterygoid bone with teeth, a humerus, several vertebræ, and a few fragments of others. These were imbedded in a greenish sandstone, and apparently all belonged to the same individual, which I think was a different species, if not another genus, from the New Jersey *Mosasaurus*.

The museum of the Academy of Natural Sciences of Philadelphia contains thirty-two specimens of vertebræ of *Mosasaurus* from the Green-sand of New Jersey. They are chiefly from Burlington and Monmouth Counties, and were presented to the Academy by Mr. J. P. Wetherill, Dr. S. G. Morton, Dr. Charles T. Budd, Mr. T. Conrad, Dr. J. H. Slack, and Mr. L. T. Germain. The specimens belonged to a dozen or more individuals of different ages and sizes. All are much mutilated; one only retaining the vertebral arch. They consist of the following:—

1. A large cervical or anterior dorsal vertebra, represented in Fig. 1, Plate VII, from Monmouth County, N. J. The body measures three inches and a half from the bottom of the anterior concavity to the summit of the posterior convexity. The latter is sub-rotund, nearly as wide as high, measuring about two inches and two lines in diameter. The breadth of the specimen is six inches between the ends of the transverse processes, which are robust, conoidal, and project from the fore part of the body and abutment of the vertebral arch, obliquely backward, outward, and slightly downward. The spinal canal is obcordate, and about fourteen lines high and wide. The hypapophysis springs from a broad carina-like base, and is directed obliquely downward and backward. It is cylindrical, sixteen lines in transverse diameter, and truncated at the extremity, which is depressed at the centre into a conical pit.

2. A mutilated body of a cervical or anterior dorsal vertebra, from Burlington County, N. J. The body is two inches and a half long. Its posterior convexity is sub-circular, truncated above, and measures twenty lines wide and nineteen high. The hypapophysis is cylindrical, directed downward and slightly backward, and measures nine lines in transverse diameter.

3. Two bodies of cervical or anterior dorsal vertebræ, one of which is represented in Figs. 2, 3, Plate VII. The body is two inches and five lines long, but broader in relation with its height than in the preceding. The posterior convexity is reniform in outline, two inches wide and seventeen lines high. The cylindrical

hypapophysis, ten lines in diameter, projects from the middle of the body directly downward.

4. The body of a dorsal vertebra, not possessing a hypapophysis. Length three inches and a quarter; posterior convexity reniform in outline, thirty-one lines wide and twenty-one high. The remaining roots of the robust transverse processes spring from the body at its conjunction with the vertebral arch.

5. A series of three dorsal bodies, without hypapophysis, and measuring two inches and a half long. The roots of the transverse processes are situated at the middle of the sides of the body. The posterior convexity is reniform, thirty-two lines wide and twenty-three high.

6. A dorsal body with robust, conoidal transverse processes projecting from the forepart outward and backward. Length of body thirty lines; posterior convexity thirty lines wide, twenty-two high.

7. The body of a much mutilated dorsal vertebra, with the same form as the latter but larger.

8. Two bodies of lumbar vertebræ, with the remains of long, flattened transverse processes projecting outward and downward from the lower part of their sides. The posterior convexity is widest at its lower third, and narrows to the emarginate border of the spinal canal. Length of body in one specimen twenty-six lines, in the other twenty-three; greatest width of posterior convexity in both specimens thirty-one lines, height twenty-four lines. This form of vertebra is represented by Fig. 4, Plate 247, of the fourth edition of Cuvier's Ossemens Fossiles. The larger of the two specimens is represented in Figs. 9, 10, 11, Plate VII.

9. Five very much mutilated specimens of the same character as the preceding, but larger. From two different individuals and localities. The largest specimen is thirty-two lines long; the smallest twenty-six lines.

10. Five small vertebræ of the same form as the preceding, from several individuals and localities. The largest specimen is twenty-one lines long; the smallest eighteen lines. Two are represented in Figs. 12, 13, 14, Plate VII.

11. Four large caudal vertebræ with the same form of body, and with roots of transverse processes having the same form and position as in the preceding. In addition, roots of chevron bones project from the posterior inferior part of the bodies. The most perfect of the specimens has the length, width, and height equal, being thirty-nine lines in these different directions.

12. Two caudal bodies with lateral tubercles or mere rudiments of transverse processes; otherwise having the same form as the preceding, but smaller, their length being twenty-seven lines.

13. Three much mutilated caudals, relatively narrower than the former. The largest is twenty-eight lines long; the smallest twenty-four lines.

14. The body of a caudal vertebra, fourteen lines long.

Since writing the foregoing I have received, for examination, from Prof. Cook the following specimens:—

1. A dorsal vertebra, from Freehold, Monmouth County, N. J., loaned by Dr. C. Thompson. The specimen corresponds in form with a rather larger one previously described, and is represented in Fig. 8, Plate VII. It also bears considerable re-

semblance, both in form and size, with one of the specimens figured by Dr. Gibbes as characteristic of his *Amphorosteus Brumbyi.*[1]

2. The bodies of two large cervicals or anterior dorsals. The specimens, together with small fragments of a huge skull, were found in the first bed of Green-sand at Holmdale, Monmouth County, N. J. They are too much mutilated for detailed description, but are interesting on account of their size, as they measure a trifle over four inches in length. From their under part projects a robust, cylindroid hypapophysis, which, in both specimens, is broken at the extremity.

3. A specimen consisting of a pair of large posterior dorsals or lumbars, and part of a third with the bodies coossified by means of an irregular exostosis surrounding the articular surfaces. It belongs to Rutger's College, and though its locality is unknown, it is supposed by Prof. Cook to have been derived from the deepest layer of the Green-sand of Monmouth County, N. J. The anterior pair of vertebral bodies together measure seven inches in length; the anterior concave surface of the first body is about four inches in diameter, and the vertebral canal, retained entire, is transversely elliptical, and measures eleven lines wide and eight lines high.

From Nebraska Territory, the museum of the Academy of Natural Sciences has received a collection of remains of *Mosasaurus*, consisting chiefly of vertebræ, which were discovered by Dr. F. V. Hayden. The specimens are as follows:—

1. Several fragments of weather-worn rock, originally from the same mass, containing a series of sixteen caudal vertebræ, two others of small size detached from the series, and several bones of the extremities. The specimens were obtained on the Yellowstone River, and the bones all appear to have belonged to the same individual. The rock in which the fossils are imbedded bears some resemblance to that described by Dr. Goldfuss, as containing the *Mosasaurus* skeleton from the vicinity of the Big Bend of the Missouri River. It is a very hard, brittle, argillaceous limestone, amorphous, and of a dark, dull leaden hue. On the surface it has become softened, by the action of the weather, into a yellowish-gray material. The rock adheres so tenaciously to the equally brittle bones that they have been seriously injured in the attempt to expose them. The vertebræ, several of which are represented in Figs. 15, 16, Plate VII, present the anatomical characters ascribed to the posterior caudals of *Mosasaurus* by Cuvier, Goldfuss, and others. All had coossified chevron bones; and the anterior of the series have rudimental transverse processes, which entirely disappear in the more posterior ones. The body of the first of the series measures nineteen lines in length and twenty-three lines in height and width; that of the last is fourteen lines in length and twenty lines in height and width. The better preserved of the detached caudals, represented in Fig. 16, Plate VII, has its body only nine lines in length.

2. Two bodies of posterior caudals, well preserved, from Cheyenne River. They had coossified chevron bones and no trace of transverse processes. They measure fourteen lines in length, eighteen high, and nineteen wide. One of the specimens is represented in Figs. 17, 18, Plate VII.

3. Two caudal bodies, of the same form as the preceding, but rather larger, from

[1] Mem. on Mosasaurus, Plate III, Figs. 14, 15, 16.

Little Moreau River, near Fort Pierre. The length of the more perfect is fifteen lines, the height twenty lines, and the width twenty-one lines.

4. A caudal body and a posterior dorsal body, from the forks of Cheyenne River. The former possesses rudimental transverse processes projecting from the middle of the sides, and measures eighteen lines in length, twenty-one in height, and twenty in width. The latter belonged to a very small species, comparatively, or to a very young individual of the larger species, but presents no indication of sutural attachment of parts. It measures fifteen lines in length, sixteen lines high, and nineteen lines wide.

5. A mutilated posterior dorsal body, and a mutilated anterior caudal body, from Little Moreau River, near Fort Pierre. The former had robust, transverse processes projecting from the middle of the sides of the body anteriorly. Its length is thirty-six lines, the height of its posterior convexity thirty-four lines, and its width thirty-three lines. The caudal had no chevron bones, but strong transverse processes projecting from the lower part of the sides of the body. The articular extremities in outline are triangular with strongly rounded angles. The length of the body is twenty-eight lines, the height of the posterior convexity about twenty-six lines, and the width below twenty-nine lines.

The vertebræ of *Mosasaurus*, previously mentioned as having been received from Dr. Spillman, who discovered them near Columbus, Mississippi, consist of two cervicals and the fragment of a dorsal.

The cervical vertebræ, represented in Figs. 4, 5, 6, Plate VII, have their body twenty-nine lines long, with a transversely oval posterior convexity twenty lines wide and sixteen lines high. The spinous process, long, strong, and laterally flattened, measures about two and a half inches along its anterior border. The spinal canal is about seven lines high and six lines wide. The transverse processes are of robust proportions and remarkable form. Springing from the conjunction of the vertebral arch and body, they form a rectangular protuberance, at first descending upon the side of the latter and then turning forward at a right angle to its anterior border. Their upper extremity is thick; and they narrow in their descent and anterior extension. Their free extremity presents an L shaped articular surface for a cervical rib. The hypapophysis is a strong process projecting downward from the back portion of the under side of the body; springing from a carina-like base it ends in an ovoid, truncated extremity, as seen in Fig. 4, Plate VII.

The fragment of a dorsal vertebra, represented in Fig. 7, Plate VII, has the body thirty lines in length, and in its details resembles the cervicals just described, except that its hypapophysis is a mere rudiment, indicating the position of the vertebra to be the next succeeding those anterior dorsals which possess a more distinctly developed process of the same character.

All the vertebræ which I have described or indicated, and indeed all the specimens I have seen, are apparently complete in their development, that is to say, none of them exhibit marks of original separation of the composite elements. The union of these in reptiles, especially the complete coossification of the vertebral arch and body, indicates maturity in the skeleton. Never having seen Mosasauroid vertebræ exhibiting certain signs of immaturity I have associated this negative evidence with the ichthyc character of the tail, and suspected that perhaps as in fishes, the vertebræ of *Mosasaurus* were developed from single centres of ossification. If such were the case, mere differences in size of corresponding vertebræ would not be sufficient to determine a difference of species.

From Prof. George H. Cook, of Rutger's College, New Brunswick, N. J., I have recently received, for examination, a number of remains of the *Mosasaurus*, from the Green-sand of Monmouth County, N. J. Among them is a collection, consisting of a multitude of small fragments of a skull, from the Marl digging on the farm of Isaac Smock, of Holmdale. The best preserved of the fragments consist of the greater part of both quadrate or tympanic bones, and the anterior extremity of the face or muzzle. The tympanic bones agree in form with the corresponding parts of those of the Maestricht skull preserved in the Paris museum. They measure about six inches in height, so that they are somewhat smaller than in the latter specimen.

The anterior extremity of the face, represented in Fig. 6, Plate XIX, consists of the forepart of the right maxillary bone, and nearly the entire intermaxillary bone. The end of the snout, as formed by the latter, is a demi-cone, with the flat surface comprising the forepart of the mouth. The height, breadth, and length of the demi-cone are nearly equal, being about three inches. The intermaxillary bone is prolonged upward and backward, and ends in a narrow process contributing to the partition of the anterior nares. It contains on each side of the palatine surface the fangs of two teeth, together with cavities for successors. It would thus appear that the number of intermaxillary teeth in *Mosasaurus* is one less on each side than supposed by Cuvier, though his numeration applied to the Maestricht *Mosasaurus*, in which species the number may have been greater than in the New Jersey Monitor.

In one respect the fossil appears to differ from the corresponding portion of the Upper Missouri skull, described by Dr. Goldfuss. In his, Plate 7, Vol. XXI, of the Nova Acta, representing a lateral view of the skull, the intermaxillary is not visible above the border of the maxillary bone, but is so in the New Jersey fossil, as seen in Fig. 6, Plate XIX of this memoir.

The forepart of the maxillary bone has lost the end which unites it with the alveolar border of the intermaxillary corresponding in extent to the position of the first maxillary tooth. Behind the latter the fossil contains the fangs of the four succeeding teeth. Accompanying the specimen are other fragments of the alveolar border, together measuring a foot in length, and occupied by the fangs of seven teeth, but not fitting from the loss of an intervening portion. About an inch above the alveolar edge there is a longitudinal row of large vasculo-neural foramina, which communicate with a canal situated along the outer part of the bottoms of the fangs of the teeth. Similar foramina form a row along the intermaxillary bone near its upper boundary. The anterior extremity of the nares, seen in the fossil, corresponds in position with the interval between the fifth and sixth maxillary teeth.

The length of the fossil, from the end of the snout to the posterior broken extremity, is ten and a half inches; the distance from the end of the snout to the anterior nares is ten inches.

Another collection, received from Prof. Cook, consists of fragments of the forepart of the lower jaw, obtained by Dr. C. Thompson from the Marl of Freehold, Monmouth County, N. J. Restored to their proper place the specimens correspond in size, shape, and number of insertions for teeth with the portion of a jaw of the Maestricht Monitor, figured in Plate VI, of the Historie de la Montagne de St. Pierre. The fragments compose twelve inches of the right dental bone, represented in Fig. 13, Plate XI, and sixteen of the left one. The latter presents a depth of four inches gradually decreasing to the anterior end where it measures about two inches. In their length the bones are remarkably straight, and their symphysial extremity, without arching inward, is obtusely rounded. The outer surface and base are convex. The former, half way between the latter and the alveolar border, exhibits a longitudinal series of large elliptical foramina directed obliquely forward and outward from the dental canal. Nearer the base approaching the symphysis, and also in the latter position, there exist a number of similar foramina. The left dental specimen has accommodated nine teeth, which are lost, except the fifth tooth and the fang of the first. The right dental specimen accommodated seven teeth, which are lost, except the fangs of the anterior three. The fangs and alveoli in the specimens are directed obliquely forward and upward with a feeble curvature. The angle of inclination of the fangs successively increases from behind forward. In the fifth tooth it is about 50°; in the first one about 30°.

The fifth tooth remaining in the left dental bone, has its crown mutilated, but a portion of the inner surface being preserved, exhibits a number of well-defined planes. The fang is about three inches in length, and exhibits a large excavation postero-internally for a successor.

In the right dental specimen the fang of the first tooth, two and a quarter inches long, presents a small concavity postero-internally, just below the alveolar border, for a successor. The fang of the second tooth is about one-third excavated, and the excavation at base impresses the front of the fang of the third tooth about its middle. Postero-internally the third fang presents a small excavation for its own successor.

Fig. 11, Plate VIII, represents a basi-sphenoid bone of *Mosasaurus*, from the first marl bed of Holmdale, Monmouth County, loaned to me by Prof. Cook. The specimen, a fragment of a huge skull, measures eight inches in length and six inches in breadth at the posterior diverging processes, which abut against the basi-occipital bone.

The basi-occipital bone, from Mississippi, part of the collection of Dr. Spillman, previously mentioned, is two inches long in the median line, and of ten lines greater width at the anterior diverging processes. The latter are separated by a wide concavity from each other and from the occipital condyle. They terminate in a reniform convexity; in front sustain the angularly divergent processes of the basi-sphenoid bone, and posteriorly support in part the lateral occipitals. The condyle, somewhat mutilated, in its entire condition has measured about two and a quarter inches in transverse diameter, and a little over an inch vertically. The portion contributed by the lateral occipital, preserved on one side in the fossil, is about three-fourths of an inch wide and half an inch high.

The tympanic bone, accompanying the former specimen, though much fractured, and partly imbedded in its matrix, is sufficiently well preserved to exhibit its true form. It presents considerable difference from that of the *Mosasaurus* of New Jersey, as it does also from that of the Maestricht skull of the Paris museum. It is of much greater breadth in proportion to its length, and is in comparison very abruptly narrowed at its lower part. Its height is three inches and a half, and its extreme breadth above is equal. The width of the mandibular articulation is one inch ten lines. The tympanic passage is proportionately larger, as is also the case with its posterior overhanging process.

The differences between this tympanic bone and that of the New Jersey, Missouri, or Maestricht *Mosasaurus* indicate the Mississippi *Mosasaurus* to be a distinct species.

Cuvier[1] observes, that very few bones of the extremities of *Mosasaurus* have been found, and their rarity was such that, for a moment, he was led to doubt whether the animal possessed limbs. He states that he was soon undeceived by recognizing a bone of the pelvis which certainly belonged to *Mosasaurus*. The bone, considered to be a pubis, resembling that of the Monitor, is figured in the Ossemens Fossiles. Cuvier further says, that among some fossils from Seichem he detected a scapula resembling that of the Monitor; and subsequently received drawings from Maestricht of a clavicle resembling that of a common Lizard, and also a coracoid bone. From the specimens and figures Cuvier supposes the shoulder of the *Mosasaurus* to have exhibited a close resemblance with that of the Lizards. After remarking that he had been unable to procure any long bones of the limbs of *Mosasaurus*, he expresses his views in regard to certain figures of bones, represented by Faujas-Saint-Fond[2] and Camper,[3] reproduced in the Ossemens Fossiles. In regard to the figure of a portion of an ulna, Cuvier observes, that if the bone belonged to *Mosasaurus*, it would indicate the extremities to have been moderately elevated. But he continues, the bones of the feet, so far as they are known, appear, on the contrary, to have belonged to a sort of contracted fin, as in the Dolphins or *Plesiosaurians*. Of the different bones of the feet, figured in the Ossemens Fossiles, after Camper, Cuvier likens some of them to the principal carpal bones of the Crocodile, another appeared to belong to some huge Saurian, some are phalanges, and two are attributed by him to Turtles, whose remains are not less common in the deposits containing those of the *Mosasaurus*. In conclusion, Cuvier adds that "it was not without hesitation that he expressed his conjectures from mere figures, when the immediate comparison of the bones themselves would scarcely suffice, so great is their diversity and so small the precision of their forms in reptiles."

Goldfuss[4] describes and figures several bone fragments from the deposits of the Cretaceous period of the Upper Missouri, which he views as the portion of a scapula, a coracoid bone, and an olecranon process of the *Mosasaurus*. In relation to the habits of the animal, he says, as it lived in the ocean the toes no doubt were

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[1] Ossemens Fossiles, Ed. 4, T. 10, pp. 170–173.
[2] Hist. Nat. de la Mont. de St. Pierre de Maestricht. [3] Annales du Muséum, T. XIX.
[4] Schädelbau des Mosasaurus; Nov. Act. Acad. Caes. Leop. Carol. Nat. Cur., Vol. XXI, Pars 1, p. 173.

webbed, but the remains which have been discovered, on the contrary, do not lead to the supposition that it possessed fins like the *Ichthyosaurians*.[1]

Prof. Owen,[2] after remarking that no part of the organization of *Mosasaurus* is so little known as that of the locomotive extremities, and substantially quoting the views of Cuvier, expressed above, enters into the description of some long bones of the extremities, " showing the Lacertian type of structure," which were obtained in the Green-sand formation of New Jersey. Professor Owen observes, "on the highly probable supposition that these bones belong to *Mosasaurus*, they indicate the extremities of that gigantic Lizard to have been organized according to the type of the existing *Lacertilia* and not of the *Enaliosauria* or *Cetacea*."

Pictet[3] says the humerus of *Mosasaurus* is thick and short, like that of *Ichthyosaurus*, but gives no evidence for this assertion. He adds, we may conjecture, from the flattening of the bones of the members, that the feet were probably converted into fins like those of the *Enaliosaurians*.

Some remains, apparently of *Mosasaurus*, which I have the opportunity of examining, indicate the limbs to have been fins, partaking in their structure the characters of those of the marine Turtle and the *Plesiosaurus*.

The humerus previously mentioned, found in association with several cervical vertebræ, a tympanic bone, and a pterygoid with teeth, submitted to my inspection by Dr. Spillman, of Mississippi, is represented in Figs. 1, 2, Plate VIII. Having every appearance of belonging to the same skeleton as its associated bones, there can be but little doubt of its appertaining to *Mosasaurus* or one of its allies.

The specimen is of the right side, and bears a striking resemblance to the humerus of a Turtle, with which I suppose it to have corresponded in the relative position of its parts, and shall, therefore, so describe it.

The shaft is short and rapidly expanded towards the extremities. Its middle part is cylindrical, but much compressed antero-posteriorly. The borders form a deep curve in the length, and are transversely convex, but the outer is the more obtuse. The posterior surface, Fig. 1, is transversely convex; the anterior, Fig. 2, nearly flat, and marked just above the middle by a roughness (*d*) for muscular attachment.

The proximal extremity expands to more than three times the breadth of the middle of the shaft. A demi-spheroidal head (*a*) projects forward, midway between two tuberosities, and is partially sustained in the usual manner by a gradual uprising abutment of the shaft. The tuberosities include a deep concavity back of the head, and are associated by the posterior terminal portion of the shaft, which presents a broad and slightly concave surface extending between them. The greater tuberosity (*b*), situated postero-superiorly, extends a short distance proximally beyond the head so as to increase the length of the bone. It is compressed antero-posteriorly, and, in the specimen, is imperfect at the summit. The lesser tuberosity (*c*), situated

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[1] Op. cit., p. 196. Da sie sich im Meerwasser aufhielten, so waren die Zehen ihrer Füsse ohne Zweifel mit Schwimmhäuten verbunden; die gefundenen Knochenreste lassen dagegen nicht vermuthen dass die Flossenfüsse, wie die Fischeidechsen gehabt hatten.

[2] British Fossil Reptiles, p. 190

[3] Traité de Paléontologie, Ed. 2, T. 1, p. 505.

postero-inferiorly, is thicker than the former, and exhibits strong marks for muscular attachment.

The distal extremity of the bone expands to about twice the breadth of the middle of the shaft. It is almost flat in front, moderately convex behind, and terminates in a thick angular border, which, though somewhat mutilated, has the appearance as if it had formed a fixed or immovable joint with the bones of the forearm. The measurements of the specimen are as follows:—

	Inches.	Lines.
Extreme length of the specimen in its present state	10	
Breadth of shaft at middle	1	11
Thickness of shaft at middle	1	2
Breadth at tuberosities, estimated	6	
Diameter of head	1	8
Breadth at distal end	3	8
Thickness at distal end	1	2

A fragment of a huge bone, from the Green-sand of Burlington County, N. J., contained in the cabinet of the Academy of Natural Sciences, is represented in Figs. 3, 4, 5, Plate VIII, rather less than one-third the diameter of the original. The specimen has been usually viewed as the proximal extremity of the humerus of an enormous Turtle, and even Agassiz was impressed with the same idea, for it is the fossil characteristic of his *Atlantochelys Mortoni*.[1] It bears a resemblance to the corresponding portion of the humerus just described, and probably belongs to the gigantic *Mosasaurus*.

The shaft, broken across near its middle, appears of exceeding narrowness in comparison with the breadth of the bone at the tuberosities, and, indeed, is much narrower in this respect, relatively, than in the humerus above described. From this character alone we have good reason to suspect that the two specimens indicate a small and a large species of *Mosasaurus*.

The broken end of the bone, under immediate examination, presents an ovoidal section, with the greater diameter thirty-four lines, the shorter twenty-nine lines. The shaft contains no medullary cavity, but is occupied by an interior coarser ossific structure. The upper or front part of the shaft, as in the preceding specimen, exhibits a rough, tuberous surface for muscular attachment.

The head is ovoidal in outline, fifty-three lines in its antero-posterior diameter, and forty-four lines in its short diameter.

The breadth of the bone, from the summit of one tuberosity to that of the other, is eleven inches. The greater tuberosity projects three inches proximally beyond the head, increasing by so much the length of the bone. It is compressed antero-posteriorly, is convex and rough at the summit; measures four inches wide at its middle, and twenty-six lines thick. The smaller tuberosity, irregular in form and much roughened for muscular attachment, measures forty-one lines in thickness.

The length of the fragment, from the summit of the greater tuberosity to the broken end of the shaft, is eleven inches.

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[1] Proc. Acad. Nat. Sci. 1849, 169.

The mass of hard blue stone, previously noticed, containing a number of caudal vertebræ in a row, obtained by Dr. Hayden on the Yellowstone River, also contains a broad bone, represented in Fig. 12, Plate XVII, together with several small bones, like that represented in Fig. 13, of the same Plate, all of which appear to have belonged to the same skeleton.

The broad bone is yet partially imbedded in its hard matrix, the removal of which would endanger the integrity of the specimen. It resembles in general form the ulna or fibula of *Plesiosaurus*, and from its being found with caudal vertebræ might be suspected to be the latter bone. It is not, however, unlikely that it may prove to be a tarsal bone, one of which it likewise resembles in the foot of *Plesiosaurus*. It is about as broad as it is long, and the exposed surface exhibits a radiate ossific structure. Internally the upper part of this surface is transversely convex, but is slightly depressed below; externally it is concave. The upper border is convex in the direction of the breadth of the bone. The inner border is longitudinally concave, transversely convex, thick, and smooth. The outer border is thin, emarginate, and presents an irregular pitted appearance as if it had been covered with cartilage. The lower border at its inner third forms an obtuse angle, is thick, and subdivided into a pair of concave articular facets. The measurements of the bone are as follows:—

	Inches.	Lines.
Extreme length	3	2
Breadth above	2	10
Breadth at the middle	2	4
Breadth below	3	2
Thickness at the lower border	1	2
Thickness at the outer border		4

The small bones above alluded to appear to be metatarsals and phalanges; and they closely resemble the corresponding bones of the *Plesiosaurus*. One of the best specimens, represented in Fig. 13, Plate XVII, has a quadrate shaft strongly expanded at the extremities. The proximal end is the larger, and presents a transversely oval, flat articular surface. The distal articular surface is likewise oval, but is concave. The measurements of the specimen are as follows:—

	Lines.
Length	22
Breadth of proximal end	14
Thickness of proximal end	7
Breadth of middle of shaft	5
Thickness of middle of shaft	4
Breadth of distal end	12
Thickness of distal end	7

Two additional specimens, partially imbedded in their matrix, present very nearly the same form and size as that just described.

Other bones of the limbs, which may, with the same probability as the preceding, be referred to *Mosasaurus*, I have not had the opportunity of examining.

An isolated bone, somewhat crushed in appearance, belonging to the cabinet of Prof. James Hall, and obtained by Messrs. Meek and Hayden, from the Cretaceous deposits of Nebraska, is represented in Fig. 6, Plate VIII, and may, perhaps, appertain to a young *Mosasaurus*. It resembles a radius or tibia of *Plesiosaurus*. It is much compressed, cylindroid in form, and expanded nearly equally towards the extremities. The articular surfaces are transversely elliptical, slightly convex, and roughened for the attachment of cartilage. The measurements of the specimen are as follows:—

	Inches.	Lines.
Length	2	8
Breadth at middle of shaft	1	1
Thickness at middle of shaft		6
Breadth at extremities	1	8
Thickness		9

An isolated bone, obtained by Dr. Spillman, from the same formation, which contained the humerus and other bones previously described, is represented in Fig. 7, Plate VIII. It resembles the preceding specimen suspected to be a radius or tibia of a young *Mosasaurus*, but is much less compressed, and its articular surfaces are nearly plane or slightly concave. Its measurements are as follows:—

	Inches.	Lines.
Length	2	
Breadth at middle of shaft		9
Thickness at middle of shaft		7
Breadth of proximal end	1	6
Thickness of proximal end	1	
Breadth of distal end	1	4
Thickness of distal end		10

A carpal bone, represented in Fig. 8, Plate VIII, found by Dr. Hayden on the Big Cheyenne River, probably belongs to *Mosasaurus*. The specimen is hexagonal at the border, and has its broad surfaces moderately concave. Its greatest breadth is one inch, its shortest ten lines; its thickness ranges between three and five lines.

An undetermined reptile bone, accompanying the latter, is represented in Fig. 10, of the same Plate. It is a short, much flattened, cylindroid bone, constricted at the middle, where it measures one inch and a quarter wide, and three-quarters of an inch thick. The upper extremity expands into a broad, flat, circular articular surface, with a narrow oblique prolongation at one side. The surface is broken off at the opposite side, but independent of the prolongation it measures about one inch and a quarter in diameter. The lower extremity expands into a transversely semi-circular, ellipsoidal articular surface, measuring two inches and three-quarters in its long diameter and ten lines in its short diameter. The length of the bone is one inch and three-quarters.

Another undetermined reptile bone, represented in Fig. 9, Plate VIII, belonging to Prof. James Hall, was found by Messrs. Meek and Hayden, among loose fragments at the base of a Cretaceous bluff, five miles below Daurion's Hill, Nebraska. The bone is a little over two inches in length, and somewhat resembles the preceding, but appears lengthened at the expense of the breadth. The shaft at middle is eleven lines wide and eight lines thick, and is ovate in transverse section. The upper extremity expands into a flat, nearly circular articular surface, about one inch and a quarter in transverse diameter, and a little less in the opposite diameter. The lower end of the bone expands transversely, and ends in a long, curved ellipsoid surface, apparently subdivided to articulate with three carpal bones. The length of this surface transversely is two inches and a quarter, its breadth three-quarters of an inch.

Specimens of isolated teeth, possessing the general characters assigned to those of the Maestricht Monitor or *Mosasaurus*, but exhibiting considerable diversity of size and form, are frequently discovered in the deposits of the Cretaceous period of the United States. A number of such teeth are contained in the cabinet of the Academy of Natural Sciences, and others have been loaned to me for examination, but I find it difficult to decide whether they belong to one or more species of the genus or to several distinct genera. In attempting to determine the limit of variation in the form of the teeth of *Mosasaurus*, I have greatly felt the want of a careful description in detail, accompanied by accurate figures, of the fine specimen of the jaws and teeth, upon which the genus was founded, and which is now preserved in the museum of the Jardin des Plantes, at Paris. I have had access to an excellent plaster cast of the specimen presented by the Directors of the latter institution to the American Philosophical Society, but in many respects it fails to show nice shades of character, which are, no doubt, to be observed in the original, or which might be the subject of description and accurate delineation. The descriptions and figures by Faujas-Saint-Fond, Cuvier, and others, though sufficiently characteristic of the genus, and mainly correct, are not given with the detail and precision that are required for comparison of the specimens I have the opportunity of examining.

Cuvier[1] briefly describes the teeth of *Mosasaurus* in general. He observes, that they are all pyramidal and slightly curved; their external face is plane, and defined by two acute ridges from the internal face, which is round, or rather demi-conical. Subsequently[2] he remarks, that the ridges are entire and without denticulations. He does not refer to the existence of divisional planes upon the teeth; and an inspection of undoubted teeth of the genus leaves no question that the ridges of the crown are minutely denticulate in the unworn condition. An examination of the cast, above mentioned, also proves that there is some diversity in the shape of the teeth in different parts of the series.

Goldfuss,[3] in describing the teeth of *Mosasaurus*, says they are slightly compressed laterally, towards the apex feebly curved backwards, and are divided into a larger inner and smaller outer half by an acute linear ridge, which is transversely striated. Their surface appears polygonal; the outer surface presenting five, the inner seven pyramidal planes. Prof. Owen,[4] in referring to the description of Goldfuss, remarks, "the feeble indications of angles observable in some of the teeth, those of the upper jaw chiefly, of the *Mosasaurus Hoffmanni*, do not bear out the term 'polygonal,' which he applies to the crowns of that species as well as to those of his *Mosasaurus Maximiliani*; still less can I find these angles so constant and regular as to

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[1] Ossemens Fossiles, Ed. 4, T. X, p. 144. [2] Ibid., p. 145.

[3] Schädelbau des Mosasaurus; Nov. Act. Acad. C. L. C. Nat. Cur., Vol. 21, p. 178.

[4] British Fossil Reptiles, p. 185.

divide the outer surface of the crown into five, and the inner surface into seven facets."

The plaster cast, above mentioned, of the jaws of the Maestricht Monitor, shows that the front teeth are narrower than those behind. The external surface of the crown is comparatively narrow and slightly convex, while the internal surface is of considerable extent, forming in section the transverse half of an ellipsoid. In passing backward in the dental series it appears that the external surface of the crowns increases in breadth and becomes more convex, while the internal surface in a corresponding manner decreases. In the back teeth the crown appears to be laterally compressed conical, with the external surface nearly as wide and convex as the internal, so that a transverse section presents an ellipse with acute poles. Thus the front teeth of the cast correspond with those usually described as characteristic of *Mosasaurus*, while the back ones are more like those supposed by Prof. Owen to indicate a distinct genus, which he has named *Leiodon.*

In most of the teeth, usually assigned to *Mosasaurus*, the inner and outer surfaces of the crown are more or less distinctly subdivided into a series of narrow planes, which are most evident towards the base of the crown. These planes are variable in number, and are often slightly depressed or feebly concave. They are sometimes multiplied towards the base, but become indistinct or even disappear at the summit. In the plaster cast the divisional planes of the surfaces of the crown, while sufficiently evident in the more anterior teeth, appear to be obsolete in those most posterior, though it is true that their absence in the latter may arise from defective modelling.

In the Maestricht Monitor, Cuvier[1] observes that, "the teeth are hollow only during their development, as they are then in all other animals. They become filled throughout their length, and are most frequently found entirely solid. They complete their development in becoming attached to the jaw by means of an osseous body very different in structure from that of the tooth, with which it is nevertheless intimately associated. The successional tooth originates in a special alveolus produced at the same time, and it penetrates the osseous body of the tooth in use. In enlarging the successional tooth finally detaches the osseous body from the jaw with which it was organically united; the body by a sort of necrosis being shed and carrying with it the tooth it supported. Gradually the successional tooth, with its body, improperly called its osseous root, assumes the position from which the old one was removed."

Subsequently, Cuvier,[2] after remarking that "he had formerly committed the error of calling the osseous structure, connecting the tooth with the jaw, the root," observes that "he had since recognized it to be the dental pulp, which, instead of remaining soft as in mammals, becomes ossified and identified with the alveolus." Cuvier continues, "the tooth has no true root, but adheres strongly to the pulp which secreted it, and is further held in connection with it by the remains of the capsule which furnished the enamel, and which, by becoming ossified also, and

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[1] Ossemens Fossiles, Ed. 4, T. 10, p. 134.

[2] Ossemens Fossiles, 136.

uniting itself with the maxillary bone and the ossified dental pulp, inserts and fixes the tooth with additional force."

Again, in comparing the mode of implantation of the teeth of *Mosasaurus* with the living *Monitor* and *Iguana*, Cuvier[1] observes of the former that "the socles (pedestals) or ossified pulps, which support the teeth, are adherent in hollows or true alveoli contrived in the thickness of the border of the jaw."

Goldfuss,[2] referring to the Maestricht and the Missouri *Mosasaurus*, says, "in both, the crowns of the teeth, invested with shining enamel, are sustained upon the dental capsule which is transformed into an osseous socle, coossified with the alveolus, and they are in part hollow internally and in part solid."

Owen, in his Odontography, page 258, in reference to *Mosasaurus*, observes that "the maxillary teeth combine the pleodont with the acrodont characters." Further on he continues, "its dentition exhibits in an eminent degree the acrodont character; the teeth being supported on expanded conical bases anchylosed to the summit of the alveolar ridge of the jaws; no existing Saurian exactly parallels this mode of attachment of the teeth, either in regard to the breadth of the alveolar border or in the relative size of the osseous cones to the teeth which they support. A shallow socket is left where the tooth and its supporting base are shed." The same authority, in a more recent work, Palæontology, page 279, remarks that "the teeth are anchylosed to eminences along the alveolar border of the jaw according to the acrodont type."

Pictet, in his Traité de Paléontologie, tome 1, page 504, speaks of the teeth of *Mosasaurus* as being deprived of true roots and anchylosed to the jaw.

Gibbes, in his Memoir on the Mosasaurus,[3] follows the descriptions of Cuvier and Owen.

Gervais, in the Zoologie et Paléontologie Françaises, tome 1, page 262, in describing some teeth which he refers to *Leiodon*, observes that as in *Mosasaurus* they are inserted in alveoli with which their root is identified by means of the surrounding layer of cement. In a note he adds the remark, "c'est a tort que l'on décrit les dents des *Mosasaures* comme réellement acrodont a la maniere de celles de beaucoup de Sauriens actuels."

From the fossil specimens I have had the opportunity of examining, the history of the dentition of *Mosasaurus*, so far as I have been able to trace it from the imperfect materials, appears to be as follows:—

The mature teeth of *Mosasaurus* have curved conical crowns with long, robust fangs inserted into sockets or alveoli, with which they were at first connected in the ordinary manner by connective tissue, but with which they subsequently became firmly coossified.[4] They contain in the interior a large fusiform pulp cavity com-

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[1] Ossemens Fossiles, 143.

[2] Schädelbau des Mosasaurus; Nov. Act. Acad. C. L. C. Nat. Cur., XXI, 178. Bei beiden sitzen die, mit einem braunen, glänzenden Schmelze überzogenen Zahnkronen auf der zu einen verknöcherten Sockel umgewandelten, in der Alveole angewachsenen Zahnkapsel, und wird im Innern theils hohl, theils ausgefüllt.

[3] Smithsonian Contributions, Vol. II.

[4] Goldfuss (Nov. Act. Acad., XXI, Pl. 9) has given two figures of teeth with their fangs, which

municating through a canal with a funnel-shaped pit at the end of the fang. See Plates IX, X, XI.

The conical crowns of the teeth are curved backward with an inclination inward; the curvature being more rapid approaching the apex. They are generally divided in front and behind by an acute ridge into an inner and an outer surface. In some teeth, apparently belonging to the most posterior of the dental series of the jaws, and to those of the pterygoid bones, there is only one ridge, which is situated along the back or concave border of the crown. The ridges exhibit a minutely crimped and sub-denticulated arrangement,[1] which was obliterated by wearing.

The proportionate extent of the inner and outer surfaces of the crown, as defined by the two ridges above indicated, varies very much in the different specimens of fossil teeth, apparently according to the position the latter occupied in the dental series.

In those teeth, which I suspect to belong to the anterior part of the dental series, the crown has the form corresponding with the descriptions which have usually been given as characteristic in general of the teeth of *Mosasaurus* (Plate IX, Figs. 1, 2, 3; Plate X, Figs. 1, 2, 3). It is very unequally divided by the acute ridges; the inner surface occupying two-thirds or more of the extent of the crown. The convexity or transverse curvature of the outer surface forms a short segment of a comparatively large circle; that of the inner surface forms one-half to two-thirds or more of a circle, whose diameter is that of the crown. The transverse section of the crown might be appropriately called shield-shaped, as represented in the woodcut outlines, Nos. 1, 2, 3.

In those teeth which are supposed to belong to the middle of the dental series the disproportion between the outer and inner surfaces of the crown is comparatively trifling, and the transverse section is circular or nearly so (Plate IX, Figs. 5, 6; Plate X, Figs. 7-9).

Teeth attributed to the more posterior part of the dental series have their crowns compressed from within outwardly and nearly equally divided by the acute ridges, and in transverse section are elliptical with acute poles (Plate X, Fig. 10).

Finally, the last teeth of the series have compressed crowns, with a single ridge, and an ovate transverse section (Plate X, Fig. 4).

The inner and outer surfaces of the crowns in most of the fossil teeth are unequally subdivided into narrow planes, variable in number. They slightly multiply towards the base of the crown, and become fewer and less distinct, or altogether disappear towards the apex. They vary in degree of distinctness in different teeth, and in many do not exist at all (Plates IX, X, XI).

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he indicates as a maxillary and a palatal tooth of *Mosasaurus Hoffmanni.* The tooth represented in his figure 4 looks as if it may have belonged to near the middle of the dental series. The inner side of its fang exhibits a small lenticular excavation; part of the receptacle of a successional tooth. Fig. 5, represented as a palatal or pterygoid tooth, I suspect rather to belong to the back part of the maxillary series. The two figures are reproduced by Gibbes in Plate I, of his Memoir on the Mosasaurus.

[1] This arrangement appears not to have been noticed by Cuvier in the teeth of the Maestricht Monitor. Ossemens Fossiles, T. X, 145.

The fossil teeth under examination would appear to indicate that the subdivision of the inner and outer surfaces of the crown is best marked in the anterior teeth of the series, becomes less evident in passing backward, and ceases in the last teeth. Some of the specimens would appear to show that the subdivision of the crown held some relation with the age of the animal; not existing in the young, but developed in the mature animal. Other specimens appear to indicate that the difference was due to individual peculiarity, or perhaps in some it may denote a difference of species if not of genus.

The fangs of the teeth of *Mosasaurus* are remarkable for their great proportionate size, being several times the bulk of the crown they support (Plate IX, Figs. 1–7; Plate X, Figs. 1, 2, 4, 7, 8, 10).

From the enamel border of the base of the crown the fang expands in the form of a cone to the entrance of its socket, where it presents its greatest diameter and is more or less defined by a shoulder or ledge (Plate IX, Figs. 1, 5; Plate X, Figs. 7, 8, 10; Plate XI, Figs. 1–6).

The intra-alveolar portion of the fang, from two to four times the length of the extra-alveolar portion, is straight, oblique, or slightly curved, cylindroid, and slightly narrowed towards the obtusely rounded end. Frequently it is more or less compressed from without inwardly; and occasionally wrinkled at bottom.

The mature fang was at first simply inserted about three-fourths or more of its length in its socket, with which it was evidently adherent in the ordinary manner by connective tissue. Subsequently, however, it became firmly coossified with the alveolus; the ledge or base of the extra-alveolar portion with the entrance of the alveolus at the border of the jaw; the intra-alveolar portion with the sides and bottom of the alveolus.

The pulp cavity (Plate IX, Fig. 6, *f;* Plate XX, Fig. 3, *c*) of the mature teeth of *Mosasaurus* occupies a large extent of space in their interior. It is fusiform, or doubly conical, one cone extending into the crown, the other into the fang. It communicates by a large canal with a funnel-shaped pit, usually more or less compressed, at the bottom of the fang.[1] Occasionally the canal is occupied by a coarse cementum pervaded by many large vasculo-neural canals, as represented in the diagram, Fig. 3, *d*, Plate XX.

The crown of the teeth of *Mosasaurus* (Fig. 3, *a*, Plate XX) is composed of compact dentine invested with a thin layer of enamel. At the base of the enamelled crown the dentine extends, in the form of an inverted cone, within the extra-alveolar portion of the fang and terminates in a thin, abrupt annular margin, encircling the pulp cavity, as represented in the diagram, Fig. 3, *e*, Plate XX.

The dentine, as represented in Figs. 4, 5, 6, *a*, Plate XX, presents the ordinary constitution of an amorphous substance, pervaded with innumerable canaliculi diverging from the pulp cavity to the periphery of the crown, dividing in their course and giving off multitudes of lateral anastomosing branches. Below the

[1] Owen says, "The pulp cavity generally remains open at the middle of the base of the crown of the tooth; irregular processes of the cavity extend as medullary canals into the conical base of the tooth." Odontography, 259.

enamel border of the crown the dentine is defined from the cementum of the extra-alveolar portion of the fang by a more amorphous bond of union of the two structures, as indicated by the clear dividing line in the figures above mentioned.

The fang (Fig. 3, *b*, Plate XX) is composed of cementum or bone, as represented in Fig. 4, 5, 6, *b*, of the same plate. It is mainly composed of vertical osseous fibres, pervaded by numerous vascular canals pursuing the same course as the former. It is of much finer texture than the bone of the jaw with which it may be intimately coossified, and is admirably adapted to sustain the crowns of the teeth, both as regards its organic and its physical functions.[1]

The teeth of *Mosasaurus*, belonging to the functional series or those in use, were succeeded by a new set which underwent their development at the postero-internal portion of the alveoli occupied by the former. For the reception of the growing crowns of the new teeth the fangs of the functional series were gradually excavated through absorption of their structure, in a direction from within obliquely outward and forward, upward and downward. At first the inner parapet of the jaw slightly contributed to the parietes of the cavity for the new tooth, but, with this trifling exception, it was through excavation of the contiguous fang of the functional tooth that the former was accommodated. In the progress of the excavation, the pulp cavity of the functional tooth became exposed and then cut off from communication with the nerves and bloodvessels which supplied its contained pulp. The fossil specimens further indicate that it was during the progress of the excavation of the fangs of the functional teeth that these became coossified with their alveoli, as if to resist a tendency to expulsion from the jaw.

The cavities for the new teeth, in the fossils, are ovoid in form, and open at the postero-internal part of the extra-alveolar portion of the base of the fangs of the functional teeth; and from the opening the apex of the new tooth is seen protruding.

After the development of the crown of the new tooth the fang was produced, and the increase gradually became so great at the next step as to have converted the fang of the old tooth into a large capsule, surmounted by its crown still in use. With the advance of growth of the new tooth the crown of the old one became so enfeebled in its connection with its excavated fang as readily to be broken off by external violence, or to be displaced by the continued growth of the fang and protrusion of the crown of the new tooth. The fang of the latter continued its growth within a mere cylinder of the fang of the old tooth until its crown was made to assume a position in the functional series.

The development of the new tooth was scarcely completed before a successor commenced the same process, and thus one tooth was followed by another throughout the life of the animal, as in recent Reptiles (Plate IX, Figs. 1, 4, 5, 6; Plate X, Figs. 1, 4, 7, 8, 10; Plate XI, Figs. 4, 5, 6, 8, 10).

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[1] Owen says, "The expanded base of the tooth," referring to what has been mentioned above as the extra-alveolar portion of the fang, "is composed of a mere irregular mass of dentine, which, by its progressive subdivisions into vertical columnar processes, assumes a structure resembling that of true bone." Odontography, 259.

Some of the fossil specimens show that not unfrequently, while a successional tooth occupied a cavity within the fang of its predecessor, it was accompanied by another, situated behind the former. For the accommodation of the second successor a cavity was produced, not only at the expense of the fang occupied by the first one, but partly at the expense of the alveolar partition and fore part of the fang of the functional tooth behind. Figs. 1, *c*, 10, *c*, Plate X, and Figs. 5, *e*, 6, *e*, Plate IX, exhibit successive stages in the production of a cavity for a contemporaneous second successional tooth. The large cavity, represented in the last figure, is evidently compounded of two.

The pulp cavity of the teeth of *Mosasaurus* varied in size according to the period of development and age of the teeth, but all the fossil specimens I have seen indicate that it was absent at no period. I have never seen a solid tooth of the American *Mosasaurus*, contrary to the statement of Cuvier, in regard to the Maestricht Monitor, that the teeth are only hollow during their development, and are most frequently found entirely solid.[1] Nor does the large size of the pulp cavity in the mature teeth warrant the term of pleodont applied to the *Mosasaurus* by Owen.[2]

In the shedding of the crowns of the teeth of *Mosasaurus* they appear generally to have been detached from their excavated fangs a couple of lines from the enamel border. In several fossil specimens the base of the shed crowns is excavated in a conical or lenticular manner from the periphery to the central remnant of the pulp cavity. The peripheral border varies from a thin sharp edge to a fractured one of a couple of lines in thickness. The remnant of the pulp cavity, where it communicates with the excavation, is about a third of the diameter of the crown, and from one-third to one-half its length.

The alveoli generally appear to be completely separated in the ordinary manner among most animals by thin osseous partitions. In those instances in which there were two nearly contemporaneous successors to a tooth in use, the crowding to accommodate the former appears to have been such that the alveolar partition was obliterated, and was subsequently replaced by the cylindrical remains of the fangs which were excavated for the successional teeth.

The fossil specimens I have had the opportunity of examining, illustrating the dentition of *Mosasaurus*, are as follows:—

1. An alveolar fragment, containing a mutilated tooth and the fang of a second, from Burlington County, New Jersey, belonging to the museum of the Academy of Natural Sciences. It indicates an individual as large as that to which belonged the great skull of the Maestricht *Mosasaurus*, preserved in the museum of the Jardin des Plantes of Paris; and the mutilated tooth it contains resembles in its form those in advance of the middle of the series in the plaster cast of the skull just mentioned. An inner view of the specimen is given in Fig. 1, Plate IX. The fragment is from the right side of the upper jaw, and measures about eight inches in length by three inches in thickness. The external surface is straight longitudinally and convex vertically. About half way between the alveolar edge and the broken border, a distance of about three inches, it presents a transverse row of large vasculo-neural

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[1] Ossemens Fossiles, Ed. 4, T. 10, p. 134

[2] Odontography, 258.

foramina, which communicate with a narrow canal situated just externally to the bottom of the fangs of the teeth.

The mutilated tooth of the specimen (Fig. 1, *a*) has a large portion of the crown destroyed, especially at its outer part, but it has been artificially restored in such a manner as sufficiently well to exhibit its original form.

This agrees with the ordinary descriptions characterizing the teeth of *Mosasaurus*. It is conical, curving moderately backward and inward, and in its perfect condition has measured about two inches and a half in length. The diameter at the enamelled base has been about fourteen lines, both antero-posteriorly and transversely. The transverse section is shield-shaped, as represented in the wood-cut outlines, Nos. 1, 2, 3, of more perfect specimens of teeth. A pair of acute, feebly denticulated, crimped ridges divide the crown irregularly into two surfaces, of which the outer is about one-half the extent of the inner. The transverse curve of the outer surface forms a short segment of a comparatively large circle, and measures at the bottom of the crown fifteen lines; the curve of the inner surface forms half an ellipse, and measures twenty-nine lines. Both surfaces have been subdivided into narrow planes; the outer exhibiting traces of three or four; the inner presents eight, of which the extreme ones are twice the width of those intermediate.

The fang (Fig. 1, *b*) is three inches and three-quarters in length, and is exserted about one-fourth; the base of the extra-alveolar portion measuring an inch and three-fourths in diameter. The intra-alveolar portion is firmly coossified with its alveolus, and is about one-half excavated postero-internally for the accommodation of a successional tooth. The cavity, from which the latter has been lost, is open at the postero-internal portion of the alveolar border, as represented in Fig. 1, *d*, and is also exposed by the destruction of the thin bottom of the alveolus, as seen in the same figure at *c*. Notwithstanding the extent of the excavation of the fang, the pulp cavity of this tooth is not exposed, except through a narrow aperture remaining from the canal of communication with the bottom of the fang.

The next succeeding fang of the fossil (Fig. 1, *f*) is like that just described, except that the cavity for a successional tooth is comparatively small. It is seen in the figure at *h*, opening at the border of the jaw postero-internally. It is oval, about sixteen lines in depth, and eight lines in breadth. The end of the fang is seen, as represented in the figure at *g*, through the open bottom of the alveolus. The canal, which usually communicates through the fang with the pulp cavity, is filled up with coarse cementum. At the summit of the extra-alveolar portion of the fang, from the loss of the crown, the bottom of the pulp cavity of the latter is exposed. The aperture is obliquely oval, and measures nine lines in the long diameter and six in the short diameter. From the aperture the cavity extends into the fang, in the form of a cone, an inch and a half in depth.

Behind the fang just described, the fossil retains one-half of an alveolus, which is interesting, from its exhibiting a thin plate of bone, as seen in Fig. 1, *i*, the remains of the fang which once occupied it. The plate is coossified with the alveolus, and formed part of the wall of the cavity of a successional tooth which is lost.

2. A fragment, apparently from the forepart of the lower jaw, containing the fangs of four teeth, from Burlington County, New Jersey, presented to the Academy of Natural Sciences by Dr. S. G. Morton. The fragment is ten inches long, and was sufficient to accommodate six teeth. At its widest part, opposite the position of the fifth tooth from the anterior extremity, it measures two inches and a half. The inner and outer surfaces are straight longitudinally and convex vertically. The outer surface, about an inch and a half from the alveolar edge, and near the broken border of the specimen, presents a transverse row of four large vasculo-neural foramina, communicating with the remains of the dental canal within.

The four fangs of teeth, contained in the specimen, are about three inches in length, of which about three-fourths are inserted within alveoli. The exserted or extra-alveolar portions of the fangs form truncated cones at the border of the jaw surmounted by the fractured borders of the lost crowns. The loss of the latter has exposed the base of the large interior pulp cavities, which measure from half to three-fourths of an inch in diameter and extend in an inverted conical manner within the fangs.

At the border of the jaw, the bases of the extra-alveolar portions of the fangs range in transverse diameter from fourteen to twenty-two lines.

The intra-alveolar portions of the fangs are cylindroid, moderately curved, and terminate in rounded extremities just internal to the position of the dental canal.

The first and third fangs of the specimen are loosely inserted in their sockets, with which they appear never to have been coossified. The second and fourth fangs are firmly coossified with their alveoli, and are deeply excavated postero-internally into large cavities which accommodated successional teeth, but which are lost from the specimen.

The second, third, and fourth fangs are separated by thin osseous partitions of the alveoli.

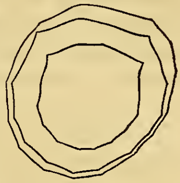
The fourth fang presents in its postero-internal part a small cavity for a successional tooth.

The first fang encroached so much on the position of the second as to have depressed its anterior part. It presents the remains of a very small cavity for a successional tooth in the same position as the other fangs, and exhibits what appears to be a portion of a second and larger one at the forepart.

3. A tooth, from Monmouth County, New Jersey, loaned to me for examination, from the collection of Rutger's College, by Prof. Cook. The specimen, represented in Fig. 2, Plate X, resembles the tooth in the jaw fragment first described, or is of the form which is usually viewed as characteristic of *Mosasaurus*. It is perfect, except that the apex and anterior carinated ridge of the crown are worn, and it measures five inches and a half in length.

The length of the enamelled crown in its present condition is twenty-two lines; the antero-posterior diameter at base thirteen lines, and the transverse diameter fourteen lines. The outer and inner surfaces are defined by acute, linear ridges, which become more carinated towards the apex of the crown. The unworn posterior ridge is minutely denticulated, and traces of the same condition are visible on the anterior ridge. The outer surface of the crown is nine lines wide at the bottom and eight lines at the middle. It forms less than one-sixth of a circle, whose radius is about eight lines, and is irregularly subdivided into four planes below, extending into three towards the apex. The inner surface forms about three-fourths of a circle, whose radius is six lines, and is irregularly subdivided into eleven planes. The circumference of the crown at the enamel border is three inches and three-quarters, of which the inner surface is two inches and eleven lines, the outer surface ten lines. The accompanying outlines, No. 1, represent transverse sections of the crown at its base, a short distance above the base, and near the middle.

No. 1.

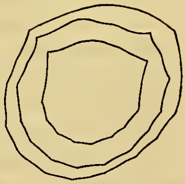


The exserted portion of the fang, or that which extends the cone of the crown, is from nine to ten lines high, and seventeen lines in diameter at base. The inserted portion is cylindrical, three inches in length, and rounded at the bottom. It was coossified with its alveolus, as indicated by firmly attached portions of bone to its inner side. Its canal of communication with the pulp cavity of the tooth is completely occupied by a coarser ossific substance. On the inner side posteriorly there exists an excavation, one inch and a half deep and three-quarters of an inch wide, being part of the cavity for a successional tooth.

4. A tooth, from the Green-sand of Freehold, Monmouth County, New Jersey, belonging to Dr. C. Thompson, and loaned to me for examination through Prof. Cook. It is represented in Fig. 1, Plate X, and is rather larger than the preceding specimen, which it resembles in form.

The enamelled crown, broken at the apex, when perfect measured about two inches and a half in length; its diameter at base antero-posteriorly is fourteen lines, transversely fourteen lines and a half. The outer and inner surfaces are defined by well-marked acute ridges, which are minutely denticulated. The outer surface is an inch wide at the bottom of the crown, three-fourths of an inch at its middle, and is subdivided into three planes. The inner surface forms more than half a circle, whose radius is about seven lines, and it is distinctly subdivided into eleven planes. The circumference of the crown at the enamel border is four inches, to which the inner surface contributes two inches ten lines; the outer surface fourteen lines. The accompanying outlines, No. 2, represent sections at the base of the crown, and from the lower and upper third.

No. 2.

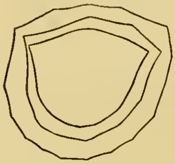


The fang is three inches and three-fourths in length, and appears not to have been coossified with its alveolus; at least it exhibits no traces of attached portions of the jaw. The bottom of the fang presents a wide elliptical pit, narrowing into a fissure, continuous with the canal of communication with the pulp cavity of the tooth. The inner side of the fang posteriorly presents an excavation (Fig. 1, *d*) for a successional tooth, and a second (*c*), shallower impression, to accommodate a successor to the functional tooth in advance.

5. The shed crown of a tooth, from near Woodbury, Gloucester County, New

Jersey, belonging to the museum of the Academy of Natural Sciences. It is represented in Fig. 3, Plate X, and was previously indicated and figured by Harlan[1] and Morton.[2] In form it resembles the corresponding portion of the teeth above described, but is slightly larger. Its dividing ridges are distinctly denticulated; the outer surface is divided towards the base of the crown into four planes, which diminish and finally disappear towards the apex; the inner surface is divided into eleven planes, which also diminish and become obsolete towards the apex. The length of the crown when perfect has been about two inches and three-quarters; the antero-posterior diameter at base about thirteen lines; and the transverse diameter is fourteen lines and a half.

No. 3.



The base of the specimen is excavated in a trumpet-like manner, extending to a thin edge at the periphery of the crown. This condition evidently indicates the specimen to have been shed during the life of the animal, notwithstanding the little wearing to which the tooth appears to have been subjected.

The accompanying outlines, No. 3, represent sections from the base, middle, and near the apex of the specimen.

6. The shed crown of a tooth, from Burlington County, New Jersey, presented to the Academy of Natural Sciences by Mr. L. T. Germain. The specimen, represented in Fig. 6, Plate X, has the apex and base broken, but when perfect appears to have been less than two inches and a half long, about thirteen lines in diameter antero-posteriorly and twelve lines transversely. The ridges of the crown are distinctly denticulated, but separate the surfaces less unequally than in the preceding specimens. The outer surface is subdivided into nine planes, passing into seven and then becoming obsolete towards the apex of the crown. The inner surface is subdivided into about twenty planes, diminishing and finally disappearing towards the apex of the tooth. The subdivisional planes are more or less obscured by longitudinal striation of the enamel, more especially on the inner side. This striation diminishes and finally disappears towards the apex. It does not exist in the specimens previously described.

No. 4.

The accompanying outline, No. 4, represents a transverse section of the crown below its middle.

The base of the specimen is excavated towards the central pulp cavity in a salver-form manner from a broken edge at the periphery about a line and a half thick.

7. An entire tooth, from Monmouth County, New Jersey, loaned to me for examination, from the collection of Rutger's College, by Prof. Cook. The specimen represented in Fig. 3, Plate IX, I suspect to belong to the forepart of the lower jaw of *Mosasaurus*. It is smaller, but has the same general form as the entire teeth previously described.

The crown is more curved than in any of the preceding specimens, but like them

[1] Journ. Acad. Nat. Sci., Vol. IV, Plate XIV, Figs. 2, 3, 4; Med. and Physical Researches.

[2] Synopsis of Organic Remains, &c., Plate XI, Fig. 9.

presents its inner and outer surfaces separated by minutely denticulated ridges, and subdivided, though less distinctly, into narrow planes. The length of the crown is twenty-two lines; its antero-posterior diameter at base eleven lines; its transverse diameter twelve lines; its inner circumference twenty-eight lines; and its outer circumference eleven lines. The inner surface is obscurely subdivided into nine or ten planes, disappearing towards the apex of the crown; the outer surface into three or four planes, equally obscure, and disappearing in the same manner. The accompanying outlines, No. 5, represent sections at the base and near the apex of the crown.

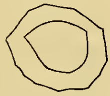
No. 5.

The fang is moderately curved, cylindroid, and measures about two inches and a half in length, of which the extra-alveolar portion comprises about half an inch. The bottom presents an elliptical funnel-shaped pit narrowing into the canal of communication with the pulp cavity. The sides of the fang exhibit no trace of excavations corresponding with cavities for successional teeth.

8. A tooth, from Monmouth County, New Jersey, presented to the Academy of Natural Sciences by Dr. J. H. Slack. The specimen, represented in Fig. 2, Plate IX, resembles that last described so nearly that it looks as if it might have been derived from the same individual, though it is considerably smaller.

The crown is seventeen lines long, with the base eight lines in diameter antero-posteriorly and seven lines and a half transversely. The surfaces of the crown are less unequally divided than in the preceding specimen by the usual ridges, which in this case are rather obscurely denticulated. The outer surface of the crown is subdivided into four planes, merging into three and disappearing towards the apex; the inner surface is subdivided into eight planes, likewise becoming obsolete towards the apex. The accompanying outlines, No. 6, represent transverse sections of the crown from near the base and apex.

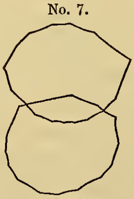
No. 6.



The fang is twenty-three lines long, and closely resembles that of the preceding specimen, in its form, the entrance to the pulp cavity, and in the absence of an excavation produced by a successional tooth.

9. A mutilated tooth, which accompanied the latter specimen, from the same locality and donor. It is larger and has a proportionately shorter and more robust fang than the preceding. The crown is more equally divided by the usual ridges, and the surfaces are more distinctly subdivided into planes; the outer surface exhibiting five, the inner surface nine. These indistinctly multiply near the base of the crown, and diminish in number and finally become obsolete towards the apex. The antero-posterior diameter of the base of the crown is eleven lines; the transverse diameter nine lines. The accompanying outline, No. 7, represents a transverse section near the base of the crown.

No. 7.



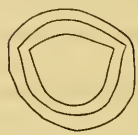
No. 8.

The fang is compressed from without inwardly, and measures two inches in length; sixteen lines antero-posteriorly, and twelve lines transversely. It presents no trace of a cavity for a successor, and the entrance to its pulp cavity is like that in the preceding specimen.

10. A mutilated tooth, from Burlington County, New Jersey, presented to the Academy of Natural Sciences by Charles C. Abbott. It is intermediate in form and size with the specimens numbered 7 and 8. The outer surface of the crown, corresponding with the antero-posterior diameter, is eight lines and a half, and it exhibits three planes. The inner surface exhibits eight planes, and the transverse diameter equals the former one. The accompanying outline, No. 8, represents a section near the base of the crown. The fang is curved cylindroid, slightly compressed, and measures two inches and a quarter in length. Its inner side posteriorly exhibits a small lenticular excavation, three lines long, produced by a successional tooth.

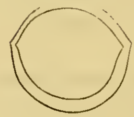
11. Two teeth, which have lost their fangs, from Monmouth County, New Jersey, presented to the Academy of Natural Sciences by E. D. Cope. The specimens, represented in Fig. 5, Plate X, and Fig. 12, Plate XI, look as if they had been derived from the same individual. They correspond in form with the more familiar one viewed as characteristic of *Mosasaurus*, but they are smooth or devoid of subdivisional planes, or at most exhibit only the feeblest disposition to their development at the base of the crown. The pulp cavity, within the specimens, presents the outward form of the crown. The length of the more perfect specimen, Fig. 5, from the enamel border of the base of the crown to the worn apex, is twenty-two lines; its antero-posterior diameter at base is eleven lines; its transverse diameter the same. The accompanying outlines, No. 9, represent transverse sections near the base of the crown, and just below and above the middle. The length of the crown of the other specimen, Fig. 12, is two inches.

No. 9.



12. An entire tooth, from Monmouth County, New Jersey, presented to the Academy of Natural Sciences by Dr. J. H. Slack. It is represented in Fig. 4, Plate IX, and is intermediate in size with those of the approximate Figs. 2 and 3, to which it also bears a general resemblance in form.

No. 10.

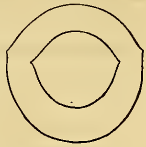


The unworn crown is twenty lines long, and is nearly circular in transverse section, as represented in the accompanying outlines, No. 10, taken from the base and below the middle. The diameter of the base of the crown antero-posteriorly is ten lines and a half; the transverse diameter nine lines and a half. The ridges separating the surfaces of the crown are minutely denticulated, and both surfaces are smooth or entirely devoid of subdivisional planes and striations. The inner surface is a little more extensive than the outer one, as represented in the accompanying sections.

The fang is straight, cylindroid, and measures two inches and a half in length and thirteen lines in diameter. It exhibits no evidence of having been coossified with its alveolus, and on the inner side posteriorly, as represented in Fig. 4, *b*, it presents a small excavation for the accommodation of a successional tooth. At the free extremity it presents a funnel-shaped pit, prolonged into the central canal of communication with the pulp cavity.

13. A tooth, which has lost its fang, from Monmouth County, New Jersey, presented to the Academy of Natural Sciences by Charles C. Abbott. It is represented in Fig. 11, Plate X, and measures two inches in length. Its apex is worn, and it is invested with enamel to the extreme base of the specimen. It bears a near resemblance to the crown of the preceding specimen, but is much larger. The base is circular in section, and measures an inch in diameter. The inner surface is slightly more extensive than the outer one, as seen in the accompanying sections, No. 11, taken from the base and above the middle of the crown. Both surfaces are devoid of the faintest trace of subdivision into planes, and are separated by the usual minutely denticulated ridges. The centre of the broken base of the crown exhibits the funnel-shaped summit of the pulp cavity, the wall of which at the broken border of the specimen is four lines thick.

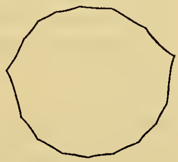
No. 11.



14. Nine teeth, coossified with small attached portions of the jaw, from Monmouth County, New Jersey, presented to the Academy of Natural Sciences by Dr. J. H. Slack. They were found together in the same marl pit, and have every appearance of having belonged to the same individual.

One of the specimens, represented in Figs. 8, 9, Plate X, is about five inches and a half in length. The apex of the crown is worn off more than in any other specimen of the kind I have ever seen. The dividing ridges are also considerably worn, though enough of one remains to ascertain that they were minutely denticulated. In its present condition the crown is two inches long, and its nearly circular base measures fourteen lines and a half antero-posteriorly and fourteen transversely. The inner side is more extensive than the outer; the former being twenty-six lines in circumference at its base, the latter twenty lines. The inner surface is distinctly subdivided into nine planes; the outer into seven. The accompanying outline, No. 12, represents a transverse section near the base of the crown.

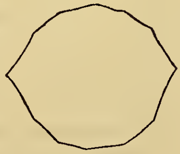
No. 12.



The extra-alveolar or exserted portion of the fang continues the cone of the crown, and is fourteen lines long by about two inches in diameter at the base. The intra-alveolar portion of the fang is two inches and three-quarters long, and appears to be a constituent portion of the jaw, so intimately is it coossified and continuous with its alveolus. Its inner side posteriorly is deeply excavated, as represented in Fig. 8, *c*, for the accommodation of a successional tooth.

A second specimen, represented in Fig. 7, Plate X, closely resembles the former, except that the inner and outer surfaces of the crown are nearly equal in extent, and are each divided into six principal planes, of which one presents a partial but feeble subdivision. The crown, very much worn at the apex and along the anterior ridge, in its present condition is two inches in length, and thirteen lines in transverse diameter at base, while the antero-posterior diameter has been about fourteen lines. The inner circumference of the base is about twenty-three lines, the outer twenty-two lines.

No. 13.

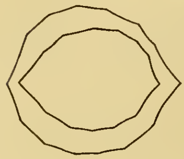


The accompanying outline, No. 13, represents a transverse section taken from near the base of the crown. The fang is three inches and three-quarters in length, and exhibits a cavity for a successional tooth like that of the preceding specimen.

Attached to the same specimen, but not represented in the figure, there is a coossified fragment of the fang of the tooth, which was situated in advance, and which was about one-half excavated to accommodate a successional tooth.

A third specimen, much mutilated, nearly resembles the former one. The inner and outer surfaces of the crown are nearly equal in extent, and each is subdivided into seven planes. The antero-posterior diameter at the base is fourteen lines and three-quarters; the transverse diameter thirteen lines. The outer of the accompanying outlines, No. 14, represents a section at the base of the crown.

No. 14.



The fang is half excavated away at the inner side and bottom for the accommodation of a successional tooth. The excavation just below the level of the extra-alveolar portion of the fang communicates with the pulp cavity its entire breadth.

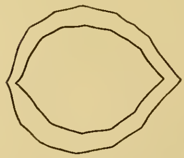
A fourth specimen, much mutilated, bears a near resemblance with the former two, but is considerably smaller. The crown, from its worn apex to the base, is sixteen lines long; its antero-posterior diameter at base is twelve lines and a half; the transverse diameter ten lines. The inner and outer surfaces are nearly equal in extent, but the latter is even slightly the greater, and is divided into seven planes, while the former is divided into six. The inner of the accompanying outlines, No. 14, represents a section of the crown near the base, —appearing more elliptical than in preceding sections.

The fang is about two inches and three-quarters long, and is nearly half excavated for a successor. The excavation communicates with the open canal of the pulp cavity.

The fifth specimen, represented in Fig. 5, Plate IX, consists of a tooth, together with the fang of a second, coossified with an alveolar fragment of the jaw.

The crown of the tooth has its apex broken and its posterior ridge worn. When perfect it appears to have been about two inches long; and its elliptical section at base measures fifteen lines antero-posteriorly and thirteen transversely. The inner and outer surfaces are nearly equal, the former being subdivided into six, the latter into eight unequal planes. The accompanying outlines, No. 15, represent sections near the base and middle of the crown.

No. 15.



The fang of the tooth is three inches and three-quarters long, and is one-half excavated antero-internally for the accommodation of a successional tooth, as represented in Fig. 5, *e*. The excavation communicates with the pulp cavity on a level with the bottom of the extra-alveolar portion of the fang, as seen at *f*.

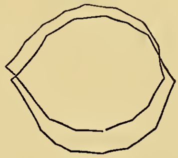
The fang of the other tooth is about one-third excavated postero-internally, as represented on the right of Fig. 5, *e*, and the excavation has exposed the pulp cavity of the tooth as seen at *f*.

The contiguous sides of the two fangs are likewise excavated together for the accommodation of a successional tooth, as seen at the middle of Fig. 5, *e*, and thus the two teeth exhibit cavities for the accommodation of three successors.

The sixth specimen is represented in Fig. 6, Plate IX, and consists of a tooth of nearly the same size and form as that in the specimen last described.

The crown when perfect has measured over two inches in length; and at base it measures fourteen lines in diameter antero-posteriorly, and twelve lines and a half transversely. The inner surface is rather more extensive than the outer, and is divided into seven planes, while the latter presents six planes. The curve of the base of the inner surface measures two inches, that of the outer surface twenty lines. The lower of the accompanying outlines, No. 16, represents a section near the base. The fang upon its inner part is almost one-half excavated to accommodate a successor, as represented in Fig. 6, *e*. The excavation has exposed the lower half of the pulp cavity, seen at *f*.

No. 16.



The seventh specimen consists of an entire tooth, represented in Fig. 10, Plate X, nearly resembling the two last described teeth.

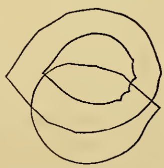
The crown is two inches in length, elliptical in transverse section, and measures at base antero-posteriorly fourteen lines and a half; transversely twelve lines. The inner and outer surfaces are nearly equal, and are rather less distinctly subdivided into planes than in the preceding specimens which accompanied this one. The upper of the accompanying outlines, No. 16, represents a section near the base of the crown.

The fang anteriorly and postero-internally presents two excavations for the accommodation of successional teeth, as represented in Fig. 10, *c*, *d*. The postero-internal excavation communicates with the pulp cavity, as seen at *e*.

The eighth specimen, represented in Fig. 4, Plate X, has the general form and proportions of its companions, but is smaller, except the fourth specimen above indicated, which it most nearly resembles.

The crown is twenty-two lines long, elliptical in transverse section, and measures fourteen lines in diameter at the base antero-posteriorly, and eleven lines and a half transversely. Its most remarkable peculiarity consists in the possession of a single carina or ridge situated posteriorly along the concave border; the ridge being minutely denticulated as in those of preceding specimens. The anterior border of the crown is thick and convex, and towards the apex presents several prominent vertical folds. The inner and outer surfaces, of equal extent, are feebly subdivided into traces of from four to six planes. The upper pair of accompanying outlines, No. 17, represent transverse sections near the base and apex of the crown. The fang is deeply excavated postero-internally, as seen in Fig. 4, *d*, for the accommodation of a successor, but the excavation has not exposed the pulp cavity of the tooth.

No. 17.



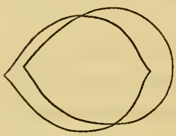
The ninth, or remaining specimen of the series under examination, is represented in Fig. 5, Plate XI, and is a miniature resemblance of the tooth last described. The crown when perfect has measured less than three-fourths of an inch in length, is elliptical in transverse section, and measures at base five lines and three-quarters antero-posteriorly, and four lines and a half transversely. Its single posterior carinated ridge is minutely denticulated as in the large teeth, and the surfaces are devoid of planes.

The fang, independent of the alveolar fragment with which it is coossified, measures about an inch and a half long, and has at its inner side posteriorly a deep excavation for a successional tooth, as seen in Fig. 5, *a*.

15. A perfect tooth, coossified with a fragment of the jaw, from Monmouth County, New Jersey, loaned by William Cornell, through Prof. Cook. The specimen was received after the present memoir and its accompanying plates were nearly completed. It closely resembles the eighth specimen of the series above described. The crown is unworn, is twenty lines long, and is elliptical in transverse section. Its base is one inch in diameter antero-posteriorly, and nine lines and a half transversely. It possesses a single ridge, situated along its posterior or concave border; and the surfaces are smooth, except that the outer one presents a feeble disposition to subdivision into four planes. The lower of the accompanying outlines, No. 17, represents a section from near the base. The fang is three inches long.

16. Two teeth, from Monmouth County, New Jersey, presented to the Academy of Natural Sciences by Dr. J. H. Slack. One of the specimens resembles the two large ones last described. The crown has the apex broken off, but is otherwise perfect. Its transverse section is elliptical, and measures at base antero-posteriorly thirteen lines; transversely ten lines and a half. It possesses a single carina, situated posteriorly, and the surfaces are totally devoid of planes. The accompanying right hand outline, with one point, No. 18, represents a section near the base. The fang is about three inches long, and exhibits on its inner side near the centre a slight excavation, five lines long, as the commencement of a cavity for a successor. The canal communicating with the pulp cavity through the fang is open.

No. 18.



The second specimen, represented in Fig. 7, Plate IX, is nearly perfect, and measures about four inches and a half long. It corresponds in all its anatomical characters with the teeth described by Prof. Owen as characteristic of a distinct genus, to which he has given the name of *Leiodon*.

The crown is twenty-one lines long, elliptical in transverse section, as represented in the accompanying left hand outline, with two points, No. 18, and measures at base antero-posteriorly thirteen lines; transversely eleven lines. Minutely denticulated ridges divide it in the usual manner into inner and outer surfaces of nearly equal extent and convexity and totally destitute of subdivisional planes.

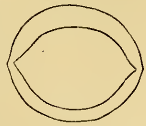
The fang is straight, and presents no trace of having been coossified with its alveolus, as is also the case with that of the preceding specimen. It further exhibits no trace of a cavity for a successional tooth.

17. The shed crown of a tooth, from St. Georges, New Castle County, Delaware contained in the museum of the Academy of Natural Sciences. It is represented in Fig. 11, Plate IX, and resembles the corresponding part of the tooth just

described. It also bears a near resemblance to a specimen described by Prof. E. Emmons,[1] under the name of *Elliptonodon compressus.*

The enamelled crown is an inch and a half long, and is elliptical in transverse section, as represented in the accompanying outlines, No. 19, representing sections below the middle and at the base. The latter measures an inch antero-posteriorly, and ten lines transversely. The acute ridges divide the crown into two surfaces about equal in extent and convexity. The surfaces exhibit a faint disposition to subdivide towards the base, but for four-fifths of their length are smooth. The transverse annulation, represented by the artist in the figure, is only one of staining of the enamel, though there is a feeble constriction of the crown corresponding with the band above its middle. The base of the specimen is excavated in a funnel-shaped manner from a thin sharp edge at the periphery to the central pulp cavity.

No. 19.

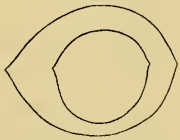


18. Two specimens of teeth, from Mount Holly, Burlington County, New Jersey, contained in the museum of the Academy of Natural Sciences.

One of the specimens, represented in Fig. 9, Plate IX, consists of the shed crown of a tooth, much worn at the apex. In its present condition it measures nineteen lines long, extending from the enamel border at the base, and in transverse section is elliptical, as represented in the outer of the accompanying outlines, No. 20. The antero-posterior diameter at base, in the perfect condition, measured sixteen lines, and the transverse diameter is thirteen lines and a half. The surfaces, about equally divided by the anterior and posterior acute ridges, are entirely devoid of subdivisional planes. The enamel is more rugose than in any of the preceding teeth, but otherwise I can see no important difference between it and several of those last described. The base is excavated in a salver-form manner, from a broken edge about a line in thickness, to the central pulp cavity.

The second specimen, represented in Fig. 10, Plate IX, consists of a comparatively small tooth, with the apex of the crown broken off so as to expose the summit of the pulp cavity. In color and general character the specimen looks as if it may have belonged to another part of the dental series of the same individual as its larger companion.

No. 20.



In form the crown has nearly resembled that of the specimen described as No. 12, represented in Fig. 4, Plate IX. When perfect it has measured about thirteen lines long; and its circular base is eight lines in diameter. It is irregularly divided by the acute ridges, of which the anterior is almost entirely obliterated by wear. The inner surface is much more extensive than the outer, and both are smooth, presenting neither trace of subdivisional planes nor rugosities. The inner curve of the base is fifteen lines and a half, the outer curve eleven lines. The inner of the accompanying outlines, No. 20, is a transverse section from the base of the crown.

The straight fusiform fang is two inches and a quarter long, and appears as if it had not been coossified with its alveolus. Just back of the centre of the inner side

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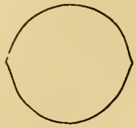
[1] North Carolina Geological Survey, 222, figs. 41, 42.

of the intra-alveolar portion it exhibits a shallow niche, about five lines long, as a commencing cavity for a successor.

19. The shed crown of a tooth, from Freehold, Monmouth County, New Jersey, sent to me for examination from the collection of Dr. C. Thompson, through Prof. Cook. It is represented in Fig. 8, Plate IX; is somewhat water-worn, and has lost its apex. It resembles the crown of the last described specimen, but is larger and has its surfaces equally divided by the anterior and posterior ridges. The diameter of the nearly circular base, represented in the accompanying outline, No. 21, is ten lines and a half antero-posteriorly, and ten transversely.

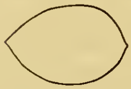
No. 21.



20. A tooth, coossified with its alveolus, from Monmouth County, New Jersey, loaned by O. R. Willis, through Prof. Cook. It is represented in Fig. 10, Plate XI, and is two inches and three-quarters long.

The crown resembles that of the specimens described under Nos. 16, 17, 18, and represented in Figs. 7, 9, 11, Plate IX, except that it is more compressed and curved in relation with its length. It presents the form viewed as characterizing the genus *Leiodon*, and is about equally divided by the usual pair of ridges into two surfaces, which are smooth. The length of the crown is fifteen lines; its antero-posterior diameter at base ten lines and a half; its transverse diameter seven lines. The transverse section is elliptical, with acute poles, as represented in the accompanying outline, No. 22.

No. 22.



The fang is of unusual breadth, in comparison with its length, and is compressed from without inwardly. Postero-internally it is deeply excavated, as seen in Fig. 10, *c*, for the accommodation of a successional tooth.

21. The fragment of a jaw containing two teeth, from Monmouth County, New Jersey, presented by Dr. J. H. Slack to the Academy of Natural Sciences. It is represented in Figs. 6, 7, Plate XI, and bears a near resemblance to the corresponding portions of a specimen figured by Dr. Morton [1] and loaned to him by Dr. De Kay as characteristic of *Geosaurus Mitchelli*.

The jaw fragment is three inches and a half long, and is broken away along the line of the dental canal, at the bottom of the alveoli. Its outer surface is vertically moderately convex, and presents at the broken border a row of three vasculo-neural foramina communicating with the remains of the dental canal. The two extremities of the specimen exhibit portions of alveoli, from which teeth appear to have been lost together with their fangs. Postero-internally to the portion of the anterior alveolus (*f*) there is an excavation (*e*) for a successional tooth.

The intermediate portion of the fragment contains the fang (*c*) of a shed tooth, coossified with the jaw and containing a successor (*d*), and an entire tooth (*a*) occupying a functional position behind the former.

The fang (*c*) of the shed tooth is so intimately coossified with the jaw as almost to appear as a constituent portion of the latter. The extra-alveolar portion of the fang presents a funnel-shaped excavation or crater, communicating at bottom by

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[1] Synopsis of the Organic Remains of the Cretaceous Group, etc., p. 28, Plate XI, Fig. 10.

an orifice with the excavation for the successional tooth. The latter excavation nearly involves the whole of the intra-alveolar portion of the fang. The contained tooth (Fig. 6, *d*, Fig. 7) is a fully developed crown, with a large interior pulp cavity, extending to the thin edge of the developing fang as usual in dentition. It resembles that of the last described specimen, but is shorter and more robust in its proportions. Further, the acute ridges divide the crown unequally, the outer surface being more extensive and convex than the inner. The surfaces also are strongly wrinkled longitudinally, especially towards the base, and there exists an evident disposition to subdivide into planes, especially on the outer surface, as represented in Fig. 7. The crown is thirteen lines and a half long, elliptical in transverse section, as represented in the accompanying outline, No. 23. The antero-posterior diameter of the slightly contracted base is nine lines; the transverse diameter eight lines. The inner curvature of the base is nine lines and a half, the outer curvature fifteen lines and a half.

No. 23.

The tooth (Fig. 6, *a*) occupying a functional position behind the preceding has the crown considerably worn at the apex, and the enamel is also partly worn away at the base antero-externally, and on several positions of the dividing ridges. It resembles the unworn crown occupying the cavity in advance, but the appearance of a tendency in the surfaces to subdivide into planes is less obvious, and, indeed, is hardly evident on the external surface, where it is most so in the other tooth.

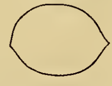
The fang is intimately coossified with its alveolus, and a deep excavation (*b*) exists at its posterior part internally for a successional tooth. The exserted portion of the fang is eight lines long, and at the alveolar margin occupies a breadth antero-posteriorly of sixteen lines, transversely thirteen lines.

22. Fragments of both sides of the lower jaw, and of both pterygoid bones, with teeth, from the same individual. The specimens were obtained from the Greensand of Holmdel, Monmouth County, New Jersey, and have been submitted to my examination by Prof. Reiley, of Rutger's College, through Prof. Cook. The teeth preserved in the fragments resemble those above described which have the laterally compressed, smooth crown, and correspond with those which have been viewed as characteristic of the genus *Leiodon*.

A fragment of the back part of the right dental bone, represented in Fig. 3, Plate XI, contains a perfect tooth, apparently the penultimate, a portion of the alveolus behind, and portions of the two alveolj in advance.

The outer surface of the bone is a vertical plane, rounded at the alveolar border and broken at the lower. The back end is broken off, and the oblique border below is that for articulating with the coronoid bone behind. A large vasculo-neural foramen, opening into the dental canal along the middle of the specimen, is situated below the tooth retained in the specimen. Part of a similar and smaller foramen is also situated rather higher at the anterior broken border.

No. 24.



The tooth preserved in the fragment has its fang coossified with the alveolus and the border of the jaw. It bears a near resemblance with the specimen described under No. 20. The crown, situated somewhat obliquely with its outer face directed forward, is an inch long, and is divided by minutely denticulated ridges into two smooth surfaces, of which the outer is slightly the larger. The transverse section, as represented in the accompanying outline, No. 24, is elliptical, and the antero-posterior diameter at the slightly constricted base is nine lines and three-quarters; transversely six lines and a half.

The extra-alveolar portion of the fang is half an inch high; sixteen lines in diameter antero-posteriorly at the alveolar border, and eleven lines transversely. The intra-alveolar portion of the fang is an inch long, and encroaches for half its length within the dental canal.[1] Postero-internally, together with the contiguous portion of the jaw, it is excavated into a cavity which contains the crown of a successional tooth.

The alveolus in advance retains the outer half of a coossified fang, which was about a third excavated for a successor. The portions of the alveoli at the anterior and posterior border have the appearance as if their former occupants had been lost entire, crown and fang together.

A fragment of the left dental bone, of which Fig. 4, Plate XI, represents an inner view of part of the specimen, nearly corresponds with the former one of the opposite side. The entire tooth it contains corresponds in position with that in advance of the one preserved in the former. The tooth larger than in the preceding specimen is like it in form. The crown, with its apex considerably worn, thus reduced, is thirteen lines long; is nine lines and three-quarters in diameter at base antero-posteriorly, and seven lines and a half transversely. The fang is two inches long, and the dental canal pursues its course just external to its bottom.

The specimen is especially interesting from the circumstance that the successional tooth (*c*), inclosed in the cavity of the fang (*b*) in advance, having been accidentally partially broken away, exhibits in the interior a minute successor (*d*). It thus appears that in the succession of development of the teeth of *Mosasaurus* a new tooth originates within its predecessor, while this is still contained in the excavated fang of the tooth occupying a functional position at the border of the jaw. As the latter is displaced by its successor it would appear that as the crown of this protrudes from the jaw the new tooth is excluded from its place, and is made to assume a position on the exterior of the fang of its parent. The new tooth, as if desirous of once more obtaining admission into the position from which it had been excluded, in its growth induces absorption of the fang of its predecessor so as to accommodate its increasing size.

Two fragments of the right pterygoid bone, represented in Figs. 1, 2, Plate XI. The larger fragment contains a tooth and the fangs and alveoli of four others; the smaller fragment contains two teeth, part of another, and part of a large successional cavity which appears to correspond with a similar part at the end of the larger fragment. It would thus appear that there were eight teeth to the full series, corresponding in this respect with the number of pterygoid teeth in the Maestricht Monitor. The anterior teeth, however, are very much larger than in

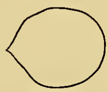
[1] The artist neglected to represent in the figure the bottom of the fang, visible through the vasculo-neural foramen, so that the tooth looks actually acrodont.

the latter, and, indeed, they so far exceed them in relation with the size of the mandibular or maxillary teeth that I for a long time hesitated in admitting the fragments to belong to the pterygoid bone, and suspected that they belonged to part of the upper jaw. The anterior extremity of the larger fragment, however, exhibits sutural marks, and the fang of the first tooth indicates this to have been smaller than those immediately succeeding it. The second, third, and fourth teeth were the largest of the series and nearly equal in size; then followed in size the first and fifth, which were nearly equal, and finally the sixth to the eighth, which became successively smaller.

The anterior pair of fangs (Fig. 2, *a*, *b*) preserved in the larger fragment are coossified with their alveoli, and include in cavities on their inner side posteriorly the mutilated remains of successional teeth. Succeeding the fangs indicated there is a large vacant alveolus (*c*), from which the former occupant has been lost, fang and crown together. Then follows a tooth (*d*), with the end of the crown broken, and the fang coossified with its alveolus.

The tooth, from the broken apex of the crown to the bottom of the fang, is two inches and ten lines long. The crown, in shape and construction, resembles those described under Nos. 14 and 16, which have only a single acute ridge along the posterior or concave border of the crown. The surfaces are devoid of subdivisional planes, though there is a slight tendency to their development externally. The transverse section is ovate, as represented in the accompanying outline, No. 25. The antero-posterior diameter at the base is nine lines; the transverse diameter seven lines. The fang on its inner side presents a small excavation containing the remains of a successor.

No. 25.



Back of the tooth described is a vacant alveolus, from which its former tenant has been lost, crown and fang together. To the inner side posteriorly of this vacant alveolus there is a small cavity for a successional tooth which had been destined to occupy the former.

Above the fangs of the teeth the bone internally presents a large space or groove into which the bottoms of the alveoli for a short distance protrude.

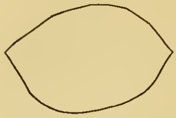
The two teeth, occupying the small or posterior fragment of the pterygoid bone (Fig. 1), are miniatures of the tooth preserved in the anterior fragment, and closely resemble the last of the series described under No. 14, and represented in Fig. 5, Plate XI. The crown of the foremost of the two teeth has its apex broken, and measures at base five lines and a half antero-posteriorly, and four lines and a quarter transversely. The crown of the last tooth is half an inch long, four lines and a quarter in diameter at base antero-posteriorly, and three lines transversely.

23. The crown of a small tooth, which has lost its fang, from Burlington County, New Jersey, presented to the Academy of Natural Sciences by T. A. Conrad. It is represented in Fig. 15, Plate XI, and resembles the crowns of the two teeth last described, like them having but a single acute ridge at the back or concave border. Its apex is worn off, but in its perfect condition it measured about an inch in length. Its ovate base is seven lines and a half in diameter antero-posteriorly, and six lines transversely.

This specimen apparently serves to fix the true character of a similar one obtained by Prof. Emmons at Elizabethtown, Cape Fear, North Carolina, and described by me under the names of *Drepanodon impar*[1] and *Lesticodus impar*.[2]

24. A tooth, differing from any other specimens in its soft, chalky consistence and ochre color, from near Hanover, Burlington County, New Jersey, contained in the museum of the Academy. The crown is worn and broken at its apex, and when perfect appears to have been near two inches long. It is elliptical in section, and not quite equally divided by the usual ridges into two surfaces, which exhibit an obscure disposition to subdivide into planes. The antero-posterior diameter of the base of the crown is fourteen lines, the transverse diameter ten lines. The accompanying outline, No. 26, represents a section at the base of the crown, of which the inner curve is twenty-one lines, the outer seventeen lines.

No. 26.



The fang is two inches and a half long, nearly two inches in breadth from before backward, and one inch and a quarter transversely. It is about one-third excavated at the bottom and postero-internally for a successional tooth, but the excavation does not expose the pulp cavity, except through two narrow vasculo-neural canals of the fang.

25. A much mutilated tooth, from Monmouth County, New Jersey, presented to the Academy of Natural Sciences by Charles C. Abbott. The crown nearly resembling that last described, both in size and form, has the remains of the inner surface rather more distinctly subdivided into planes, and is slightly striated at the base. The outer surface, nearly all destroyed, in the small remaining portion gives evidence of its also having been more distinctly subdivided than in the former specimen. The antero-posterior diameter of the base of the crown is thirteen lines, and its transverse diameter has been about nine lines.

The fang, preserved entire, unexcavated, and without evidence of having been coossified with its alveolus, is particularly remarkable for its small size, in relation with the crown, in comparison with other specimens. It measures an inch and a half long, is nearly as broad, being seventeen lines antero-posteriorly, and is ten lines transversely.

The interior pulp cavity of the tooth appears as a large compressed fusiform receptacle, extending as nearly to the end of the fang as it does to the summit of the crown.

26. A mutilated tooth, from Monmouth County, New Jersey, presented to the Academy of Natural Sciences by Dr. J. H. Slack. The crown had nearly the same form as that of the preceding specimen, but it is smaller, and the surfaces are distinctly subdivided into planes. The antero-posterior diameter of the base of the crown is 11 lines, the transverse diameter seven lines and three-quarters.

27. Two shed crowns of teeth, nearly alike, one from St. George's, New Castle County, Delaware, presented to the Academy of Natural Sciences by T. A. Conrad;

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[1] Proc. Acad. Nat. Sci. 1856, VIII, 255; Report of the North Carolina Geological Survey, 1858, 224, Figs. 45, 46.

[2] Proc. Amer. Philos. Soc., 1859, VII, 10.

the other from near Woodbury, Gloucester County, New Jersey, presented to the Academy by Dr. J. L. Burtt. The former is represented in Fig. 12, Plate X; the latter in Fig. 13, of the same Plate.

No. 27.

No. 28.

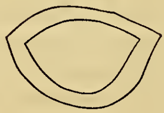
They resemble the crown of the tooth last described, but are in a better condition of preservation. They are divided in the usual manner into two surfaces, of which the inner is rather more convex than the outer, and both are distinctly subdivided into planes. The New Jersey specimen, of which the outline, No. 27, represents a transverse section, presents four planes on its outer side and seven on its inner side; and it measures eighteen lines in length, nine lines and three-quarters antero-posteriorly at base, and seven lines transversely. The Delaware specimen, of which the outline, No. 28, is a section, exhibits seven planes externally and internally, and measures seventeen lines long, nine lines and a quarter antero-posteriorly at base, and six lines and a half transversely.

28. A tooth, from Mount Holly, Burlington County, New Jersey, presented to the Academy of Natural Sciences by Dr. S. G. Morton. The crown has its apex broken off, and the ridges dividing the former are considerably worn. When perfect it has been about an inch and a half long, with the base ten lines and a half antero-posteriorly, and eight lines transversely. The surfaces are devoid of subdivisional planes, or exhibit only the faintest traces of several towards the back border of the crown. The inner surface more convex than the outer, has the curve of its base eighteen lines in width, while the outer one is thirteen in width.

The fang is entire, and appears not to have been coossified with its alveolus. The exserted portion forms a curved shoulder measuring externally only five lines in length, while at the border it is sixteen lines in antero-posterior diameter, and thirteen lines in transverse diameter. The intra-alveolar portion of the fang is an inch and a half long, straight, somewhat compressed, and tapering below. On its inner side posteriorly is a small excavation for a successional tooth.

29. A fragment of a jaw, with portions of three alveoli, of which one contains the fang of a tooth deeply excavated and containing a successor. The specimen is from Marlboro, Monmouth County, New Jersey, and was loaned to me, from the collection of Rutger's College, by Prof. Cook.

No. 29.



The successional tooth, of which an inner view is represented in Fig. 11, Plate XI, is a crown with a large interior pulp cavity and thin walls. From the apex to the broken edge of the base it measures about twenty-two lines in length. In transverse section it is irregularly elliptical, as represented in the outlines, No. 29; its inner curvature being more convex and longer than the outer. The anterior and posterior acute ridges are minutely denticulated, and the surfaces they separate are totally devoid of subdivisional planes.

30. Two small teeth, from Freehold, Monmouth County, New Jersey, belonging to the collection of Dr. C. Thompson, and loaned to me through Prof. Cook. They are represented in Figs. 14, 15, Plate X, and appear to have belonged to the same individual.

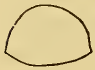
They have the same general construction as the teeth above described, but in some respects are peculiar. The crown is demi-conical, curved backward, and divided before and behind by acute ridges with obscure traces of denticulation. The outer surface, the reverse of the ordinary condition in preceding specimens, is much more extensive and convex than the inner one, and both are devoid of subdivisional planes.

The crown of the smaller specimen, Fig. 14, has its point slightly bent outwardly; externally is nine lines long, with the curvature of the base thirteen lines; the curvature of the base internally is eight lines. The antero-posterior diameter of the base is seven lines; the transverse diameter five lines. The outline, No. 30, represents a transverse section below the middle of the crown.

No. 30.

The crown of the larger specimen, Fig. 15, has its apex broken off, but when perfect was about an inch long. The base is eight lines in diameter antero-posteriorly, and five lines and three-quarters transversely. The curve of the external surface at bottom is fourteen lines; that of the internal surface eight lines. The outline, No. 31, represents a transverse section near the base of the crown.

No. 31.



The fang presents the usual characters described in the preceding specimens, but the excavation corresponding with the cavity for successional teeth is more median in its position than in the others, as represented in Fig. 15, *c*.

31. A fragment of the left side of a lower jaw from Monmouth County, New Jersey, presented to the Academy of Natural Sciences by Charles C. Abbott. It is apparently from the fore part of the mandible of a young *Mosasaurus*, and is of special interest because it contains the fangs of three teeth, of which one is firmly coossified with its alveolus, while the others are loosely inserted. The specimen, from which the inner part of the bone has been removed to exhibit the fangs of the teeth, is represented in Fig. 8, Plate XI.

The fragment of jaw is five inches in length, and at its middle is an inch and three-quarters in depth. Its outer surface forms about one-third of a cylinder, and just above the middle presents a row of four large vasculo-neural foramina, communicating with the dental canal, which pursues its course exterior to the bottoms of the included fangs of the teeth. A row of smaller foramina exists also near the base of the fragment. Near the alveolar border, opposite the posterior of the contained fangs, the jaw is an inch and a quarter thick. The inner side of the base, as seen in the figure, exhibits the sutural marks for the splenial bone.

The coossified fang of the specimen is intermediate to the others, and is nearly half excavated to accommodate a successor which it still retains, as seen in Fig. 8, *d*.

The successional tooth, of which an outer view is also given in Fig. 9, is a narrow, much curved, conoidal crown, about fourteen lines long; six lines wide at base antero-posteriorly, and five lines and a quarter transversely. It is divided in the usual manner by a pair of minutely denticulated ridges into two surfaces, which are smooth and devoid of subdivisional planes. The inner surface more convex and extensive than the outer, presents a curvature at base of eleven lines, while the outer curvature measures seven lines. The outline, No. 32, represents a transverse section near the base of the crown.

No. 32.

The loosely inserted fangs in advance and behind the one containing the successional tooth, appear never to have been coossified with their alveoli. The foremost one, in the usual position postero-internally, presents a shallow lenticular depression a couple of lines in length, the earliest appearance of a cavity for a successional tooth. This escaped the notice of the artist, and has therefore been inadvertently left out of the figure. The posterior fang (*b*) exhibits a large and conspicuous excavation (*c*).

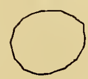
The remains of alveoli at the broken ends of the specimen exhibit coossified portions of fangs, with large excavations indicating them to have been like the one preserved with its contained successor.

This very instructive specimen, in the successive development of the teeth, certainly shows that the crown of the new tooth is developed at the postero-internal portion of the alveolus, and induces a gradual absorption in the contiguous simply inserted fang to accommodate itself. As the crown continues to grow its containing cavity enlarges at the expense of the fang of the old tooth, which in the meantime becomes coossified with its alveolus as if to strengthen its position or resist expulsion, which might indeed readily take place, were it not for the coossification. After the new crown has reached its full growth, it is followed by the development of its fang which causes the protrusion of the former, while the old fang is reduced to a mere chimney or tube bushing or investing the alveolus.

32. A tooth, which has lost the intra-alveolar part of its fang, from Mullica Hill, Gloucester Co., New Jersey, presented to the Academy of Natural Sciences by Dr. W. C. Hartman. It is represented in Fig. 16, Plate X; and has nearly the size and form of the successional tooth in the fragment last described.

The crown, somewhat worn at the apex, is an inch and a quarter long, and about six lines and a half in diameter at base antero-posteriorly, and five lines and three-quarters transversely. An acute ridge divides it anteriorly, which is not perceptibly denticulated; a posterior ridge is undeveloped, that is to say, in what appears to be the position it might occupy, there is only a feeble elevation like those which subdivide the surfaces of the crown. The outer of the latter exhibits five planes disappearing beyond the middle of the crown. The inner surface, towards the base, exhibits less distinctly nine subdivisional planes. The outline, No. 33, represents a section near the base of the crown.

No. 33.



33. The crown of a tooth, which has lost its fang, from a Cretaceous formation of Alabama. The specimen was loaned to me by Dr. R. W. Gibbes, who described and figured it in his Memoir on Mosasaurus and the allied genera,[1] page 9, plate III, figs. 6-9, and referred it to an extinct Saurian under the name of *Holcodus acutidens*. The specimen, represented in Fig. 17, Plate X, has the enamelled crown three-fourths of an inch in length. The base is elliptical in transverse section, and measures five lines antero-posteriorly, and four lines transversely. The crown is nearly equally divided by acute ridges, which are imperfect in the specimen, but appear not to have been denticulated. The surfaces are subdivided into narrow,

slightly depressed planes, and the inner one is strongly striate at base. The bottom of the exposed pulp cavity of the crown is two lines and a half by one line and three-quarters in diameter.

34. Two imperfect specimens of teeth, obtained by Dr. Hayden from the Cretaceous formation Number 4, at the mouth of White River, Nebraska. One of them, represented in Fig. 18, Plate X, is the shed crown of a small tooth, resembling the preceding, except that it is slightly narrower in proportion to its length, and the surfaces, though generally more striate, are almost devoid of subdivisional planes, especially the inner one. Its length is ten lines, the antero-posterior diameter of the oval base four lines and three-quarters, and the transverse diameter four lines. The second specimen, Fig. 19, consists of portions of both fang and crown of a tooth, which appears to have resembled the former one.

35. The fragment of an upper jaw of the right side received for examination from the Museum of the Smithsonian Institution. It is labelled *Leiodon*, from near Marion, Alabama, and the adherent matrix indicates that it had been imbedded in a soft cream-colored limestone, resembling the coarser varieties of chalk. It measures four inches along the alveolar border, and contains three fangs, from which the crowns have been broken off. The outer surface is longitudinally straight, vertically convex, and is rough. About an inch above the alveolar border it exhibits a transverse row of vasculo-neural foramina communicating with a dental canal within. The intermediate of the three fangs preserved in the specimen is deeply excavated in the usual manner and contains the crown of a successional tooth. The latter, represented in Fig. 7, Plate XIX, is about ten lines long, and agrees in form with those ascribed to *Leiodon*.

36. A supposed pterygoid bone, previously indicated, from near Columbus, Mississippi, discovered by Dr. Wm. Spillman, together with vertebræ, a humerus, and other remains of a Mosasauroid Reptile, already described. The specimen is represented in Fig. 14, Plate XI; and I suppose it to be the greater portion of the left pterygoid. It bears some resemblance to a fragment of the lower jaw of a Lepidostoid Fish, and clearly indicates a species, if not a genus, distinct from the more familiar *Mosasaurus* of New Jersey.

The fragment is broken at both ends, though the anterior one appears to be nearly complete; and in its present state it measures three inches long. The outer border is broken, and the upper transversely convex surface, over an inch in breadth, is also mutilated. The inner border forms a narrow ledge defining the lower from the upper surface.

The specimen contains five teeth, a vacant alveolus, and portions of two others at the extremities, so that the complement of teeth appears to have accorded with that of the pterygoid series of the great *Mosasaurus*. The crowns are sustained on large osseous pedestals, as in the latter, but instead of being lodged in deep sockets they are rather arranged in a series occupying a broad groove; the fangs being coossified with each other, with the outer parapet of the bone, and the bottom of the groove, leaving the inner sides for three-fourths their length exposed.

The anterior four teeth successively increase in size, are then followed by a capacious vacant socket, and then by another tooth as large as the fourth one.

The crowns are conical, with a circular base, and are strongly curved backward. They are nearly equally divided by an acute ridge, externally and internally, which only extends about half the length of the crowns from their apex. The anterior and posterior surfaces are strongly and comparatively coarsely striated.

The crown of the first tooth is two lines long, that of the second two lines and three-fourths, of the third four lines; the others are broken at the apex. The diameter of the first at base is one line and a half; of the last tooth three lines.

The fangs of the anterior three teeth are coossified together, but are separated from that of the fourth tooth by a wide crescentoid fissure. Following the fourth tooth is a thimble-like socket half an inch deep at its outer wall, and five lines wide. The fangs of the second, fourth, and last teeth present excavations at their inner part posteriorly for the accommodation of successors.

Among the many specimens of teeth which have been indicated and described, it may be noticed that there are a number of well-marked varieties of form which might be viewed as representing different genera and species of *Mosasauroids*, were it not that through intermediate forms they more or less graduate into one another. Referring to the plates IX, X, XI, in which nearly all the varieties of teeth have been figured, the gradation of form can readily be traced. If most of the specimens belong to the same species, the variation of form is certainly remarkable; but on the other hand, if the well-marked varieties of form be considered as indicating distinct species, then the number of these is far greater than any one had suspected.

a. The specimens described under Numbers 1, 3, 4, 5, 7, 8, 10, represented in Figs. 1, 2, 3, Plate IX; Figs. 1, 2, 3, Plate X, exhibit teeth answering to the usual description of authors as characteristic of the great *Mosasaurus.* The crown, long, conical, curved especially towards the apex, and unequally divided by a pair of acute ridges into two surfaces, of which the inner is the more extensive and convex, and both are subdivided into narrow planes. The specimens present a wide range in size, and differ in the relative extent of their two surfaces, and in the number and distinctness of their subdivisional planes.

b. Number 9 resembles those intermediate in size of the foregoing, but has the crown more compressed and less unequally divided by the acute ridges.

c. Number 6, Fig. 6, Plate X, resembles the larger specimens of *a*, but has the crown somewhat compressed, is less unequally divided by the acute ridges, has more numerous subdivisional planes but less distinct, and it is striated.

d. The eight large specimens of Number 14, most of which are represented in Figs. 5, 6, Plate IX; Figs. 7–10, Plate X, resemble the larger ones of *a*, but the crowns are nearly or quite equally divided by the acute ridges. In several the crown is nearly as full as in *a*, but in others is compressed; and in one specimen Fig. 4, Plate X, there is but a single acute ridge to the crown. The ninth tooth of the series Number 14, Fig. 5, Plate XI, supposed to have belonged to the same individual, is a miniature form of the specimen just indicated with a single acute ridge, except that it is destitute of subdivisional planes.

e. Numbers 11, 12, 13, the smaller specimen of Number 18, and Numbers 19 and 31, Figs. 4, 8, 10, Plate IX; Figs. 5, 11, Plate X, and Figs. 9, 12, Plate XI, exhibit crowns of teeth having nearly the form of those of *a*, but totally devoid of subdivisional planes. They present a great range of size, and vary in the relative extent of their inner and outer surfaces.

f. Number 15 resembles the large specimen of *d*, Fig. 4, Plate X, which has a single acute ridge, but it is almost destitute of subdivisional planes.

g. Numbers 16, 17, and the large specimen of Number 18, Figs. 7, 9, 11, Plate IX, have crowns like the more compressed ones of *d*, but are totally destitute of subdivisional planes, and one of the specimens has but a single acute ridge as in *f.*

h. Numbers 20, 22, 23, 35, Figs. 1–4, 10, Plate XI; Fig. 7, Plate XIX, have crowns like the preceding *g*, and the small one of *d*.

i. Number 21, Figs. 6, 7, Plate XI, has the crowns as in the preceding, but strongly striated, and with a disposition to form subdivisional planes.

j. Numbers 24, 28, 29, Fig. 11, Plate XI, have crowns intermediate in character with the more compressed ones with subdivisional planes of *d*, and the two ridged ones of *g* without subdivisional planes.

k. Numbers 25, 26, 27, Figs. 12, 13, Plate X, have compressed crowns, nearly equally divided by acute ridges, and with the surfaces subdivided into planes, like the compressed crowns of *d*, but they are smaller.

l. Number 30, Figs. 14, 15, Plate X, have demiconoidal crowns, with the inner surface of less extent and convexity than the outer, the reverse condition usually observed in *Mosasaurus*. They perhaps indicate a different genus from the true *Mosasaurus*.

m. Numbers 32, 33, 34, Figs. 16, 17, 18, 19, Plate X, are small forms intermediate to those of *e* and *k*.

n. Number 36 Fig. 14, Plate XI, exhibits teeth with crowns decidedly peculiar.

MACROSAURUS.

Macrosaurus lævis.

Macrosaurus lævis, OWEN, Jour. Geo. Soc., Lond. 1849, V, 380.
Macrosaurus, EMMONS, Report North Carolina Geol. Sur., 1858, 213, Fig. 34 *a*.

In the Proceedings of the Geological Society of London, Prof. Owen describes two vertebræ, forming part of a collection of fossils, from the Green-sand of New Jersey, submitted to his examination by Prof. Henry Rogers.[1] These vertebræ, Prof. Owen states, "appertain to the procœlian type, and in the degree of the anterior concavity and posterior convexity of the centrum most resemble the vertebræ of *Mosasaurus*. They are, however, longer and more slender; the character of the caudal vertebræ of the *Mosasaurus*, with their anchylosed hæmal arch, is well known and sufficiently marked. That the vertebræ in question have not formed part of a tail of a reptile, is shown by the entire absence of hypapophyses as well as hæmapophyses from the under surface of their centrum; from the side of which, however, a large transverse process, probably a parapophysis, has projected. That

[1] Notes on Remains of Fossil Reptiles discovered by Prof. Henry Rogers, in Green-sand Formations of New Jersey. Proc. Geol. Soc. Lond., 1849, V, 380.

they had not come from the cervical or abdominal regions of the spine of the Mosasaur was satisfactorily proved by examples of vertebræ of the true *Mosasaurus Maximiliani*, from both these regions of the body, from the same deposits and locality. The difference in the forms and proportions of the vertebræ in question with corresponding ones of the *Mosasaurus* having diapophyses from the sides of the centrum, and no hypapophyses, is so great, that I cannot refer them with any probability to the same genus: they might belong to the *Mosasauroid* genus *Leiodon;* but in the absence of the confirmatory evidence of the teeth it seems preferable to refer the vertebræ in question to a new genus, which I propose to call '*Macrosaurus*,' from the length of the body indicated by the proportions of the vertebræ. I have no doubt, however, that it appertains to the *Mosasauroid* family of Lacertian Reptiles, not to the procœlian Crocodilia."[1]

The collection of the Academy of Natural Sciences contains a number of vertebræ, which appear to me to agree in character with those assigned by Prof. Owen to *Macrosaurus*, but I cannot avoid the suspicion that both the specimens in question and those described by the high authority just mentioned, really appertain to the dorsal series of *Mosasaurus.*

Figures 19, 20, Plate VII, represent one of the vertebræ referred to, from Freehold, Monmouth County, New Jersey, presented to the Academy by Mr. O. R. Willis. The body measures three inches in length, and when perfect had its posterior convexity about twenty-seven lines high and wide. From the fore part projects, on each side, a robust, conoidal, transverse process, which, when entire, has measured an inch and three-quarters in length.

Another specimen, represented in Figs. 1, 2, Plate III, is also from Monmouth County, New Jersey, and was presented to the Academy by C. C. Abbott. It probably belongs to a more anterior position of the dorsal series than the preceding, with which it agrees in the size and form of the body. The transverse processes have projected from the conjunction of the latter with the vertebral arch about the middle of the length of the body, and have been of robust proportions. The vertebral canal, preserved in the specimen, has its floor depressed towards the middle, and is seven lines high and ten wide at its entrance anteriorly.

A similar, but somewhat larger dorsal vertebra has been described and figured by Prof. Emmons, in the North Carolina Geological Survey.[2] The specimen was obtained from the Green-sand of Cape Fear River, North Carolina, and has been referred by Prof. Emmons to *Macrosaurus.*

A series of four mutilated dorsal vertebræ, agreeing in form and construction with the preceding, from Burlington County, New Jersey, were presented to the Academy by Mr. L. T. Germain. The first has its body two inches and a half long, the others are slightly less. The first, when perfect, has had its posterior convexity about twenty-one lines in diameter; a second, which did not immediately follow the former, had its convexity about twenty-three lines wide, and nineteen high; and

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[1] Notes on Remains of Fossil Reptiles discovered by Prof. Henry Rogers, in Green-sand Formations of New Jersey. Proc. Geol. Soc. Lond., 1849, V, 381, Plate XI, Figs. 1–6.

[2] P. 213, Fig. 34, *a*.

a third has its convexity two inches wide, and twenty-one lines high. The spinal canal, preserved in two of the specimens, has a semi-circular form in transverse section, and measures nine lines wide, and six lines high at the entrance.

POLYGONODON.

Polygonodon vetus.

Polygonodon vetus, LEIDY, Proc. Acad. Nat. Sci., 1856, VIII, 221.
Polygonodon rectus, EMMONS, Report North Carolina Geological Survey, 1858, 218, Fig. 37, A.; Manual of Geology, 1860, 208, Fig. 3.
Mossosaurus rectus, EMMONS, North Carolina Geol. Surv., 1858, 218.

The name of *Polygonodon vetus* was founded on a remarkable specimen, consisting of a shed tooth, from the Green-sand of Burlington County, New Jersey, from whence it was obtained by Lewis T. Germain, and was loaned to me for examination by Prof. Cook. The specimen represented in Figs. 12, 13, Plate IX, consists of a nearly entire crown, worn at the apex and along the anterior and posterior borders. In construction it resembles the crown of the teeth of *Mosasaurus*, but is exceedingly narrow in comparison. It is in the form of a slender cone with the length more than three times the breadth of the base, compressed from without inwardly, and slightly curved inward and backward. It is nearly equally divided by acute ridges extending the length of the crown anteriorly and posteriorly. The ridges are much worn, so that it cannot be ascertained whether they were denticulated. The surfaces of the crown are subdivided into well-defined and slightly unequal narrow planes, there being seven externally and six internally. The enamel is quite smooth, though finely fissured longitudinally and jet black in the specimen. The transverse section, as represented in the outline, No. 34, is elliptical with acute poles. The base is hollowed into a shallow funnel from a thick broken edge to a central pulp cavity, which is small, narrow, and of the shape of the crown. The interior dentine is jet black and of dense structure.

No. 34.

The length of the specimen is twenty lines; its width at base six lines by four lines and a half. The tooth may have belonged to *Discosaurus* or *Cimoliasaurus*, but the matter must be left for future determination.

A specimen, identical in form and size with that just described, was found by Prof. Emmons on Cape Fear River, North Carolina, and was probably derived from the Green-sand. It is described and figured in the North Carolina Geological Survey, page 218, Fig. 37 (A).

HADROSAURUS.

Hadrosaurus Foulkii.

Hadrosaurus Foulkii, LEIDY, Proc. Acad. Nat. Sci., Phila., 1858, 218.

A remarkable reptile, of huge proportions, has been proved to have existed during the Cretaceous period of the Western Continent, to which the name of *Hadrosaurus Foulkii* has been applied.

Attention was first called to the discovery of remains of the *Hadrosaurus*, in the autumn of 1858, by W. Parker Foulke, of Philadelphia, Member of the Academy of Natural Sciences, a gentleman who has always displayed a great interest in the advancement of the objects of the latter institution. While passing the season at Haddonfield, Camden County, New Jersey, Mr. Foulke learned from one of his neighbors, John E. Hopkins, that in digging marl upon his farm, twenty years back, there had been found a number of large bones. These were said to have consisted mainly of vertebræ, and had been gradually distributed among visitors, who were curious in such objects, so that none remained in the possession of Mr. Hopkins.

In the hope of finding additional portions of the skeleton, with the permission of the latter gentleman, Mr. Foulke employed men to search in the place of the old excavation. This was situated in a narrow ravine, through which a brook flowed eastwardly into the south branch of Cooper's Creek. At the depth of nine feet from the surface the men were successful in finding numerous bones. These were imbedded in a stratum of tenacious, bluish-black, micaceous clay, in association with a multitude of shells,[1] an echinoderm,[2] several small teeth and vertebræ of fishes,[3] a coprolite, and some fossilized coniferous wood.

The bones are ebony-black, firm in texture, heavy, and strongly impregnated with ferruginous salts, especially sulphuret of iron, which often also adheres to parts in nodules and fills up interstices, foramina, and the spongy structure. They are generally well preserved, except that many are fractured, but none are water rolled, and a few specimens only appear somewhat crushed.

These osseous remains, upon which the genus *Hadrosaurus* has been founded, indicate a Reptile of equally huge proportions, and of the same habits of life, as the great *Iguanodon* of the Wealden and Cretaceous deposits of Europe; and of all living forms, though widely different, was most nearly related with the *Iguana*, *Cyclura*, and *Amblyrhynchus*.

The bones, besides a number of small uncharacteristic fragments, consist of twenty-eight vertebræ, mostly with their processes lost; a humerus, radius, and an ulna complete; an ilium and a supposed pubic bone, imperfect; a femur and tibia

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[1] According to Dr. Isaac Lea (Proc. Acad. Nat. Sci., 1861, 150) the shells consisted of *Arca Enfaulensis*, *A. Saffordi*, *Astarte crenulirata*, *A. octolirata*, *Anomia tellinoides?* *A. argentaria*, *Cardium multiradiatum*, *C. Enfaulense*, *Cardita subquadrata*, *Corbula subcompressa*, *C. crassiplicata*, *C. Foulkei*, *Crassatella lintea*, *Ctenoides crenulicostata*, *Dosinia depressa*, *D. Haddonfieldensis*, *Dentalium Enfaulensis*, *Exogyra costata*, *Gervilia ensiformis*, *Inoceramus involutus*, *Leda protexta*, *L. longifrons*, *Linaria metastriata*, *Legumen apressus*, *L. ellipticus*, *Modiola Juliæ*, *Nucula percrassa*, *Ostrea denticulifera*, *O. larva*, *O. plumosa*, *O. tecticosta*, *Pecten simplicius*, *Pinna laqueata*, *Siliquaria biplicata*, *Tellina (Tellinimera) eborea*, *Trigonia Enfaulensis*, *Lunatia paludiformis*, *Turbonilla laqueata*, *Turritella vertebroides*, *T. Hardemanensis*, *Ammonites placenta*, *Scaphites iris*. The condition of these fossils is such as prove that they were deposited in a sediment completely at rest. The most tender and delicate forms remain without abrasion, and usually, in the case of the bivalve mollusks, the two valves are attached. The great tenacity of the clay, and extreme tenderness of the specimens render it almost impossible to get out perfect ones. Proc. Acad Nat. Sci., 1848, 221.

[2] *Cidares armigera*.

[3] *Odontaspis* and *Enchodus*.

complete; a fibula, with one end lost; two metatarsal bones and a phalanx, complete; two small fragments of jaws, and nine teeth.

Of the vertebræ three appear to belong to the cervical series, seven to the dorsal series, and the remaining eighteen to the caudal series.

The three mutilated cervical vertebræ, represented in Figs. 1, 2, 3, Plate XII, are from the middle or posterior part of the series. Their body is provided with a hemispherical articular convexity in front, and a corresponding concavity behind. The outline of the articular end is hexahedral The articular convexity is somewhat flattened at the summit, which slopes upward. The lateral borders of the convexity expand and unite below in a broad lip. The sides of the body, at their fore part above the middle, are furnished with a tuberosity, or inferior transverse process, terminated by a concave, roughened facet for articulation with a cervical rib. Below the process the side of the body is concave longitudinally and vertically. The lower part of the body forms a broad ridge, slightly convex transversely and concave longitudinally, expanding towards the articular margins of the bone, but to the greatest degree posteriorly.

In one of the specimens, in which the vertebral arch is preserved, though devoid of its characteristic processes, the spinal foramen is seen to be of large size and nearly circular; measuring sixteen lines high and eighteen lines wide.

The length of the body, in the most perfect specimen, measures at the side about two inches and a half. The same specimen from the bottom of its articular concavity to the summit of the corresponding convexity measures thirty-two lines. The depth of the articular concavity is about thirteen lines; the prominence of the anterior convexity is seventeen lines from the lateral border of its base.

The extreme height and width of the body of a second specimen, which possessed about the same length as the former, measures at the base of the articular convexity about thirty-eight lines. The breadth of the abutment of the vertebral arch in the same specimen is nineteen lines.

A dorsal vertebra, represented in Figs. 4, 4, *a*, Plate XII, from the anterior part of the series, has its body convexo-concave as in the cervical specimens. The length of the body laterally is about three inches; its height and width anteriorly thirty-four lines. The articular ends are cordiform in outline. The anterior articular convexity is nearly as prominent as in the cervical vertebræ, but the corresponding posterior concavity (Fig. 4, *a*) appears less deep, from the borders being bevelled off outwardly.

The sides of the body are longitudinally concave, and meet below in a saddle-like ridge expanding in front and behind.

The sides of the vertebral arch, at their forepart, exhibit a vertically elliptical concave facet for articulation with the head of a rib. The abutment of the arch measures twenty-three lines wide. The spinal foramen is subcordate, widest above, and measures fifteen lines in height and width.

Four dorsal vertebræ, represented in Figs. 5–8, Plate XII, from the middle of the series, have their body ot the same form as the specimen just described, but the extremities exhibit a less prominent convexity in front, and a shallower concavity behind. They vary a little in size, and slightly in other characters. Their body, measured at the side, averages about three inches and a half in length, and below is slightly shorter. In front they measure about thirty-eight lines in height, and forty lines in width. The articular ends have the same outline as in the former specimen.

The articular convexity of the more anterior pair of specimens, Figs. 5, 6, which are slightly longer than the others, is irregular, presenting the appearance of an expanded mass that has collapsed. In the succeeding pair of specimens, Figs. 7, 8, the articular convexity is more uniform, and is defined from the lower border of the body by a crescentoid lip prolonged below. The border of the articular concavities, in the four specimens, is bevelled off and prolonged inferiorly.

The spinal foramen is subcordate. In the anterior pair of specimens it is about fifteen lines in height and width; in the posterior pair about fourteen lines in height and width.

The articular facet for the head of the rib is observed in the four specimens to rise successively higher on the sides of the vertebral arch, and as in the former specimen described, it is a vertically elliptical concavity. From the relative position of these articular facets, the four vertebræ have been placed in the succession designated, otherwise I should have been induced to place the hinder pair in advance from the more uniform anterior convexity of their body, and their slightly less length.

In the posterior pair of specimens, Figs. 7, 8, the articular processes of the arch are preserved, and in one of them part of the spinous process. The length of the vertebræ between the anterior and posterior articular processes is five inches and a half. The processes are elliptical planes with their long diameter nearly parallel with the axis of the vertebræ. Those anterior look towards each other with a slight inclination upward; those posterior of course have an opposite direction.

A transverse process, on the right side of the specimen, Fig. 7, apparently unbroken, is of robust proportions, extends outwardly, backward, and upward, and terminates in a rounded end without enlargement.

Two posterior dorsal vertebræ, represented in Figs. 9–11, Plate II, have the same general form of body as those just described. It is, however, shorter, but broader and deeper. Thus the smaller of the two specimens has the extreme length of the body at the sides forty-one lines; the width and depth anteriorly forty-five lines. The larger specimen has its body forty lines long, and four inches wide and deep anteriorly. The sides of the body, as in the preceding vertebræ, are longitudinally concave, and terminate below in a rather sharp saddle-like ridge expanding towards the articular borders.

The articular ends, Fig. 11, are cordiform in outline, with the lateral and inferior borders strongly everted and convex. The posterior end is moderately concave with wide everted margins. The depth of the concavity at its centre is about five lines. The anterior articular end, Fig. 11, presents a crescentoid depressed or sub-concave surface below, including a sub-convex prominence extending from the centre to the upper border of the articular surface.

The spinal foramen is cordiform, rather wider than high, being about fifteen lines transversely, and thirteen vertically. The abutments of the vertebral arch are twenty seven lines wide, and present no mark for the head of a rib. The latter, however, appears to have been situated higher, exterior to the upper back part of the position of the anterior articular processes, which are rather wider apart than those of the preceding vertebræ.

No lumbar vertebræ or portions of a sacrum were discovered with the collection of *Hadrosaurus* remains under examination.

Eighteen caudal vertebræ, probably less than half of the original number, form part of the collection. In all of them the body is moderately biconcave; the concavities being of nearly equal depth. The borders of the articular surfaces are strongly everted, convex, and prolonged below into pairs of robust, sloping abutments for the articulation of chevron bones. The sides of the body are concave longitudinally, convex vertically, and are defined below by obtuse ridges, extending between the anterior and posterior chevron abutments. The under surface of the body forms a concavity with a square outline whose angles are produced by the abutments just mentioned. The articular ends are hexahedral in outline.

Three vertebræ, of which two are represented in Figs. 9, 10, Plate XII, from the commencement of the caudal series, are remarkable for their diminution in length and great increase of breadth and depth, in comparison with the dorsal and cervical vertebræ. Their body averages thirty-one lines in length, and in the three specimens ranges from five inches and a half to six in breadth by about five inches and a quarter in depth. They appear to have been provided with strong transverse processes, as the broken roots of these extend from about the middle of the body to the conjunction of the latter with the vertebral arch. The spinal foramen is transversely oval, about nine lines in depth and fourteen in width. The breadth of the abutments of the vertebral arch is about fifteen lines.

The articular processes have subcircular flat facets, those in front being directed obliquely towards each other, those behind looking obliquely outward and downward. The anterior ones project a little in advance of the line of the front articular surface of the body; the posterior ones overhang the back articular surface.

The ten succeeding specimens of caudal vertebræ, of which six are represented in Figs. 11–16, Plate XII, exhibit a gradual but slight increase in length until they almost equal in this respect the posterior dorsals above described, and they undergo a gradual diminution in depth and width. The body of the eighth specimen in the series under consideration is about equal in bulk to that of the posterior dorsals above described; those in advance are larger, those behind are smaller.

The first (Fig. 11) of the ten specimens has its body thirty-three lines long, sixty-one broad, and fifty-four deep; the sixth specimen has the body thirty-six lines long, and fifty-one lines broad and deep; and the tenth (Fig. 16) has its body thirty-eight lines long, and forty-three lines broad and deep.

In succession, the abutments of the chevron bones become more distinctly defined on each side by an intervening notch, which, however, at no time extends to their base.

The spinal foramen undergoes a gradual diminution in capacity and assumes a more circular form. In the second specimen of the series it is nine lines deep and twelve wide; in the tenth it is eight lines deep and wide.

The abutments of the vertebral arch present a slight successive increase in width. In the first specimen it is twenty lines wide; in the tenth specimen twenty-two lines.

The articular processes are like those of the preceding caudal vertebræ, and successively increase their distance apart Thus in the second specimen of the series under consideration the space reaching from those anterior to the ones posterior measures forty-six lines; in the third specimen the same space occupies forty-eight lines; and in the tenth, fifty lines.

The spinous process, preserved entire in the third specimen (Fig. 13), is eight inches and a half long. Directed upward and backward it is at first cylindrical, but approaching its free extremity becomes laterally compressed. Judging from the remains of this process in the other caudal vertebræ, it has had a similar form throughout.

The transverse processes are apparently all broken or bruised at the ends in the vertebræ in which they have existed. In the six specimens in advance they appear to have been formed as distinct elements, and were apparently coossified by a broadly expanded root to the conjunction of the vertebral body and arch. In the anterior two specimens (Figs. 11, 12) they appear to have been short, robust prominences, with their root extending nearly as far down as the middle of the side of the body. In the succeeding three (Fig. 13) specimens the processes appear to have been short, obtuse prominences, not reaching by their expanded root below the upper third of the side of the body. In the next three of the series, as seen in Figs. 14, 15, the transverse processes are obsolete, or appear as a slight, roughened prominence, at or below the union of the vertebral body and arch. In the last specimen no trace of the process appears, as seen in Fig. 16.

The remaining five caudal vertebræ of the collection, of which the back four are represented in Figs. 17–20, possess the same general form of the body as in the preceding specimens, and exhibit a successive diminution of depth and breadth in relation with the length, which also undergoes a moderate reduction. Thus in the first of the specimens the body is nearly of equal length, depth, and width, their measurements being about three inches. The body of the succeeding three specimens (Figs. 17–19), which are nearly equal in size, is thirty-three lines long, twenty-eight wide, and twenty-five deep. The last specimen (Fig. 20) has its body thirty lines long, and twenty-one wide and deep.

In the first of this series the spinal canal is vertically oval, eight lines high, and six wide; in the fourth specimen it is subcircular, five lines and a half wide and high.

The abutments of the vertebral arch in the first specimen are twenty lines wide; in the fourth specimen, thirteen lines.

Transverse processes appear not to have existed in these five caudal vertebræ, as no trace of them is visible. The vertebral arch in all is too much mutilated to ascertain whether it was provided with articular and transverse processes.

All the vertebræ I have described appear to be fully grown, their arch being firmly coossified with the body. The sutural conjunction between the two arts occupies a broad elliptical space, the outline of which is distinctly evident, extending between the prominent borders of the articular faces of the body.

The ossific structure of the vertebræ is coarse, and the articular surfaces of the bodies are rather uneven and roughened. The specimens generally present no conspicuous vascular foramina, and only a few of them exhibit one or two moderate sized orifices of this kind at the lower part of the body.

From the description of the vertebræ it may be perceived that they increase in size to the posterior part of the dorsal series. In comparison with the latter the anterior caudal vertebræ undergo a great increase in breadth and depth, but decrease in length. Subsequently the caudals gradually diminish in depth and breadth, but increase in length to near the end of the tail, where they again slightly decrease in the latter direction.

In the cervical series of vertebræ the bodies are prominently convex in front, and in a corresponding degree concave behind. These conditions are maintained in the anterior of the dorsal series, but subsequently the convexity is depressed and the concavity becomes more shallow, and even the posterior dorsals have assumed a moderately biconcave character. In the caudal series the vertebral bodies are decidedly biconcave throughout.

The transverse processes of the anterior caudal vertebræ appear to have been of robust proportions, but rapidly declined in the series, and ceased to exist altogether in the posterior caudals.

The specimen of an anterior caudal above described, in which the spinous process has been preserved entire, may serve to guide us in attempting to estimate the depth and breadth of the tail of *Hadrosaurus*. The vertebra I suppose to be the seventh or eighth caudal, and if we assume that it possessed a chevron bone of half the length of the vertebral arch together with its spinous process, the tail in the position of this vertebra would have measured about a foot and a half in depth, and about eight inches in thickness. Such a form of tail, though admirably adapted to swimming, would, however, not be incompatible with terrestrial habits, as we observe in the living *Iguana* and *Cyclura*.

The vertebræ of *Hadrosaurus* bear a near resemblance to those referred to the *Iguanodon* by Drs. Mantell and Melville.[1] In both genera the cervical series are convexo-concave, which character is retained in a less degree in the anterior dorsal vertebræ. In *Iguanodon*, according to the authors just mentioned, the posterior dorsal and anterior caudal vertebræ are plano-concave, which may likewise be the case in the corresponding bones of the *Hadrosaurus*, but in the specimens under examination, the anterior articular surface of the bodies is slightly depressed, so that the posterior dorsals and anterior caudals of *Hadrosaurus* are described as biconcave. In both genera the posterior caudals are biconcave.

Prof. Owen says: "Both articular ends of the vertebræ of the *Iguanodon* are nearly flat, thereby differing more from the concavo-convex vertebræ of the *Iguana* than those of any of the existing Crocodiles or Lizards do."[2] According to this

[1] Addit. Obs. on the Osteol. of the Iguanodon, &c. Phil. Trans. Roy. Soc., Lond., 1849, p. 271

[2] British Fossil Reptiles, Pt. VI, Dinosauria, p. 324.

general character ascribed to the vertebræ of *Iguanodon*, those of *Hadrosaurus* are totally different.

The convexo-concave vertebræ attributed to the cervical series of *Iguanodon* by Drs. Mantell and Melville, are referred by Prof. Owen to a Crocodile under the name of *Streptospondylus major.*[1] Other vertebræ attributed to the posterior dorsal or lumbar and to the caudal series, by Drs. Mantell and Melville, are referred by Prof. Owen to two additional crocodilian Reptiles under the names of *Cetiosaurus brevis* and *C. brachyurus.*[2]

No portions of the skull of *Hadrosaurus* were discovered except some small fragments of the jaws, represented in Figs. 24–26, Plate XIII. One of these, a portion of the lower jaw, much mutilated externally, Fig. 25, exhibits on its inner aspect, Fig. 24, a series of longitudinal alveolar grooves separated by narrow intervening ridges. The other, apparently a portion of the upper jaw, Fig. 26, exhibits similar grooves, but these are bent at an obtuse angle about the upper third of their course.

As previously mentioned, in association with the bones of *Hadrosaurus Foulkii*, there were discovered nine teeth, which above all other parts tended to determine the relationship of the fossils. The teeth are so small in comparison with what one would expect to find in company with the other remains, that had they been discovered alone, they would perhaps not have been suspected of belonging to *Hadrosaurus.* They present the same general conformation and peculiarity of structure as those of the *Iguanodon*, indicating, as in the latter, a vegetable feeding Reptile, one which masticated its food like the herbivorous Mammalia.[3] Although among

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[1] Report Brit. Assoc., 1841, p. 91. [2] Ibidem, p. 94, 100.

[3] Dr. Mantell, in his work entitled "Petrifactions and their Teachings," p. 228, in an article on the discovery of the *Iguanodon*, gives the following account: "Soon after my first discovery of bones of colossal reptiles in the strata of Tilgate Forest, some teeth of a very remarkable character particularly excited my curiosity, for they were wholly unlike any that had previously come under my observation. The first specimen that arrested my attention was a large tooth, which from the worn, smooth, and oblique surface of the crown had evidently belonged to an herbivorous animal, and so entirely resembled in form the corresponding part of an incisor of a large pachyderm ground down by use, that I was much embarrassed to account for its presence in such ancient strata, in which, according to all geological experience, no fossil remains of mammalia would ever be discovered; and as no known existing reptiles are capable of masticating their food, I could not venture to assign the tooth in question to a Saurian."

Dr. Mantell states that "through Mr. Lyell, who was about to visit Paris, he availed himself of the opportunity of submitting the tooth to the examination of Cuvier, who, without hesitation, pronounced it to be an upper incisor of a Rhinoceros." This mistake, under the circumstances, was not surprising, as the worn teeth of *Iguanodon* actually resemble the incisors of the Rhinoceros more than they do the teeth of any other known animal, and at the time of the determination no reptiles were known with teeth adapted to the mastication of vegetable food.

Cuvier, in the Ossemens Fossiles, Ed. 4, T 10, 199, in reference to the teeth of the *Iguanodon*, says that "they may possibly belong to a Saurian, but one more extraordinary than any other known. The peculiarity of the teeth consists in their having been worn away as in herbivorous mammals, so that when I first saw a specimen which was much worn, I did not doubt that it was derived from a mammal." He adds, that "it was only after M. Mantell had sent him a series of specimens worn and unworn that he became entirely convinced of his error."

Dr. Mantell further remarks that "he had previously submitted the tooth and some other specimens to the Geological Society of London, where they were generally viewed as belonging to some large living Reptiles there are vegetable feeders, such as the *Iguana* and *Amblyrhynchus*, yet the teeth of these with their trenchant jagged borders, are adapted to lacerating or sawing instead of masticating the food.

Several of the teeth of *Hadrosaurus* are nearly identical in form and details of structure with the specimen of a tooth discovered a short time previously to the former, by Dr. F. V. Hayden, in the Bad Lands of the Judith River. The tooth just mentioned, together with several other much worn specimens, I referred to a distinct genus under the name of *Trachodon*, but I shall not be surprised to learn that future discovery determined *Hadrosaurus* and *Trachodon* to be the same.[1]

Of the nine specimens of teeth preserved among the collection of remains of *Hadrosaurus*, seven are alike in form, and are supposed to have belonged to the lower jaw; the other two, different from the former, are supposed to have belonged to the upper jaw.

The teeth of *Hadrosaurus* were probably inserted in the jaws in the same manner as Dr. Mantell supposed to be the case in the *Iguanodon*, that is to say, with the enamelled surfaces of the crowns of the upper teeth directed outward, and of the lower teeth inward; an arrangement, as remarked by Dr. Mantell, which finds an analogy in the reversed position of the molar teeth of ruminating animals.

The shape and markings of the teeth of *Hadrosaurus* appear to indicate that they were placed in much closer apposition with one another and their successors than in *Iguanodon*; the arrangement in the former being very remarkable. In *Iguanodon* the teeth occupying a position in the functional series were succeeded by others

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fish, or as mammalian teeth from a diluvial deposit, and Dr. Wollaston alone supported him in the opinion that he had discovered the teeth of an unknown herbivorous reptile." Finally, he adds, "it was not until I had collected a series of specimens, exhibiting teeth in various states of maturity and detrition, that the correctness of my opinion was admitted either as to the character of the dental organs or their geological position."

[1] The teeth referred to Trachodon were discovered by Dr. Hayden, in an estuary, fresh water deposit, which he calls the Bad Lands of the Judith River, situated on the upper Missouri River, near its source. In regard to the age of the deposit, the testimony derived from the fossils is of a conflicting character, but according to Dr. Hayden, the facts warrant the opinion that if the deposit is not an American representative of the Wealden of Europe, it is at least in part as old as the Cretaceous. Proc. Acad. Nat. Sci., Phil., 1856, p. 72. Trans. Am. Phil. Soc., Phil., 1859, p. 123.

Among the collection of fossils, brought by Dr. Hayden from Western America, were several vertebræ and a phalanx, which I have referred to a Dinosaurian with the name of *Thespesius*. The specimens were obtained from the Great Lignite formation of Grand River, Nebraska, which Dr. Hayden considers to belong to the Miocene Tertiary period. The phalanx mentioned nearly corresponds in form and size with the proximal phalanx of the hind foot of *Hadrosaurus*, described in the preceding pages. Of the vertebræ, the two larger specimens are anterior caudals, and are convexo-concave; the small one, a posterior caudal, is plano-concave. Had the remains of *Thespesius* and *Trachodon* been found in a deposit of the same age, I should have unhesitatingly referred them to the same animal, and I cannot avoid the suspicion that future investigation may determine them to be the same. Should such a determination prove to be the case, the minor details of structure of the tooth of *Trachodon* different from those of *Hadrosaurus*, together with the convexo-concave anterior caudals and the plano-concave posterior caudal of *Thespesius*, in comparison with the biconcave caudals of *Hadrosaurus*, will be sufficient to separate generically the New Jersey Dinosaurian from that of the Upper Missouri. For an account of *Thespesius* see Proc. Acad. Nat. Sci., Phil., 1856, p. 311, and Trans. Am. Phil. Soc., 1859, p. 151.

in the same manner as in living Lacertians. In *Hadrosaurus* the shape of the teeth and their markings make it appear as if they were closely crowded, the functional and successional series together, so as to produce a vertical quincuncial arrangement, as represented in the partially ideal Fig. 19, Plate XIII.

The specimens of inferior teeth vary slightly in size, and present different conditions, from one that is unworn, to another which has its crown half worn away.

An unworn and almost perfect specimen, represented in Figs. 1–4, Plate XIII, is twenty-two lines in length. Viewed laterally, Figs. 3, 4, in outline it has the form of an obtuse angled triangle, of which the two shorter sides correspond with the division of the tooth into crown and fang.

The crown, separately considered, is trihedral or demiconoidal, and bevelled off on each side towards the base internally, and it comprises rather more than half the length of the tooth. It widens antero-posteriorly from the summit to the middle, and then decreases in the same direction towards the fang. In the reverse direction, it increases in breadth from the summit to the bottom of the crown.

The inner side of the crown, Fig. 1, *a*, is alone invested with enamel, and forms a lozenge-shaped surface divided in its length by a prominent median carina. It is slightly convex vertically, and has the borders a little everted, so that the divisions of the surface on each side of the carina are slightly concave transversely. The upper angle, constituting the apex of the tooth, is rounded, the lateral angles are obtuse, and the lower angle is notched.

The upper borders of the enamelled surface are thickened, rounded, and furnished with a series of feeble transverse ridges resolved into minute tubercles, as represented in the magnified view of Fig. *d*.

The outer surface of the crown, Fig. 2, has a dull aspect; at its upper half is paraboloid in transverse section, but below is ellipsoidal. The lower half presents at the sides internally a bevelled triangular plane, extending upon the fang and marked by vascular grooves, as seen in Figs. 3, 4, *c*. One of the bevelled planes, Fig. 4, *c*, next the enamel edge, is marked by a series of impressions, adapted to the accommodation of the tubercular enamel border of the contiguous side of the crown of a lateral successional tooth. The opposite plane is devoid of this series of impressions, as seen in Fig. 3, *c*.

Evidently it appears from the shape and markings of the bevelled planes just described that they were adapted to fit the summits of the crowns of lateral successional teeth, according to the plan represented in Fig. 19.

In the slightly oblique relationship of the functional and successional teeth the tuberculated enamel border of one side of the latter overlapped the contiguous lower border of the former in front, while the opposite tuberculated enamel border of the successional teeth was overlapped by the contiguous lower border of the functional teeth behind. Hence one bevelled surface presents the impression of the tuberculated enamel border of a successional tooth, and the opposite surface does not. The vascular grooves of the bevelled surfaces are due to the vessels in the membrane separating the successional from the functional teeth.

The fang is laterally compressed, conoidal, and rather shorter than the crown, of which it is an extension without the enamel. Its outer border continues the slope of the corresponding border of the crown, and forms with it a convex ridge extending the whole length of the tooth. Its inner border forms an obtuse angle from the bottom of the enamelled face of the crown, and is excavated into a shallow groove marked by vascular furrows. The grooved border appears to have been adapted to fit the outer border of the crown of a successional tooth beneath.

The measurements of the tooth are as follows:—

	Lines.
Length of the tooth externally	22
Length of enamelled crown internally	14
Breadth of enamelled crown internally at middle	5¾
Breadth of enamelled crown internally at bottom	2
Width of crown at base from without inwardly	7½
Length of fang internally	12½

The tooth just described bears a near resemblance to one of those, before alluded to, upon which the genus *Trachodon* was founded, as may be seen by comparing the figures of the former (1–4, Plate XIII) with those of the latter (12–14, Plate II). The specimen of the tooth of *Trachodon* has lost its fang, but its crown has the same form as that of *Hadrosaurus*, and nearly the same size, except that towards the base it is narrower from without inwardly, and wider in the opposite direction. In the tooth referred to *Hadrosaurus* the diameter at base, from without inwardly, is twice as great as that from side to side, but in that of *Trachodon* it is only a fourth greater, while in both the crown is of nearly equal length.

The outer portion of the crown of the tooth of *Trachodon* is irregularly roughened with a multitude of granulations or minute tubercles, and, independently of the triangular bevelled planes at its base, is subdivided by ridges into three surfaces, of which those lateral are flat, or even slightly depressed at the upper part, and the intermediate one is moderately convex. In transverse section the outer portion of the crown forms three sides of a hexagon. In *Hadrosaurus* the outer portion of the crown is smooth, and forms the two sides of the vertical section of a cone with a rounded apex.

The upper enamel borders of the tooth of *Trachodon* are devoid of the characteristic groups of tubercles observed in the tooth of *Hadrosaurus*, though they exhibit a feeble tendency to development in a slight irregularity of the limit of the border where it is defined from the dentinal structure of the outer portion of the crown, and by a slight unevenness of the borders of the apex.

Since writing the present memoir I have seen a "Supplement to the Fossil Reptilia of the Cretaceous Formations," by Prof. Owen, in the publications of the Palæontographical Society for 1860. At the end of the Supplement, Prof. Owen indicates a tooth, from the upper Green-sand, near Cambridge, England, as that of a young *Iguanodon*, which bears a near resemblance to those above described of *Hadrosaurus* and *Trachodon*. It is represented in Figs. 15, 16, Plate VII, of the Supplement, and though closely related in character with the teeth of the *Iguanodon Mantelli*, certainly differs from all those which had been previously referred to this species. The specimen has nearly the form and size as those of *Hadrosaurus* and *Trachodon*, but judging from Fig. 15 it differs in the upper borders of the crown, being broken into a series of minute imbricating laminæ. Perhaps the three teeth alluded to, so like one another, and referred to *Hadrosaurus*, *Trachodon*, and *Iguanodon*, represent three species of a genus allied to, but quite distinct from the true *Iguanodon* of which the *I. Mantelli* is the type.

Figs. 5–9, Plate XIII, represent two specimens of inferior teeth of *Hadrosaurus*, the forms of which agree with that already described. In one (Figs. 5, 6, 7) the crown is half worn away, exhibiting the triturating surface as a shield-like, inclined plane, very slightly depressed, bordered by enamel at the inner bow-like border, and feebly roughened by a linear crucial ridge, the limbs of which give off diverging branches. In the other specimen (Figs. 8, 9) the apex is worn off so as to present a small shield-like triturating surface, which is smooth or devoid of a crucial ridge traversing it.

Of the two teeth of *Hadrosaurus*, supposed to have belonged to the upper jaw, one is an unworn crown, and is represented in Figs. 10–13, Plate XIII; while the other is the crown of a smaller tooth, with its apex worn off, and retaining part of the fang, and is represented in Figs. 14–17.

The superior unworn crown, in comparison with that of the inferior tooth, presents a rather demi-ovoidal than a demi-conoidal form, but differs further from the comparatively enormous degree of projection of its carina.

The lozenge-shaped enamel surface, Fig. 10, which is to be viewed as the external one, or the reverse in position of that of the inferior teeth, is wider at the two extremities and slightly narrower at the middle than in the latter. It extends outwardly upon a carina, which starts from the apex of the crown, and gradually increases in depth until it nearly equals half the diameter of the tooth from without inwardly. The apex of the crown is much more blunt than in the lower tooth, and the bottom of the enamel surface forms two sides of a triangle, the apex of which is the bottom of the edge of the carina. The lateral angles are also more obtuse than in the lower teeth. The groups of tubercles ornamenting the lower borders of the crown, especially approaching the apex, are also somewhat larger.

The inner portion of the crown (Figs. 11, 15) is subdivided into four planes, of which the intermediate pair extend from the apex to the base, while those on each side extend from the apex to near the position of the lateral angles of the crown.

The basal half of the crown on each side presents a somewhat depressed ellipsoidal surface, with a narrow prolongation extending upon the fang (Figs. 12, 13, 16, 17, *a*), corresponding with the triangular bevelled planes of the inferior teeth, and like them exhibiting marks as if they had been adapted to fit or come into contact with lateral successional teeth. Unlike, however, those of the inferior teeth, these surfaces of the superior teeth exhibit on both sides the series of impressions induced by the tuberculated borders of the crowns of the successional teeth. Between these lateral surfaces of contact with the latter, the base of the crown is excavated, forming a narrow depressed tract (Figs. 11, 15, 17, *b*), continuous with a wide shallow groove of the fang, adapted to fit the apex and outer part of the summit of the crown of a successional tooth from above.

The fang of the superior teeth appears from the specimens to have been proportionately narrower than in the inferior teeth, and further appears mainly to spring from the enamelled portion of the crown instead of the opposed portion as in the inferior teeth. At its connection with the crown it is pentahedral in section with the two outer sides corresponding with the sides of the carina of the latter.

The measurements of the unworn upper tooth are as follows:—

	Lines.
Length of the crown	$13\frac{1}{2}$
Breadth at the lateral angles	$5\frac{1}{2}$
Breadth at bottom	$3\frac{1}{2}$
Greatest diameter from within outwardly or from the prominence of the bottom of the crown internally to the edge of the carina externally	8
Diameter of fang at its connection with the crown transversely	$3\frac{1}{2}$
Diameter of fang from within outwardly	4

The specimens of inferior teeth appear to be nearly solid, that is to say, their pulp cavity is almost obliterated, as a portion remains pervious only for a short distance within the fangs. In one of the specimens, in which the fang is broken off near its conjunction with the crown, the remains of the pulp cavity form a linear suture extending through the middle half of the diameter from within outwardly. The sides of the pulp cavity, where visible, are exceedingly rough and pitted, the pits corresponding with a multitude of minute offsets diverging from the main cavity into the dentine.

As the teeth of *Hadrosaurus* were worn away from attrition to which they were subjected, a flat, or very feebly depressed, oblique triturating surface was produced and gradually increased in breadth to the middle of the crown, and then as gradually decreased to the fang, upon which it was also continued until this became worn out. The triturating surface of the crown exhibits a shield-shaped plane of dentine bounded in the upper teeth externally by a bow-like border of enamel; in the lower teeth bounded in the same manner internally.

The series of teeth at the border of the jaw in functional position appear to have formed a continuous sloping pavement, presenting triturating points and facets of different sizes and of several patterns, according to the portions of the teeth which had reached the triturating surface, as represented in the partially ideal Fig. 18, Plate XIII. In the upper jaw the slope of the dental pavement was directed downward and inward, and was margined externally by a festooned cutting edge of enamel, as seen in Fig. 18, *d*. In the lower jaw the arrangement was reversed, the dental pavement being parallel with the former and slanting with a direction outward and upward, and the festooned cutting edge of enamel being internal, as seen in Fig. 19, *a*, *b*.

The intimate structure of the teeth of *Hadrosaurus*, as viewed by the microscope, is exhibited in Fig. 1, Plate XX, representing the transverse section of the crown of an inferior tooth above its middle. The representation is not to be viewed as exact, as the proportions of the whole section and the elements of structure, for obvious reasons, have not been preserved. It is rather a diagram exhibiting the relative position of the structural elements in the transverse section of the crown of a tooth.

The section is mainly composed of hard dentine in which the dentinal tubules emanate from a median crucial line and radiate towards the periphery. The crucial line corresponds with that previously mentioned as visible on the triturating surface of the teeth, and is to be viewed as the remains of the pulp cavity. It is pervaded with vascular canals, the cut orifices of which may be seen in the section.

The dentinal tubules pursue a gently undulating nearly parallel course, and the successive waves in the section, when viewed by transmitted light, appear alternately darker and lighter, giving rise to the impression of a concentric laminar arrangement of the dentinal structure. The tubules are exceedingly fine and arranged very closely together. They branch in their course outwardly and measure from the $\frac{1}{15000}$th to the $\frac{1}{20000}$th of an inch.

The inner surface of the section (Fig. 1, *a*) is bordered by an enamel layer about the $\frac{1}{50}$th of an inch thick. The enamel folds around the lateral borders of the crown and ceases in a rather abrupt but thin edge. In the drawing, there is represented a section (*b*) of a narrow isolated streak of enamel, which extended a short distance along the side of the crown.

The outer border of the section (Fig. 1, *d*, Fig. 2, *b*) presents a peculiar layer, about $\frac{1}{40}$th of an inch thick, apparently consisting of a spongy reticulation of vascular tissue or vaso-dentine. It is this layer which gives the surface of the teeth, where not covered with enamel, a dull aspect; and it is friable and easily scraped off from the denser dentine within. The vascular canals of the spongy tissue are of nearly uniform size and measure about the $\frac{1}{1000}$th of an inch in diameter. From the vaso-dentine many of the vascular canals penetrate into the denser dentine, in some cases to a greater depth than the whole thickness of the former, as represented in Fig. 2, Plate XX.

The specimens of bones of the anterior extremity of *Hadrosaurus* consist of the humerus and those of the forearm of the left side.

The humerus of *Hadrosaurus*, represented in Figs. 1, 2, 3, Plate XIV, bears a near resemblance in form and proportions to that of the *Iguanodon* as figured by Dr. Mantell[1] and Prof. Owen.[2] The upper part of the shaft is twice the breadth of its thickness, is concave transversely in front, and convex behind in the same direction, and has its inner border thinner than the outer. The lower part of the shaft is cylindroid, and gradually expands towards the condyles.

The bone is broadest at its upper extremity from which the head projects posteriorly midway between two nearly equal tuberosities, which extend almost as high as the former. The head (*a*) is a hemispherical roughened prominence partly sustained by an abutment-like ridge extending downward on the back of the shaft. The upper part of the inner tuberosity (*b*) is convex and rough. The upper part of the outer tuberosity (*c*) is sigmoid and likewise rough.

From the inner tuberosity, the internal border of the shaft makes a continuous concave sweep to the lower end of the bone. From the outer tuberosity, the shaft remains expanded externally, to accommodate the attachment of the deltoid muscle, nearly to its middle (*d*), when the bone rapidly narrows to its lower cylindroid por-

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[1] Phil. Trans. Roy. Soc., Lond., 1849, Plate XXXI. Petrifactions and their Teachings, p. 286, Fig. 60.

[2] British Fossil Reptiles, Dinosauria, Plate XIX, Figs. 3–6.

tion. The border of the deltoid expansion is convex, and is roughened below for muscular attachment.

The condyles are convex and rough, and are separated in front by a notch expanding upward into a broad concavity of the shaft; behind they are separated by a wide groove extending upward and disappearing upon the shaft.

The latter, which was broken across in the specimen in two positions, exhibited a large medullary cavity.

The measurements of the bone are as follows:—

	Inches.	Lines.
Extreme length of the humerus	22	6
Breadth at the tuberosities	6	10
Thickness at the head	3	3
Breadth of shaft above the middle, or just before it begins to contract into the lower half	5	4
Thickness in the same position	2	4
Breadth of cylindroid portion of the shaft	3	2
Circumference of cylindroid portion of the shaft	9	6
Thickness of cylindroid portion of the shaft	2	9
Breadth at condyles	5	
Diameter of head	2	6
Antero-posterior diameter of inner condyle	3	6
Antero-posterior diameter of outer condyle	3	

Two orifices for medullary nutritious arteries exist on the posterior inner aspect of the bone, both being directed downward. One occupies the ridge beneath the head; the other is on the inner border of the shaft just above the middle.

The bones of the forearm of *Hadrosaurus* are not remarkably different in form from those of the living *Iguana*. No adult bones of the forearm of the congeneric *Iguanodon* have been discovered. In a slab of stone containing imbedded part of the skeleton of a young *Iguanodon*, known as the Maidstone specimen and preserved in the British Museum, there are two bones described by Dr. Mantell as metacarpals, but which are considered to be the radius and ulna by Prof. Owen, who remarks that "they offer few differences worthy of notice except their greater relative strength from the corresponding bones of the *Iguana*."[1]

The radius, Fig. 6, Pl. XIV, has a compressed cylindroid shaft elevated into a subacute ridge postero-externally for the attachment of an interosseal membrane. Its upper extremity expands into a head, with a rough margin, supporting a semicircular roughened, brachial articular surface, which is slightly concave in its longer diameter, and nearly level in the opposite direction. The lower extremity widens in a clavate manner, presents a broad groove postero-internally, and ends in a convex articular carpal surface. The measurements of the bone are as follows:—

	Inches.	Lines.
Extreme length of the radius	20	6
Circumference at middle of the shaft	5	11
Long diameter of the head	3	8
Short diameter of the head	2	6
Long diameter of carpal end	3	1
Short diameter of carpal end	2	3

[1] British Fossil Reptiles, Dinosauria, p. 309.

The ulna, Fig. 5, Plate XIV, has a trihedral shaft becoming more cylindroid below, and has its three surfaces transversely concave above. The olecranon is an irregularly rounded prominence. The coronoid process is a thick plate of bone gradually widening from the shaft upward antero-internally. A similar but smaller process, somewhat broken in the specimen, springs from the shaft externally. The brachial articular surface slopes in a concave manner from the olecranon downward and forward, and extends between and upon the two processes below. The lower extremity of the ulna slightly enlarges in its descent, is convex externally, forms a wide and rather deep groove internally, and ends in a convex carpal articular surface. The measurements of the bone are as follows:—

	Inches.	Lines.
Extreme length of the ulna	23	3
Circumference at the middle of the shaft	7	
Greatest breadth at the coronoid process	5	
Greatest diameter of the carpal end	2	7
Short diameter of the carpal end	2	

The interior of both bones of the forearm is occupied by a coarse spongy substance.

The bones of the hinder extremities of *Hadrosaurus* are extraordinary for their huge size. In comparison with those of the fore extremities of the same animal they are of enormous proportions, exceeding in this respect not only all living Lacertians and Crocodiles, but even its extinct congener the *Iguanodon*. Thus in the Maidstone specimen of the *Iguanodon*, according to Prof. Owen,[1] the femur measures thirty-three inches long, while the humerus is nineteen inches; the tibia is thirty-one inches, and the ulna eighteen inches. In a collection of remains of the *Iguanodon*, from the Isle of Wight, according to Dr. Mantell,[2] the femur measured fifty-six inches in length, and the humerus thirty-eight inches. In *Hadrosaurus* the femur is forty-one inches and a half long, while the humerus is only twenty-two and a half, or little more than half the size of the former. The tibia is thirty-six inches and three-quarters long, and the ulna twenty-three inches and a quarter.

The femur of *Hadrosaurus*, represented in Figs. 1–6, Plate XV, is of the left side. In general form and proportions it bears considerable resemblance to the corresponding bone of the *Iguanodon*, as represented by Dr. Mantell[3] and Prof. Owen.[4] It has a quadrilateral shaft, with the head and trochanter situated on the same line as the condyles.

Externally (Fig. 2) the shaft forms a nearly flat surface vertically and transversely, and is strongly marked at the upper part and just below the middle by muscular attachments. From the posterior surface the outer is defined by a convex, though somewhat interrupted, rising of the bone, which extends from the back part of the trochanter to the corresponding part of the external condyle. The upper two-thirds of the outer surface are also defined in a similar manner from the anterior surface, but the lower third forms with the latter a more uniform convexity.

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[1] British Fossil Reptiles, Dinosauria, p. 268.
[2] Petrifactions and their Teachings, p. 301.
[3] Petrifactions, p. 292, Fig. 61.
[4] British Fossil Reptiles, Plate XX, Fig. 1.

The posterior surface of the shaft (Fig. 4), less level than the outer, presents a conspicuous process, as in the *Iguanodon*, springing from its middle internally, and calling to mind the third trochanter of certain Pachyderms, as the Horse and Rhinoceros. An abrupt rising of the bone, extending from the process just mentioned towards the head and internal condyle, defines the posterior surface from the inner one.

The internal and anterior surfaces (Figs. 1, 3), less defined from each other than the surfaces above described, together form a half section of a cylinder, which is antero-posteriorly compressed above where it sustains the head of the bone. The upper third of the anterior surface (Fig. 1) is transversely concave, arising from the presence of a strong process, springing from and defining its outer boundary. The process just mentioned, extending downward from the trochanter, gradually subsides and becomes continuous with two ridges, of which one forms the boundary between the anterior and outer surfaces of the shaft, while the other diverges in front to the lower third of the bone. The two ridges define three surfaces, giving origin to muscles corresponding with the triceps extensor of animals generally. Several inches below the commencement of the anterior ridge, to its inner side, is the orifice of a medullary nutritious canal, which is directed obliquely downward.

The head of the femur (Figs. 1–5, *a*) partially overhangs the inner part of the shaft which sustains it. Its sides are exceedingly rugged, for the most part being rendered so by numerous vertical ridges and intervening grooves (Fig. 3, *a*). The articular surface is sub-circular and only moderately convex, or, as compared with its condition in animals generally, is in a remarkable degree flattened. It is quite rough, and is rendered so chiefly by branching vascular grooves (Fig. 5, *a*), of which the main one proceeds obliquely across the head from the interval anteriorly between the latter and the trochanter.

The trochanter (Figs. 1–5, *b*), when both condyles are brought to a level, rises above the head of the bone, than which it is more convex and broader antero-posteriorly, but is narrower transversely. It is separated in front and behind from the head by wide notches. Its back part (Fig. 4, *b*) is roughened for muscular attachment. Its upper convex surface (Fig. 5, *b*) inclines inwardly, has quite an articular appearance, and is undefined from that of the head, with which it is continuous by means of an isthmus.

The condyles (Figs. 1–6, *d*, *e*), as usual, extend much more posteriorly than anteriorly. They are massive, with exceedingly rugged sides, especially that of the inner one (Fig. 3, *d*), being rendered so by vertical ridges and intervening grooves. Their convex articular surfaces (Fig. 6) are conjoined by a narrow isthmus, and are likewise rugged.

In the absence of a well-developed patella, as in the recent *Iguana*, *Cyclura*, and their allies, there is no trochlear surface above the condyles in front. Occupying its position there exists a large oblique groove (Fig. 1, *f*) or depression communicating with a short canal, which descends and expands in a funnel-like manner (Fig. 6, *f*) between the articulating surfaces of the condyles. The borders of the funnel-like expansion are ridged and grooved in the same manner as the exterior sides of the condyles. Posteriorly the latter are separated by a deep, wide notch. A deep popliteal concavity (Fig. 4, *g*) communicates below with a short, wide canal (Fig. 6, *g*) perforating the conjunction of the condyles posteriorly. A similar perforation exists in the recent *Cyclura.*

The posterior projection of the outer condyle is broken off in the specimen; that of the inner condyle exhibits a large rugged surface (Fig. 4, *d*) for the gastrocnemial attachment. The external condyle projects rather more inferiorly than the internal, but appears not to have been so extensive in its antero-posterior diameter.

The interior of the bone exhibits a capacious medullary cavity.

The measurements of the bone are as follows:—

	Inches.	Lines.
Length of the femur from top of trochanter to bottom of external condyle	41	6
Length from top of head to bottom of internal condyle	39	
Breadth of upper extremity	9	3
Breadth of lower extremity	8	5
Transverse diameter at middle of shaft	5	2
Antero-posterior diameter at middle of shaft	4	6
Circumference below middle trochanteroid process	15	
Circumference above middle trochanteroid process	17	
Antero-posterior diameter of head	5	8
Antero-posterior diameter of trochanter	6	9
Antero-posterior diameter of inner condyle	10	

In comparing the femur of *Hadrosaurus* with that of the living *Cyclura* and *Iguana*, to which it bears a nearer resemblance than to that of the Crocodiles, it would appear as if the condition of most of the anatomical characters were either reversed or their meaning had been mistaken. Thus in *Hadrosaurus* we have described the head of the femur as being internal and the trochanter external. In *Cyclura* and *Iguana* the head of the bone is external and the trochanter postero-internal. In *Hadrosaurus* the head is slightly below the level of the trochanter; in *Cyclura* it is considerably higher. In *Hadrosaurus* the shape of the trochanter is nearly like that of the head in *Cyclura*, and is nearly as large as the head of the same bone, but in *Cyclura* it is much smaller. In the former the femur is longest from the trochanter to the external condyle; in the latter from the head to the external condyle. Lastly, in *Hadrosaurus* the internal condyle is the larger; in *Cyclura* the external is the larger.

The tibia of *Hadrosaurus*, represented in Figs. 1–6, Plate XVI, is of the left side. It approaches in form and details of structure that of the *Iguanodon*, as represented in Prof. Owen's Fig. 2, Plate XX, of the British Fossil Reptiles, Dinosauria. It is, however, proportionately more slender towards the middle of the shaft, and it appears twisted in such a manner that the broad extremities cross each other in the direction of their greatest diameter, whereas in *Iguanodon* the broad extremities are nearly on the same plane.

The tibia is about three feet in length, and is cylindroid at the middle of the shaft, which rapidly expands into broad, clavate extremities.

The fore part of the shaft, Fig. 1, is nearly straight vertically, is smooth, and widest at its upper part. For the greater part of its extent it is transversely convex, but towards its inferior extremity forms a sloping plane directed obliquely inward, and jutting forward at its termination.

The inner part of the shaft, Fig. 2, at the upper two-thirds is comparatively narrow and cylindroid. Below, it expands into a broad triangular plane directed somewhat backward, and rendered slightly concave transversely by the prominence of the anterior border, which ends in an angular, roughened process.

The outer part of the shaft, Fig. 3, is cylindrical, with a broad, wing-like expansion curving backward at its upper extremity, and terminating in a wide, triangular surface at its lower extremity.

The back part of the shaft, Fig. 4, is cylindroid at the middle, and rapidly expands above into a wide surface rendered transversely concave by the backward projection of the inner and outer portions of the head. At its lower third it rises into an acute ridge separating the inner and outer surfaces of the bone.

The head of the tibia, Figs. 1–5, in front and at the sides together, forms a semicircular outline. Its back part viewed from above exhibits three strong prominences. The inner two (Figs. 4, 5), nearly equal in size, form, and direction, constitute a pair of articular condyles separated by a deep notch. The outer prominence is formed by a wing-like expansion of the external part of the shaft, and is separated from the condyles by a wide, concave notch. The articular surface of the head is nearly a horizontal plane at its fore part, but is convex posteriorly as it extends upon the three backward prominences. It is rough and deeply marked with vascular grooves proceeding from the back part.

The tarsal articular surface, Fig. 6, has its long diameter in a reverse direction to that of the head of the bone. In outline it forms an irregular trapezium, with the short anterior side nearly straight and directed obliquely forward and inward, with the inner side gently sigmoid, the outer border deeply sigmoid, and the posterior shortest side straight and directed obliquely backward and forward. The surface is somewhat rough. In the direction of its long diameter, or antero-posteriorly, it is for the most part concave, but is convex at the back extremity. In the direction of its short diameter it is for the most part convex, but is depressed near the antero-internal angle.

The interior of the tibia possesses a large medullary cavity. The orifice of the medullary nutritious canal is directed downward and is situated at the postero-external part of the shaft just above its middle.

The measurements of the tibia are as follows:—

	Inches.	Lines.
Length of the tibia externally	36	9
Length in front	35	
Circumference at narrowest part of the shaft, being just below the middle	11	8
Breadth of the upper extremity	11	3
Diameter of middle of head antero-posteriorly	5	6
Breadth of tarsal extremity	10	
Diameter antero-internally	5	10
Diameter at middle of tarsal surface	2	10
Diameter postero-externally	3	4

As in the case of the femur, in comparing the tibia of *Hadrosaurus* with that of *Cyclura*, etc., we are struck with an apparent reversal of many of the anatomical characters. Thus in the former the bone is longest externally, in the latter internally; in *Hadrosaurus* the long diameters of the head and tarsal extremity are opposed; in *Cyclura* they are parallel.

The fibula, represented in Figs. 7, 8, Plate XVI, from the left side, has lost its upper fourth, and in its present condition measures twenty-eight inches in length. At the broken extremity it is trilateral; and it gradually expands in a flattened, clavate manner to the lower extremity. Externally, Fig. 7, the bone is transversely convex, and for the greater part of its extent internally is concave in the same direction. The tarsal articular surface, Fig. 8, is bent ellipsoidal in outline, and is convex and roughened. At the broken end the specimen measures one inch ten lines in diameter; the tarsal extremity is five inches and a quarter wide, and two inches and one-third in thickness.

The fibula of *Hadrosaurus* bears a near resemblance to that of *Iguanodon*, as represented in Prof. Owen's Figs. 3, 4, Plate XX, of the British Fossil Reptiles, Dinosauria.

The two bones, represented in Figs. 7–10, Plate XIV, from their proportions are supposed to belong to the metatarsus, and like the bones of the leg above described probably appertain to the left side.

The large specimen (Figs. 7, 8) has a cylindroid shaft, compressed from above downwards and moderately expanding towards the extremities. The tarsal extremity is trilateral, flattened below, convex above, and presents a triangular concave surface on its inner side. The tarsal articular surface is vertically crescentic in outline and moderately concave. The phalangial extremity is quadrate, deeply impressed at the sides for the attachment of lateral ligaments, convex above, and deeply notched below. Its articular surface is vertically convex, slightly depressed towards the middle inferiorly, and extends upon a pair of prominent condyles below. The measurements of the bone are as follows:—

	Inches.	Lines.
Extreme length	12	8
Length at its upper part	11	3
Breadth of shaft at middle	3	3
Depth of shaft at middle	1	9
Depth of tarsal extremity internally	4	6
Breadth of tarsal extremity at middle	3	4
Height of phalangial extremity from a level	4	2
Breadth of phalangial extremity above and below	4	2

The second specimen (Figs. 9, 10), suspected to belong to the inner toe, has the shaft cylindroid, but much compressed obliquely from within outwardly and above downward. The extremities are broadly expanded and oblique in their position. The tarsal extremity is more than twice the height of its breadth, and presents a long elliptical articular surface, moderately concave at its upper two-thirds and convex at its lower third. The phalangial extremity appears rhombohedral in outline with concave sides. Its articular surface is vertically convex and depressed towards the median line.

The measurements of this bone are as follows:—

	Inches.	Lines.
Extreme length	12	
Depth of shaft at middle	3	3
Thickness of shaft at middle	2	
Height of tarsal extremity	6	7
Width of tarsal extremity	3	
Height of phalangial extremity	5	6
Breadth of phalangial extremity above	3	9
Breadth of phalangial extremity below	4	1

A proximal phalanx of the hind foot, represented in Figs. 11, 12, Plate XIV, is the only bone of the toes preserved in the collection of *Hadrosaurus* remains. It bears a near resemblance in size and general form and proportions with the corresponding bone of the *Iguanodon*, as represented in Prof. Owen's Fig. 1, Plate XXI, of the British Fossil Reptiles, Dinosauria. It is oblong square and moderately expanded at the extremities. The proximal extremity, being the widest and deepest portion of the bone, presents a reniform articular surface, which is in the slightest degree concave. The distal extremity is deeply impressed at the sides for ligamentous attachments. The articular surface is likewise reniform in outline, vertically convex, and hardly depressed towards the median line. The measurements of this bone are as follows:—

	Inches.	Lines.
Extreme length	6	
Breadth at middle of shaft	3	9
Height at middle of shaft	2	4
Breadth of proximal extremity	5	4
Height of proximal extremity	3	2
Breadth of distal extremity	4	5
Height of distal extremity	2	2

Among the collection of *Hadrosaurus* remains are several bones whose position in the skeleton I am unable positively to determine. One of these, represented in Figs. 4, 5, Plate XVII, most nearly resembles that indicated by Prof. Owen[1] and Dr. Mantell[2] as the ilium of the *Iguanodon*.

Assuming the bone to be a left ilium, it consists of a broad, thick plate, prolonged into a long hook-like process, which curves backward and inward and is broken at the extremity. The opposite extremity of the bone is likewise broken. The inner border of the broad intermediate plate exhibits a long, ellipsoidal, irregular articular surface for junction with the sacrum. From the outer border of the plate there projects forward a massive trilateral tuberosity, roughened externally and at the summit, which probably corresponds with the process projecting from the fore part of the ilium in the *Iguana* and *Cyclura*. The length of the specimen in its present imperfect condition, measured in a straight line, is twenty-seven inches, and its greatest breadth is nine inches and a quarter. The sacral articular surface is a foot in length and about one-fourth that breadth.

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[1] British Fossil Reptiles, Dinosauria, Plates I and II.

[2] Petrifactions and their Teachings, page 306, lignograph 65.

Another bone, the character of which I have not satisfactorily determined, is represented in Fig. 13, Plate VIII. It bears a general resemblance to that indicated by Prof. Owen[1] and Dr. Mantell[2] as the clavicle of the *Iguanodon*, but appears to me rather to resemble the pubic bone of the *Iguana* and *Cyclura* than the clavicle of the same animals.

The specimen, broken at its upper extremity, consists of a long and nearly straight cylindroid shaft, expanding at its lower extremity into a broad, thin, and flattened triangular plate. The borders of the latter are concave, and its outer and inner angles below form thick tuberous processes. A smaller process likewise projects from the outer part of the shaft just before it expands. The length of the specimen in its present state is twenty-six inches, the circumference of its shaft five inches, and the breadth of its lower extremity ten inches and a half.

A specimen of what appears to be a sesamoid bone is tetrahedral, with two concave surfaces separated by a prominent acute ridge and defined by rugged borders, and with two opposed surfaces, of which one is convex and the other nearly flat. The three axes of the bone measure forty-three, forty-one, and twenty-four lines.

As regards the size, general form and construction, and the habits of *Hadrosaurus*, from the anatomical characters of the bones and teeth, we may safely infer that it bore a very near relationship with *Iguanodon*.

To *Hadrosaurus* we may estimate the number of cervical, dorsal, and lumbar vertebræ to have been twenty-four, as in the living *Iguana* and *Cyclura*, and as is supposed to have been the case in *Iguanodon*.

The sacrum was most probably composed as in the latter of six vertebræ.

In attempting to ascertain how many vertebræ would be required, in the intervals of those caudals in our possession, to complete the tail of *Hadrosaurus*, I have supposed the whole number of caudal vertebræ to have been about fifty.

By calculating the length of the vertebræ in different portions of the column, making proper allowance for the intervertebral fibro-cartilages, and giving about two feet and a half for the skull, I would estimate the entire length of *Hadrosaurus* to have been about twenty-five feet.

The enormous disproportion between the fore and hind parts of the skeleton of *Hadrosaurus* has led me to suspect that this great herbivorous Lizard sustained itself in a semi-erect position on the huge hinder extremities and tail while it browsed on plants growing upon the shores of the ocean in which it lived.

Undetermined Reptiles allied to Hadrosaurus.

In a number of instances bones, and fragments of others, have been presented to the Academy of Natural Sciences, approaching in size those of *Hadrosaurus*, though not positively referable to the same great Saurian. One of these specimens, represented in Figs. 1, 2, 3, Plate XVII, is a left humerus, from Monmouth County, New

[1] British Fossil Reptiles, Dinosauria, Pl. I, II.

[2] Petrif., &c., page 306, Fig. 65.

Jersey, presented by Dr. J. H. Slack. It is nearly perfect, except that the lower end is mutilated. When first examined and compared with the corresponding bone of *Hadrosaurus* the differences which were observable, though not very remarkable, led me to suspect that it belonged to *Mosasaurus*. The fossils previously described as most probably representing the humerus of the latter would, of course, preclude such an idea.

The specimen is rather smaller than the humerus of *Hadrosaurus*, and bears a near resemblance to it, without, however, being identical in form. The two bones are represented in the Figs. 1–3, Plates XIV, XVII, an inspection of which serves to exhibit the differences better than they can be described. The main differences are briefly as follows: The specimen in question is shorter in relation with the breadth, especially of its upper part; the expansion of its upper outer part extends more inferiorly in relation with the length of the bone, and terminates more abruptly than in *Hadrosaurus*. The expansion just mentioned, viewed sideways in the latter (Fig. 3, Plate XIV), presents a single curved line from the summit of the external tuberosity; in the humerus under comparison the same line (Fig. 3, Plate XVII) is sigmoid, and ends below in a rough tubercle not existing in *Hadrosaurus*. The lower part of the expansion is also thicker and rougher than in the latter; and behind it is much more projecting, so that the surface of the shaft in this position is transversely concave, whereas in *Hadrosaurus* in the same direction it is convex. Independently of these differences, the Monmouth County humerus closely resembles that of *Hadrosaurus*. Its measurements, in comparison with those corresponding in the latter, are as follows:—

	Monmouth County Humerus.		Hadrosaurus Humerus.	
	Inches.	Lines.	Inches.	Lines.
Length, ... estimated, under	21		22	6
Breadth at the tuberosities . . . about	6	9	6	10
Thickness at head	3	6	3	3
Breadth of shaft just above middle . . .	5	6	5	4
Thickness in same position	2	5	2	4
Breadth of lower portion of shaft	2	10	3	2
Thickness of lower portion of shaft . . .	2	9	2	9
Circumference of lower portion of shaft . . .	9	2	9	6
Breadth at condyles, . . estimated, under	5		5	
Diameter of head	2	4	2	6

Several fragments, apparently of both femora, of a huge animal, from the Marl, near Swedesboro, Gloucester County, New Jersey, were presented to the Academy by David Ogden. The more characteristic of these nearly corresponds in form with that portion of the femur of *Hadrosaurus* between the distal extremity and the process of the middle part of the shaft. If it really appertained to the Saurian just named, the breadth and thickness of the fragment, in relation with the length of the *Hadrosaurus* femur above described, would indicate the bone in its perfect condition to have been nearly five feet in length. The fragment in its present state is seventeen inches long. The lower end is composed of coarse, spongy substance, indicating its proximity to the articular extremity. The upper end is much less quadrate than the femur of *Hadrosaurus* would appear to be in a corresponding position, and is rather transversely reniform in outline. It exhibits a medullary cavity, occupied by a hard, ash-colored matrix, four inches and a half in transverse, and two inches and three-fourths in antero-posterior diameter, with walls of compact ossific substance from one to two inches and a quarter in thickness. The fragment at its narrowest point is seven inches wide, four inches and a half thick at the middle, five inches internally, and three inches and three-fourths externally.

A second of the fragments, above indicated, appears to be part of the inner side of the shaft of the femur just below the head, and measures nearly four inches in thickness. A third fragment appears to be from the inner side of the lower part of the shaft of the opposite thigh bone.

Several fragments of large bones, from the Green-sand of Monmouth County, New Jersey, were presented by Dr. J. H. Slack. One of the specimens appears to be from the middle of the shaft of the femur, but of this I am not certain, for what I take to be the inner half of the surface is so deeply eroded (apparently from the action of water to which it had been a long time exposed, while the other half was protected by the mud in which it lay imbedded at the bottom of the ocean) that its characteristic features are to a considerable extent lost. The fragment, about a foot and a half long, had the same quadrate form, and about the same size as the corresponding portion of the femur of *Hadrosaurus*. Its exposed medullary cavity, emptied of loose green sand with which it was filled, has a diameter of about three inches transversely, and two inches and a quarter antero-posteriorly, with the walls averaging an inch and a quarter thick.

Of the other fragments, presented by Dr. Slack, two belonged to the lower part of a fibula of the same form as that of *Hadrosaurus*, but considerably larger.

A specimen of a metatarsal bone, from Monmouth County, New Jersey, presented by Mr. Isaac M. Hopper, of Freehold, is represented in Figs. 7, 8, Plate XV. It is larger than either of those of *Hadrosaurus* above described, and also differs from them in form, though it exhibits sufficient likeness to one of them to lead to the opinion that it belonged to the same enormous Saurian. The proximal end has the same form as that of the metatarsal of *Hadrosaurus*, represented in Figs. 7, 8, Plate XIV. The distal extremity is less thick and has not such prominent condyles. The shaft is thicker, and its inner surface, instead of being narrowed from the extremities into a median prominence, forms a wide irregular plane. The measurements of the specimen are as follows:—

	Inches.	Lines.
Extreme length	13	6
Breadth of shaft at middle	3	
Depth of shaft at middle	2	3
Depth of tarsal extremity internally, about	5	6
Breadth of tarsal extremity at middle	3	3
Height of phalangeal extremity, from a level, about	3	8
Breadth of phalangeal extremity	4	

Another metatarsal bone, with its extremities mutilated, from Peale's Museum, formerly existing in Philadelphia, and probably obtained from the Green-sand of New Jersey, was presented by Dr. P. B. Goddard. It appears to have had the same form as the specimen just described, but was somewhat larger. The breadth of its shaft at the middle is three inches and three-quarters; its thickness two inches and a half.

Dr. Slack presented to the Academy four fossil bones, from the Green-sand of Monmouth County, New Jersey, which at first puzzled me as to their position in the skeleton. They bear a resemblance to the bodies of the sacral vertebræ of the *Iguanodon*, from which I suspect them to be the corresponding bones of a young *Hadrosaurus*. The specimens are all mutilated, and the best one is represented in Figs. 27, 28, Plate XIII, as a representative of the whole. Three of them are four inches and a half in length, the remaining one four inches. They are much constricted at the middle and rapidly expand towards the extremities, which terminate in slightly depressed or nearly plane, rough, cordiform articular surfaces. The lower part of the body forms a thick, transversely convex, carina-like ridge, deeply concave from before backward. The upper angles are bevelled off for conjunction with the sacral ribs or pleurapophyses, between which on each side is a wide notch, part of the foramen for the transmission of the sacral nerves. The sacral canal forms a deep groove, concave antero-posteriorly and transversely. Supposing that *Hadrosaurus* had six vertebræ to the sacrum, as in *Iguanodon*, the length of this bone in the young individual to which the specimens belonged would have measured about twenty-six inches in length.

Since writing the foregoing, Prof. Cook, of New Brunswick, New Jersey, has sent to me for examination a collection of fossils, from Monmouth County, New Jersey. Among them are several uncharacteristic fragments of bones of the extremities and portion of a vertebral body of some huge animal which I suspect to be *Hadrosaurus*. The specimens were obtained from the farm of the Rev. G. C. Schenk, of Marlboro, Monmouth County.

The collection also contains portion of the shaft of a femur, obtained by Dr. Conover Thompson, from Freehold, Monmouth County, probably belonging to a young *Hadrosaurus*. The specimen corresponds in form and construction with the middle part of the shaft of the femur of the Haddonfield *Hadrosaurus*, but is much smaller. It is four-sided, hollow interiorly, and exhibits the remains of the conspicuous process postero-internally. The shaft about the middle of the process measures three inches and three-quarters in diameter transversely, and a little over three inches antero-posteriorly.

A few remains have come under my observation, from the Green-sand formation of New Jersey, which indicate one, or perhaps two, comparatively small species of terrestrial or amphibious Sauria, apparently allied to *Hadrosaurus*.

One of the specimens, contained in the cabinet of the Academy, consists of an entire tibia, from Burlington County, and is represented in Fig. 3, Plate III. It resembles the tibia of *Hadrosaurus*, but besides being a very much smaller bone it is proportionately very much more slender; or, in other words, it is much longer in relation with the breadth of its extremities. The shaft is trihedral, and of nearly uniform diameter to within a few inches of the latter, which have nearly the same form and relative position in regard to each other as in *Hadrosaurus*. The interior of the bone is excavated with a capacious medullary cavity, which continues to within a short distance of the articular ends without being narrowed by an accumulation of spongy substance.

The measurements of the specimen are as follows:—

	Lines.	Inches.
Extreme length	15	6
Greater diameter at middle of shaft	1	4
Smaller diameter at middle of shaft	1	
Breadth of head	3	4
Thickness of head	2	1
Breadth of tarsal extremity	2	7
Thickness at inner anterior border of tarsal extremity	1	4

The other specimens referred to consist of several fragments of a tibia, portions of two metatarsals, and three phalanges, from a much larger individual, if not a different species, indicated by the tibia just described. The specimens are from Monmouth County, and were submitted to my inspection by O. R. Willis, of Freehold, through Prof. Cook.

The tibial fragments consist of the greater portion of the upper articular extremity (Fig. 6, Plate XVII), and the lower one (Fig. 7) preserved entire. Both have the same form as the corresponding portions of the tibia above described, but are much larger. Thus the thickness of the head is three inches; the breadth of the tarsal extremity is nearly four inches; and the thickness at the inner anterior border of the latter one inch and three-quarters. The medullary cavity is very capacious, being intermediate in this respect to the condition observed in ordinary mammals and birds. It reaches to within a short distance of the articular surfaces of the ends of the bone without being narrowed through the accumulation of cancellated substance.

One of the fragments of a metatarsal is represented in Fig. 8, Plate XVII. It is the distal end; has a quadrate shaft and a single articular head. The impressions for the attachment of lateral ligaments are remarkable for their depth. The interior of the fragment exhibits a medullary cavity corresponding in its capacity with that of the tibia.

The three phalanges (Figs. 9–11, Plate XVII) are all from the first series, and resemble the corresponding bones of Crocodiles; two are alike; the third is longer and narrower than the others. The proximal extremity, which is the broader, presents a single articular concavity. The distal extremity presents the common hour-glass-like or trochlear articular surface, and, as in the case of the metacarpal fragment just described, is depressed at the sides into deep pits, corresponding with the usual attachments of lateral ligaments.

The measurements of the shorter phalanges are as follows:—

	Inches.	Lines.
Length laterally	3	5
Breadth of proximal end	2	
Depth of proximal end	1	7
Breadth of distal end	1	6
Depth of distal end laterally	1	1

The measurements of the longer specimen are as follows:—

	Inches.	Lines.
Extreme length	3	10
Breadth of proximal end	1	6
Depth of proximal end at middle line	1	7
Depth of proximal end to a level	2	
Breadth of distal end	1	2
Depth of distal end laterally	1	3

ASTRODON.

Astrodon Johnstoni.

Astrodon, Johnston, American Journal Dental Science, 1859.

Dr. Christopher Johnston has submitted to my inspection the greater part of a tooth, and a transverse section of another prepared by him for microscopic examination, of an extinct Reptile, for which he has proposed the name of *Astrodon*. The specimens of teeth were obtained by Mr. Tyson from an iron ore bed, considered as belonging to the Cretaceous epoch, near Bladensburg, Maryland.

The tooth of *Astrodon*, of which four views are given in Figs. 20–23, Plate XIII, bears considerable resemblance in form to the teeth referred to the *Hylæosaurus*, an associate of the *Iguanodon* and *Megalosaurus*, in the Wealden formation of Europe. The specimen comprises nearly the length of the crown, and is about an inch and a half long. The shaft of the crown is straight, compressed cylindroid, in transverse section ovate, the outer side strongly convex, the inner side much less so. The summit of the crown is compressed conical, curved inward, convex externally, depressed internally and sub-acute at the lateral borders, one of which is worn in the specimen so as to expose a narrow tract of dentine.

The transverse section of the tooth beneath the microscope, as represented in Fig. 10, Plate XX, exhibits an interior disk of dentine, with a multitude of minute tubuli radiating from the narrow elliptical section of the pulp cavity, surrounded by a thick layer of enamel.

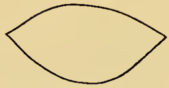
TOMODON.

Tomodon horrificus.

Among some teeth of Sharks, from Mullica Hill, Gloucester County, New Jersey, in the collection of Dr. William B. Atkinson, I observed a tooth different from any I had previously seen, from the Green-sand formations. The specimen represented in Figs. 7, 8, 9, Plate XX, Dr. Atkinson presented to the Academy of Natural Sciences. It appears to be the tooth of a gigantic carnivorous Reptile, a fitting contemporary of the *Hadrosaurus*.

The base of the specimen is broken away, and exhibits the remainder of the pulp cavity, which is small and of the form of the exterior of the tooth. The apex also is somewhat injured, though I have been unable to determine how much of the bluntness of the specimen is due to accident. It has the appearance as if it naturally terminated in a truncated manner; the enamel forming an abrupt ring surrounding a shallow depression of the dentine. The specimen to the extreme edge of the broken base is everywhere invested with thin, shining, and nearly smooth enamel, being only marked by feeble longitudinal striation and stronger transverse ridges of growth.

No. 35.



In shape the tooth is conical, strongly compressed from without inwardly, and has its broad surfaces defined before and behind by finely denticulated trenchant borders. In transverse section it forms a long ellipse with very acute poles, as seen in the outline, No. 35.

The length of the specimen in its present condition is two inches; the breadth just below the middle, where it is unbroken, is thirteen lines; and the thickness in the same position is seven lines.

Whether the tooth belongs to the same Reptile as some of the bones described in the preceding pages can only be conjectured, and under the circumstances I have indicated it under the name heading the present chapter. It may belong to *Discosaurus* or *Cimoliasaurus*, but the question can be determined only after further discovery.

PLIOGONODON.

Pliogonodon priscus.

Pliogonodon priscus, Leidy, Proceedings Academy Natural Sciences, Philadelphia, 1856, 255.
Pliogonodon nobilis, Leidy, Emmons, Report North Carolina Geological Survey, 1858, p. 223, figs. 43, 44.[1]

Under the above name I described the mutilated crowns of two teeth submitted to my inspection by Prof. Emmons, who obtained them from a Miocene deposit of Cape Fear, North Carolina. The specimens are, nevertheless, suspected originally to have belonged to the Green-sand formation. Their character I have not ascertained, and though I suspect them to have an affinity to *Mosasaurus*, they may be Crocodilian.

The specimens are elongated conical, in transverse section circular. One of them is straight, the other feebly curved. They are provided internally with acute ridges or carinæ, defining the inner and outer surfaces of the crown, which is subdivided into numerous narrow planes diversified with a few vertical interrupted plicæ more numerous on the inner surface. The base of the crown is hollowed; the dentine is fissured in concentric laminæ, and the enamel is minutely wrinkled. When perfect the crowns measured about two inches in length, and three-fourths of an inch in diameter at base.

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[1] The change of name I cannot account for except through inadvertence.

CHELONIA.

Remains of Turtles are not unfrequently discovered in the Green-sand formations of the United States, and many have been submitted to my inspection, especially from New Jersey. So little care, however, has been taken of these fossils, at the time of their discovery, that the fragments I have seen are scarcely more than sufficient to determine the order of animals to which they belong. Indeed, it has appeared to me that on the discovery of one or more of the plates which compose the shell or carapace and sternum of a Turtle the finder has amused himself in breaking the plates into as many bits as possible, though probably the destruction has rather been owing to the accidental blow of a pick or spade in digging the Marl in which the bones were imbedded. Most of the best preserved specimens I have had the opportunity of examining were obtained by Prof. George H. Cook, during his geological survey of New Jersey.

CHELONE.

Chelone sopita.

The remains of a supposed species of *Chelone*, from the Green-sand of Tinton Falls, Monmouth County, New Jersey, obtained by Prof. Cook, were first mentioned in a paragraph following a notice of remains of *Chelone grandæva*, a species of the Miocene period, in the Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. VIII, page 303.

These remains consist of portions of four detached marginal plates of the carapace, which differ so much in breadth as to lead to the supposition that they may belong to two individuals of different age, if not to two species, though I suspect they really appertain to a single individual.

The plates are smooth, except that they present distinct vascular grooves, and each is crossed transversely about the middle by a furrow defining the separation of the marginal scutes. Their inner border is thick and longitudinally grooved, and is provided with a deep conical pit for the reception of a rib process from the costal plates. From the inner border the plates gradually and uniformly thin out to the acute outer edge. The upper surface is straight longitudinally, but slightly concave transversely, and the under surface is in the same degree convex. The transverse section forms a narrow isosceles triangle slightly curved.

One of the plates has a length of about three inches and a half, a breadth of three inches and a quarter, and a thickness at the inner border of seven lines. The fragment of a second plate, more curved than the others, has a breadth of three inches and a quarter, and a thickness at the inner border of 11 lines. A third plate is four inches and a half long, two inches and a half wide, and three-quarters of an inch thick at the inner border. The fragment of a fourth plate, less curved than the others, is two inches wide, and one inch thick at the inner border.

The collection of the Academy of Natural Sciences contains a series of three marginal plates, with the half of a fourth, from the Green-sand of Mullica Hill, Gloucester County, New Jersey, presented by Mr. J. Colson and Dr. Wm. B. Atkinson, which I suspect to belong to a younger individual of the same species as the preceding.

The series, represented in Fig. 5, Plate XIX, without having the means to determine their proper position, I nevertheless suspect to belong to the posterior portion of the left side of the carapace.

The plates rapidly increase in breadth passing backward. The inner border of the series forms a continuous groove, with a deep costal pit in each plate. The upper surface of the anterior plates slants evenly outward, but becomes slightly concave in the posterior plates. The under surface corresponds with the upper. The outer border is thin and acute, and at the junction of the plates appears to have been somewhat crenate. The outer border of the third plate of the series as it approaches the succeeding plate is notched half the width of the plate (*e*). The posterior border of the last plate of the series articulated with the succeeding one only at its outer half (*f*); the inner half (*g*) of this border being obtusely rounded, and it extends close upon the costal pit of the inner border. The surfaces of the plates are smooth or marked only by vascular grooves, and each is crossed by a furrow (*i*) defining the boundary of the scutes.

The breadth of the first of the plates is one inch and a half; its thickness internally ten lines. The length of the next plate is two inches eight lines; its breadth at middle one inch seven lines; its thickness nine lines. The length of the succeeding plate is two inches seven lines; its breadth two inches and a quarter; its thickness seven lines. The length of the last plate is two inches seven lines; its breadth two inches two lines; and its thickness half an inch.

Chelone ornata.

Chelone ornata, Leidy, Proc. Acad. Nat. Sci., Phila., 1856, VIII, 303.

The museum of the Academy of Natural Sciences contains a specimen consisting of conjoined portions of two marginal plates of a Turtle, obtained by Mr. L. T. Germain, from the Green-sand of Burlington County, New Jersey. The specimen is represented in Fig. 10, Plate XVIII, and though very imperfect is, nevertheless, characteristic on account of its markings. The plates measure about an inch and a half in breadth, and in transverse section are wedge-formed. Their inner border is eight lines high, and is grooved; the outer border is acute. Both upper and under surfaces slope evenly to the edges, and both are coarsely but beautifully tuberculated. In the perfect condition of the plates the tubercles appear to have had some tendency to a radiated arrangement. The fossil is supposed to indicate a species of *Chelone*, though future discoveries may determine it to belong to another genus.

EMYS.

Emys firmus.

Prof. Cook submitted to my inspection a number of fragments of Turtle shells, from the Green-sand formation of Tinton Falls, Monmouth County, N. J., among which are several marginal plates of a carapace and fragments of sternal plates, apparently belonging to the same individual. The osseous plates are as remarkable for their thickness as those of *Emys crassus*, from the Eocene sand of Hordwell, England, described by Prof. Owen.[1]

The specimens, also supposed to indicate a species of *Emys*, consist of fragments of the third, fifth, sixth, and seventh right marginal plates, a portion of the sixth and the nearly entire seventh left marginal plates of the carapace, and portions of the right hyposternal and left hyosternal plates of the sternum.

The exterior surface of the marginal plates is obscurely marked, as if impressed by a piece of lace, but on some of the specimens the marking is obliterated. The corresponding surface of the sternal plates is evidently smooth. Outlines of scutes on the marginal plates are so obscurely indicated as not to be distinctly traceable. The fragment of the hyposternal plate is crossed by a furrow defining the boundary of the abdominal and femoral scutes, but the hyosternal plate presents only a short interrupted furrow, which may be supposed to define the limits of the humeral and abdominal scutes.

The best preserved of the marginal plates, represented in Fig. 2, Plate XIX, the sixth and seventh of the left side, have their outer surface moderately convex, and sloping at an angle of nearly 45°. Their under part is strongly excavated to form the upper boundary of the back opening of the shell. The basal margin of the sixth plate is obtuse, but it becomes more acute as it extends along the seventh plate. The two plates together measure along the curve of the basal margin five inches and three-quarters. The width of the sixth plate about its middle is two inches and a half; that of the seventh is two inches and three-quarters, and its depth is three inches and three-quarters.

As indicated in Fig. 3, Plate XIX, the left hyosternal (*b*) articulated by a truncated angle with the right hyposternal plate (*d*) across the line of the median suture of the sternum, which was quite irregular in its course. The strongly truncated posterior angle of the right hyposternal plate would indicate that it also articulated with the left xiphisternal plate across the median suture. The anterior sutural border of the left hyosternal plate is sufficiently well preserved to indicate that the entosternal plate measured two inches in transverse diameter.

The left hyosternal plate along the line of the median suture measures two inches and a half; its width in the same direction at the outer boundary of the entosternal suture is three inches; its thickness at the inner angle of the latter suture is over an inch; its thickness at the angle of articulation with the hyposternal plate is five-eighths of an inch; and where thinnest, postero-externally, the fragment is half an inch.

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[1] British Fossil Reptiles, p. 76, pl. 38.

The right hyposternal plate, along the median suture, is two inches and a half; where widest, it measures in the same direction three inches and a quarter; where thickest, just back of the middle of the median suture, it is three-fourths of an inch; and where thinnest, externally, it is half an inch.

Emys beatus.

The museum of the Academy of Natural Sciences of Philadelphia contains several plates and fragments of others of a carapace of a Turtle, from the Green sand of Mullica Hill, Gloucester County, New Jersey, presented by William M. Gabb. The specimens, represented in Figs. 1–3, Plate XVIII, consist of part of the first vertebral plate, the entire third and fourth vertebral plates, portions of the first left and second and third right costal plates, and the greater part of the first left marginal plate.

The fragment of the first vertebral plate (*a*) is the anterior half, and is crossed near the broken edge by a groove, indicating the conjunction of the first and second vertebral scutes. The lateral borders are sub-angularly convex; the anterior border is irregularly angular. The broken edge is three lines and a half thick, from which position the plate thins away to the anterior border, where it measures one line and a half thick. The breadth of the plate about its middle is fifteen lines, the estimated length about thirty-four lines. The posterior portion of the plate, which is lost, judging from the corresponding margins of the first and second costal plates, appears to have been prolonged at its angles so as to join the antero-internal angles of the second costal plates.

The space occupied by the second vertebral plate is estimated to have been about twenty lines long and fourteen lines broad at its widest part. The lateral borders of the plate were subangularly convex; the posterior border convex.

The third and fourth vertebral plates (*b*, *c*), preserved entire, are elongated hexagonal, or wide coffin-shaped. The anterior border is concave, the posterior is convex. Of the lateral borders, which are straight, in the third plate the anterior is scarcely one-third the length of the posterior, and in the fourth plate the anterior is little greater than one-third the length of the posterior. The third plate is crossed just back of the middle by a groove, indicating the conjunction of the second and third vertebral scutes. Its length is two inches, its breadth at the widest part in front is seventeen lines, and its thickness five lines and a half. The length of the fourth plate is twenty-two lines, its breadth at the fore part sixteen lines, and its thickness is the same as the former.

The fragment of the first left costal plate (*d*) is the vertebral portion, and is grooved by the first and second vertebral scutes. It is thickest at the postero-internal angle, where it measures four lines and a half and thins away to three lines, two inches from the vertebral border. It appears not to have articulated with the second vertebral plate, from which it was separated by the prolonged basal angle of the preceding vertebral plate. Internally it presents a robust costal process for articulation with the first vertebra of the carapace.

The fragments of the second and third right costal plates are also vertebral portions, and both are devoid of internal costal processes for articulating with the vertebræ, as in some of the land Turtles. The second plate (*e*) is marked by grooves of the second vertebral and the first and second costal scutes. Its anterior angle articulated with the first vertebral plate, its posterior angle with the third, and the intervening border with the second. The narrowest portion of the fragment, within the space covered by the second vertebral scute, measures twenty-two lines, and the plate widens outwardly, to the broken margin where it is twenty-four lines. The thickness of the plate at the vertebral margin is four lines and a half anteriorly and five and a half posteriorly, and it thins outwardly to the broken margin where it measures three lines and a half. Fig. 2 represents an inner view of the fragment exhibiting the merest rudiment of a costal process at *f*.

The fragment of the third costal plate (*g*) comprises two inches and a half of its vertebral portion, which articulated with the third and fourth vertebral plates. It is marked by grooves of the second and third vertebral scutes, opposite which it measures twenty-three lines wide, and is reduced towards the broken outer margin to twenty-one lines. The thickness of the plate at the vertebral border is six lines, from which it thins off to the broken border to three lines and a half.

The first left marginal plate, Fig. 3, is marked by a crucial groove of the first and second marginal scutes, the first vertebral scute and the first costal scute. The marginal scutes did not extend to the middle of the length of the plate, the outer edge of which is acute and everted, and almost twice the breadth of the costal border. From the latter the plate increases in thickness to its middle, where it measures nearly seven lines, and then thins outwardly to the acute free margin.

The upper surfaces of all the plates present a closely, though somewhat obscurely pitted appearance, recalling to mind the rain-drop marking on muddy or sandy strata. This appearance, so different from the reticular furrowing on the lines of the Turtle previously described, precludes the idea of its belonging to the same. The slight variation in breadth and moderate curvature of the costal plates as they extend outwardly, indicate a depressed or low form of carapace as in the Terrapins. The absence of costal processes for articulating with the vertebræ, in the specimens of second and third costal plates, presents a relationship of structure with some of the land Turtles. Together the fossil fragments present characters sufficient to indicate a peculiar species.

Emys pravus.

Emys pravus, Leidy, Proc. Acad. Nat. Sci. Phila. 1856, 303.

Among the Turtle remains, obtained by Prof. Cook from the Green-sand of Tinton Falls, Monmouth County, New Jersey, are the greater portions of a hyosternal and hyposternal plates, and a small fragment of the conjoined xiphisternals. These are represented in Fig. 1, Plate XIX, and indicate a species differing from any of the preceding, and supposed to belong to the genus *Emys*.

The under surface of the sternum was generally flat, and appears to have been smooth, or without characteristic markings, though the eroded condition of the specimens renders this point uncertain. The marks of scutes, if they existed, are obliterated, or are so obscure as not to be traceable with any positiveness. The median suture is irregular in its course, as were also those sutures which crossed the sternum transversely.

Though the hyosternal (*b*) and hyposternal plates (*c*) are of far greater extent than in *Emys firmus*, they are absolutely very much thinner. The posterior angle of the right hyosternal articulates across the median sternal suture with the contiguous angle of the left hyposternal plate, which is provided with a tooth-like process received into a corresponding pit of the former plate.

The entosternal and episternal plates, judging from the forepart of the hyosternal, appear to have had the arrangement seen in our common Terrapins. The breadth of the entosternal space (*a*) between the hyosternal plates has been about two inches and a half; its depth between the same plates about one inch and a half. The estimated breadth of the sternum at the articulation of the epi- and hyosternals has been four inches and a half.

The length of the hyosternal plate along the median suture is four inches; its greatest length externally is five inches and three-quarters; the width of its episternal suture is one inch and a half; and its thickness is nearly uniformly about five lines.

The length of the hyposternal plate along the median suture is five inches; its greatest length, a short distance outwardly, five inches and three-quarters; and its thickness ranges from five to seven lines.

The xiphisternals (*e*, *f*) appear together to have been rounded off posteriorly and scarcely emarginate.

PLATEMYS.

Platemys sulcatus.

Platemys sulcatus, Leidy, Proc. Acad. Nat. Sci., Phila., 1856, VIII, 303.

Three consecutive marginal plates of the left side of a carapace, found in association with remains of other Turtles in the Green-sand of Tinton Falls, Monmouth County, New Jersey, and submitted to my inspection by Prof. George Cook, have been referred to the genus *Platemys*, from no other character, however, than their form. The plates articulated, as represented in Fig. 4, Plate XIX, are the fifth to the seventh, inclusive. Their outer side inclines at an angle of nearly 45°, but slopes in a gently curving manner more outwardly towards the thin acute basal margin, which is wider posteriorly than anteriorly. The surface is feebly marked with reticular furrows, and is grooved at the position of the borders of the marginal and costal scutes. The grooves defining the costal and marginal scutes cross the plates transversely just above their middle. The grooves defining the marginal scutes laterally descend along the middle of the plates. The three bones together, along the curve of their acute basal margin, measure eight inches. The under side of the plates is broad and flat.

With the marginal plates there was found a large fragment, apparently the greater portion of a xiphisternal plate of the same individual. The under surface exhibits the same kind of reticular furrows, as the marginal plates, but it is especially interesting from the fact that it presents on its upper surface an oblong elliptical suture for the pelvis. Such an articulation would, perhaps, indicate a nearer affinity of this extinct Turtle to the existing *Sternotherus*, than to *Platemys*, with which I have associated it.

I have also seen small fragments of two other xiphisternals, with the pelvic sutures, together with a fragment of a costal plate, apparently of a much younger individual, of the same species as the foregoing, obtained by Dr. Wm. B. Atkinson, from the Green-sand of Mullica Hill, Gloucester County, New Jersey.

BOTHREMYS.

Bothremys Cookii.

In June, 1862, Prof. Cook sent to me, for examination, the skull of a Turtle, from the Green-sand near Barnsboro, Gloucester County, New Jersey, which, independent of its special or generic peculiarities, is of interest from the circumstance that it is the first Chelonian skull brought to my notice from the Green-sand formations of the United States.

The specimen, represented in Figs. 4–8, Plate XVIII, consists of the greater portion of a skull together with the lower jaw. Of the former the occipital region, the auditory passages, the zygomatic arches, and some other minor parts are lost; of the latter the condyloid portions are destroyed.

Of all recent Turtles with which I am acquainted the fossil skull, in general physiognomy and structure, resembles most that of the great Turtle of the Amazon, *Podocnemys expansa*. From this, and all others, however, it differs in several striking peculiarities.

The fossil skull is remarkable for the great proportionate breadth of the face, due to the accommodation of a large conical pit formed by each maxillary bone, as seen in Fig. 7, *a*.

The top of the skull (Figs. 4, 6) is nearly flat, inclining forward in a slight degree, and becoming slightly more convex approaching the orbits and the interval between them. The face in the latter position is broad, slightly convex, and slopes regularly to the anterior nasal orifice. Below and behind the orbits the face is of great proportionate depth, and slopes obliquely downward and outward with a moderate degree of convexity. Transversely the lower boundary of the face forms a semicircle, broken only by a moderate pointed protrusion of the premaxillaries.

The orbits are comparatively small and circular, and look obliquely upward, forward, and outward.

The anterior nasal orifice is of great proportionate breadth, its transverse diameter being twice as great as the vertical. It is in the form of a double annulus or a prostrate figure of 8.

The temporal fossæ are large, but whether they have been covered by a bony vault, as in the great Turtle of the Amazon and the marine Turtles, cannot be ascertained in consequence of the imperfection of the fossil.

The upper jaw is defined below, in the usual manner in Turtles, by an acute ridge for accommodating the corneous dental armature of the jaw.

The most remarkable character of the skull is seen in the inferior view (Fig. 7). This consists of a deep conical pit (a) occupying each maxillary bone. The bottom of the pit extends as high as the position of the upper third of the orbit externally, and is imperforate. The pit expands regularly downward upon nearly the whole palatine surface of the maxillary bone, including a portion of the premaxillary and palate bones. The lower boundary, or mouth of the pit as it may be considered to be, forms an isosceles triangle, the apex of which, slightly prolonged, extends upon the premaxillary bone to the median palate suture, and the base is formed by the posterior, acute, crescentic border of the maxillary bone bounding the temporal fossa. The outer side of the triangle is constituted by the dentary margin of the jaw; and the inner side is formed by a ridge proceeding from the middle of the premaxillary bone obliquely outward and backward, just external to the posterior nares, and extending upon the palate bone. No intervening ridges occupy the triangle formed by the mouth of the pit.

The function of the latter it is difficult to comprehend. It does not appear like an alveolus for a tooth; but probably it may have accommodated a corneous tooth-like process springing from a corresponding hollow of the lower jaw.

The posterior nares are situated about ten lines behind the front of the jaw. They are circular, are separated by a strong osseous vomer, and are directed backward in the usual manner.

The base of the skull between the temporal fossæ presents a broad surface, which was apparently furnished at the sides with conspicuous pterygoid processes, as in the great Turtle of the Amazon.

A pair of small anterior palatine foramina occupied the suture between the premaxillaries, and apparently the vomer and palate bones.

A rather larger pair of posterior palatine foramina occupy the sutures between the palate and ali-sphenoid bones.

The orbits are separated from the temporal fossæ, as in the great Turtle of the Amazon, by a postero-external wall, which, so far as I can ascertain, appears to be composed of contributions from the post-frontal, parietal, malar, maxillary, and ali-sphenoid bones. As in the Turtle just mentioned, the orbit likewise communicates with the temporal fossa by a large aperture bounded externally by the scroll-like external pterygoid process. At the back part of the inner wall of the aperture the large foramen is situated, for the transmission of the trifacial nerve.

The sutures in the fossil are, in many cases, very indistinct, and in other cases the specimen has been fractured in their course, so that it is difficult to follow them or to determine the outlines of the individual bones.

The upper surface of the parietals are flat, and exhibit no markings of investing scutes, which is also the case with the other bones of the cranium.

The frontals are small, and their upper surface is flat. They are defined by an irregularly transverse suture from the parietals, by another directed forward to the middle of the top of the orbits from the post-frontals, and by an oblique one from the pre-frontals.

The pre-frontals, as in most Turtles, are not distinct from the nasals. They are larger than the frontals, and are defined from the maxillaries by an oblique suture proceeding from the nasal orifice to the inner and lower part of the orbit.

The post-frontals are broken away at their back part; their fore part forms the supero-external fifth of the orbits.

The back part of the malars is likewise broken; their fore part forms a narrow plate introduced between the post-frontal and posterior portion of the maxillary bone, as in *Podocnemys*.

From the broken boundary of the parietals, post-frontals, malars, and maxillaries in the fossil, I suspect a bony vault to have enclosed the temporal fossa, as in *Podocnemys* and the marine Turtles.

The mandible or lower jaw (Figs. 5, 8), as in the case of the upper maxillary bones, is remarkable for the deep pit (*b*) which occupies it on each side. The bottom of the pit corresponds with the posterior extremity of the dentary bone, and it expands, trumpet-like, obliquely forward and inward upon the upper surface of the mandible. The boundaries of the mouth of the pit correspond with the anterior and posterior dental ridges extending from the symphysis and meeting at the coronoid process.

The anterior dental ridge is directed forward and not upward in the usual manner. It is nearly on a level with the base of the jaw, which is almost flat.

The coronoid process is as robust and prominent as in the soft-shelled Turtles or *Trionyces*. Just back of its base is situated, as usual, the foramen for the inferior maxillary nerve, which likewise, as in other Turtles, communicates with a groove on the inner side of the ramus of the jaw.

The connections of the dentary with the other bones of the jaw are too obscure in the fossil to be traced with success.

Measurements obtained from the fossil skull are as follows:—

	Lines.
Height of skull from a level surface	16
Breadth of face at back part of maxillæ	32
Length of face from fronto-parietal suture to anterior nasal orifice	16
Diameter of orbits, transverse and vertical	7
Transverse diameter of anterior nasal orifice	10
Vertical diameter of anterior nasal orifice, each side	5
Depth of face below orbits	9½
Breadth of face between orbits	8
Length and breadth of each frontal bone	6
Length of fronto-nasals	9
Breadth of fronto-nasals at lower margin of orbits	7
Distance of posterior nares from margin of the premaxillaries	10½
Breadth together of the posterior nares	6½
Breadth of base of skull between the external pterygoid processes	19
Breadth of lower jaw at coronoid processes	23
Distance from coronoid process to pointed extremity of symphysis	21
Breadth of jaw at symphysis	9
Height of jaw at back of symphysis	6
Height of jaw at coronoid processes	13

The question may arise whether the fossil skull belongs to any of the preceding Turtles, and if so, to which. As it is impossible, under present circumstances, to give a satisfactory answer, I have considered the specimen as characteristic of a new genus, for which the name of *Bothremys* is proposed in allusion to the remarkable pits of the jaws. The species is dedicated to Prof. George H. Cook, of Rutger's College, New Brunswick, New Jersey, by whom the specimen was obtained, and through whose explorations our knowledge of the vertebrate fauna of the Green-sand formations of New Jersey has been greatly enriched.

TRIONYX.

Trionyx priscus.

Trionyx priscus, Leidy, Proceedings Academy Natural Sciences, Philadelphia, 1851, V, 329.

A species of soft-shelled Turtle of the genus *Trionyx* appears to have existed during the deposit of the Green-sand formations of the United States, as indicated by the discovery of several small fossil fragments. These remains, if correctly referred to their true geological and zoological position, are the oldest of the genus, for no authentic species have previously been found in older formations than the Eocene Tertiary strata. But all existing *Trionyces* inhabit fresh water, and the extinct species heretofore described have been obtained from fresh-water deposits. The discovery, however, of remains of *Trionyx* in a marine formation like the American Green-sand does not prove that the genus inhabited the seas of the Cretaceous period. The species most probably, as at the present time, lived in rivers, down which the remains were carried to be deposited in. the Green-sand mud of the ocean.

The museum of the Academy of Natural Sciences contains a small portion of a costal plate of a *Trionyx*, from the Green-sand of Burlington County, New Jersey. The fragment, together with its costal ridge, is nearly half an inch in thickness; the plate away from the ridge is about three lines and a half in thickness.

A more characteristic specimen is represented in Fig. 9, Plate XVIII. It consists of the outer portion of a costal plate, apparently the sixth of the left side, and measures two inches and a half long. It was found in the marl on the farm of G. C. Shenck, Monmouth County, New Jersey, and was sent to me for examination by Prof. Cook. At the broken border it is one inch and a half wide; at the outer border two inches. The costal ridge ends in a robust and comparatively short free process. The thickness of the plate, together with the costal ridge, internally is four lines, externally six lines; the thickness of the plate before and behind the ridge about three lines and a half. The free surface of the plate is covered with a network of ridges, of which those proceeding antero-posteriorly are very coarse, while the transverse connecting ridges are much finer. The meshes of the network are hemispherical pittings.

Accompanying the specimens just described were two others, consisting of the acetabular portion of the pelvis and the upper extremity of the femur of the right side. The fragment of the femur, with the head mutilated, closely resembles in form the corresponding portion of the same bone in recent species of *Trionyx*. The breadth at the trochanters is twenty lines; the diameter of the shaft just below the latter from side to side was about six lines and a half; and from without inward it measures five lines.

I have also had the opportunity of inspecting a fragment of a costal plate of a *Trionyx*, about the size of that to which the specimens just described belonged, from the Cretaceous formation near Columbus, Mississippi, whence it was obtained by Dr. Spillman. The surface, however, is not so deeply pitted as in the costal fragments above described, nor are the ridges separating the pits so coarse. It probably indicates a different species.

A SYNOPSIS,

IN WHICH AN ATTEMPT IS MADE TO DEFINE MORE CLOSELY THE GENERA AND SPECIES OF REPTILES WHOSE REMAINS ARE DESCRIBED IN THE PRECEDING PAGES.

SAURIA.

THORACOSAURUS. Leidy.

1. Thoracosaurus neocesariensis.

New Jersey Gavial. De Kay: An. Lyc. Nat. Hist. N. Y. 1833, III, 156, Pl. III, Fig. 7–10.
Gavialis neocesariensis. De Kay: Zool. New York, 1842, III, 28, Pl. 22, Fig. 59.
Crocodilus s. Gavialis clavirostris. Morton: Pr. Ac. Nat. Sci. Phil. 1844, III, 82.
Crocodilus basifissus. Owen: Jour. Geol. Soc. Lond. 1849, V, 381, Pl. X, Figs. 1, 2.
Sphenosaurus. Agassiz: Pr. Ac. Nat. Sc. Phil. 1849, IV, 169.
Thoracosaurus grandis. Leidy: Pr. Ac. Nat. Sc. Phil. 1852, VI, 35.

Pages 5–12, Plate I, Figures 1–6; Plate II, Figures 1–3; Plate III, Figures 5–11

BOTTOSAURUS. Agassiz.

2. Bottosaurus Harlani.

Extinct species of Crocodile. Harlan: Jour. Ac. Nat. Sci. Phil. 1824, IV, 15, Pl. I.
Crocodilus Harlani. Meyer: Palæologica, 1832, 108.
Crocodilus macrorhynchus. Harlan: Med. and Phys. Res. 1835, 369.
Bottosaurus. Agassiz: Pr. Ac. Nat. Sci. Phil. 1849, IV, 169.
Crocodilus basitruncatus. Owen: Jour. Geol. Soc. Lond. 1849, V, 380.

Pages 12–14, Pl. IV, Figs. 19–21; Pl. XVII, Figs. 11–14.

CROCODILUS.

3. Crocodilus tenebrosus.

Page 14: Two cervical, a dorsal, the sacral, and two caudal vertebræ, and portions of both humeri, from Big Timber Creek, Gloucester Co., N. J. Pl. III, Figs. 12–15.

4. Crocodilus obscurus.

Page 15: Four vertebræ, the shaft of a femur, and four broken dermal bones, from Barnsboro, Gloucester Co., N. J., Pl. II, Figs. 4, 5.

Page 16, Two posterior dorsal or lumbar vertebræ, from Arneytown, Burlington Co., N. J.

Crocodiles of Uncertain Reference.

a. Page 16, Vertebræ, from Jobstown, Burlington Co., N. J. Pl. II, Fig. 6.
b. Pages 16, 17, A cervical vertebra, from St. George's, New Castle Co., Del. Pl. II, Fig. 7.
c. Page 17, Fragment of a left dental bone, from Monmouth Co., N J. Pl. IV, Figs. 22, 23.
d. Page 17, Fragment of a small *Gavial* skull, from Burlington County, N. J. Pl. II, Fig. 8.
e. Page 17, Four teeth, from Blackwoodtown, Camden Co., N. J. Pl. I, Figs. 7, 8, 9.
f. Page 17, Two teeth, from North Carolina. Pl. III, Figs. 22, 23.
g. Page 18, A dermal plate, fragment of a jaw and a tooth, from Burlington Co., N. J.

POLYPTYCHODON. Owen.

5. Polyptychodon ? rugosus.
Polyptychodon rugosus. EMMONS: North Carol. Geol. Surv. 1858, 219, Fig. 38.
Page 18, A tooth, from Elizabethtown, Bladen Co., N. C.

HYPOSAURUS. Owen.

6. Hyposaurus Rogersii.
Hyposaurus Rogersii. OWEN: Jour. Geol. Soc. Lond. 1849, V, 380, Pl. XI, Figs. 7–10.
Holcodus acutidens. In part, of GIBBES: Mem. on Mosasaurus, &c., Smiths. Contrib. 1850, II, 9, Pl. III, Fig. 13.
Pages 18–21, Pl. III, Figs. 4, 16–21; Pl. IV, Figs. 1–12.

DISCOSAURUS. Leidy.

7. Discosaurus vetustus.
Discosaurus vetustus. LEIDY: Pr. Ac. Nat. Sc. Phil. 1851, 326.
Pages 22–25, Pl. IV, Figs. 13–18; Pl. V, Figs. 1–12.

CIMOLIASAURUS. Leidy.

8. Cimoliasaurus magnus.
Cimoliasaurus magnus. LEIDY: Pr. Ac. Nat. Sc. Phil. 1851, 325; 1854, 72, Pl. II, Figs. 4–6.
Pages 25–29, Pl. V, 13–19; Pl. VI, Figs. 1–18

PIRATOSAURUS. Leidy.

9. Piratosaurus plicatus.
Pages 29, 30, Pl. XIX, Fig. 8.

MOSASAURUS. Conybeare.

10. Mosasaurus Mitchelli.
Saurian resembling the Reptile of Maestricht. MITCHELL: Obs. Geol. North America, 1818, 384, 385, Pl. VIII, Fig. 4.
Saurian resembling the Maestricht Monitor. HARLAN: Jour. Ac. Nat. Sc. Phil. 1825, IV, 235, Pl. XIV, Figs. 2–4; Med. Phys. Res. 1835, 384.

Mosasaurus. De Kay: An. Lyc. Nat. Hist. N. York, 1828–36, III, 135, Pl. III, Figs. 1, 2. Morton: Am. Jour. Sc. 1830, XVIII, 246; Syn. Org. Rem. Cret. Group, 1834, 27, Pl. XI, Figs. 7, 9. Harlan: Trans. Geol. Soc. 1835, 81; Med. Phys. Res. 1835, 285. Emmons: N. Car. Geol. Surv. 1858, 217, Figs. 36*a*, 37.

Geosaurus Mitchelli. De Kay: An. Lyc. Nat. Hist. N. York, 1828–36, III, 138, Pl. III, Figs. 3, 4; Nat. Hist. New York, Zool. 1842, III, 28, Pl. XXII, Figs. 55, 56. Harlan: Trans. Geol. Soc. 1835, 82; Med. Phys. Res. 1835, 285; Edin. Phil. Jour. 1834, XVIII, 32.

Geosaurus. Morton: Am. Jour. Sci. 1830, XVIII, 242; Syn. Org. Rem. Cret. Group, 1834, 28, Pl. 11, Fig. 10.

Mosasaurus De Kayi. Bronn: Lethæa Geognostica, 1838, II, 760; Third Edit. 1851, 2, 406.

Mosasaurus major. De Kay: Nat. Hist. New York, Zool. 1842, III, 28, Pl. XXII, Figs. 57, 58.

Mosasaurus occidentalis. Morton: Proc. Acad. Nat. Sci. Phil. 1844, 133.

Mosasaurus Camperi s. Hoffmani. In part, of Pictet: Paléont. 1845, II, 64.

Atlantochelys Mortoni. Agassiz: Proc. Ac. Nat. Sci. Phil. 1849, 169.

Mosasaurus Maximiliani. Owen: Jour. Geol. Soc. Lond. 1849, V, 382, Pl. X, Fig. 5. Pictet: in part, Paléont. 1853, I, 505. Emmons: N. Car. Geol. Surv. 1858, 218, Figs. 36 A, 37.

Mosasaurus Carolinensis. Gibbes: Mem. on Mosas., Smiths. Contrib. 1851, II, Pl. II, Figs. 1–3.

Mosasaurus Couperi. Gibbes: Ibidem 7, Pl. II, Figs. 4, 5.

Mosasaurus Mitchelli. In part, of Bronn: Leth. Geog., Third Ed., 1851–2, II, 406. Leidy: Proc. Ac. Nat. Sc. Phil. 1859, 90.

Elliptonodon compressus. Emmons: N. Car. Geol. Surv. 1858, 224, Figs. 45, 46.

Drepanodon impar. Leidy: Pr. Ac. Nat. Sc. Phil. 1856, 255.

Lesticodus impar. Leidy: Pr. Am. Phil. Soc. 1859, VII, 10.

Pages 35–37, Vertebræ, Nos. 1–14, 1–3. Pl. VII, Figs. 1–3, 8–14.

Pages 39, 40, Fragments of the skull and jaw. Pl. VIII, Fig. 11; Pl. XI, Fig. 13; Pl. XIX, Fig. 6.

Page 43, Fragment of a humerus. Pl. VIII, Figs. 3–5.

Pages 52–71, Teeth, with fragments of jaws, Nos. 1–29, 31, 32. Pl. IX, Figs. 1–11; Pl. X, Figs. 1–13, 16; Pl. XI, Figs. 1–13, 15.

11. Mosasaurus Missouriensis.

Ichthyosaurus missouriensis. Harlan: Trans. Am. Phil. Soc. 1834, IV, 405, Pl. XX, Figs. 3–8; Trans. Geol. Soc. 1835, 80; Med. and Phys. Res. 1835, 284, 348, Figs. 1–6.

Batrachiosaurus. Harlan: Lon. and Ed. Phil. Mag. 1839, XIX, 302.

Batrachiotherium. Harlan: Bul. Soc. Geol. 1839, X, 90.

Batrachiosaurus missouriensis. Meyer: Jahrb. Min. 1845, 312.

Mosasaurus neovidii. Goldfuss: Deutsch. Naturf. Vers. Mainz, 1848, I, 141; Jahrb. Min. 1845, 312.

Mosasaurus Maximiliani. Goldfuss: Nov. Acta Acad. K. L. C. Nat. Cur. 1845, XXI, 179, Pls. VI, VII, VIII, IX, Figs. 1–3; Jahrb. Min. 1845, 312. In part, of Pictet: Paléon. 1853 I, 505.

Mosasaurus Mitchelli. In part, of Bronn: Leth. Geog., Third Ed., 1851–2, II, 406.

Mosasaurus missouriensis. Leidy: Proc. Ac. Nat. Sc. Phil. 1857, 90; 1859, 92.

Pages 37, 38, Vertebræ, Nos. 1–5. Pl. VII, Figs. 15–18.

Page 44, 45, Bones of the extremities. Pl. VIII, Figs. 6, 8; Pl. XVII, Figs. 12, 13.

Page 72, Teeth, No. 34. Pl. X, Figs. 18, 19.

HOLCODUS. Gibbes.

12. ? Holcodus aoutidens.

Mosasaurus minor. GIBBES: Mem. on Mosas., Smiths. Cont. 1851, II, 7, Pl. I, Figs. 3–5.

Holcodus acutidens. In part, of GIBBES: Ibidem 9, Pl. III, Figs. 6–9.

Pages 38, 40, 41, 42, 45, 72, Vertebræ, basi-occipital bone, tympanic bone, humerus, radius, and pterygoid bone with teeth, from Mississippi. Pl. VII, Figs. 4–7; Pl. VIII, Figs. 1, 2, 7; Pl. XI, Fig. 14.

Page 77, Tooth, No. 33. Pl. X, Fig. 17.

BASEODON. Leidy.

13. Baseodon reversus.

Pages 30, 31, Teeth, No. 30. Pl. X, Figs. 14, 15.

Mosasauroid Remains of Uncertain Reference.

a. Amphorosteus Brumbyi. GIBBES: Mem. on Mosas., Smiths. Cont. 1851, II, 10, Pl. III, Figs. 10–14.

b. Page 45, Two bones of extremities. Pl. VIII, Figs. 9, 10.

MACROSAURUS. Owen.

14. Macrosaurus lævis.

Macrosaurus lævis. OWEN: Jour. Geol. Soc. Lond. 1849, V, 380, Pl.

Macrosaurus. EMMONS: Rep. North Car. Geol. Surv. 1858, 213, Fig. 34 *a.*

Pages 74, 75. Pl. III, Figs. 1, 2; Pl. VII, Figs. 19, 20.

POLYGONODON. Leidy.

15. Polygonodon vetus.

Polygonodon vetus. LEIDY: Proc. Ac. Nat. Sc. Phil. 1856, VIII, 221.

Polygonodon rectus. EMMONS: Rep. N. Car. Geol. Surv. 1858, 218, Fig. 37, A; Manual of Geology, 1860, 208, Fig. 3.

Mossosaurus rectus. EMMONS: Ibidem 218.

Page 76, A tooth, from Burlington Co., N. J. Pl. IX, Figs. 12, 13.

HADROSAURUS. Leidy.

16. Hadrosaurus Foulkii.

Hadrosaurus Foulkii. LEIDY: Proc. Ac. Nat. Sc. Phil. 1858, 218.

Pages 76–97. Pl. II, Figs. 9–11; Pl. VIII, Fig. 13; Pl. XII, Figs. 1–20; Pl. XIII, Figs. 1–19, 24–26; Pl. XIV, Figs. 1–12; Pl. XV, Figs. 1–6, Pl. XVI, Figs. 1–8; Pl. XVI, Fig. 4; Pl. XX, Figs. 1, 2.

Remains of Undetermined Reptiles allied to Hadrosaurus.

a. Page 97, Humerus, from Monmouth Co., N. J. Pl. XVII, Figs, 1–3.

b. Page 98, Fragments of femora, from Gloucester Co., N. J.

c. Page 99, Fragments of a femur and fibula, from Monmouth Co., N. J.

d. Page 99, Metatarsal, from Monmouth Co., N. J. Pl. XV, Figs. 7, 8.
e. Page 99, Metatarsal, from N. J.
f. Page 100, Sacro-vertebral bodies, from Monmouth Co., N. J. Pl. XIII, Figs. 27, 28.
g. Page 100, Fragments of bones of the extremities and a vertebral body, from Monmouth Co., N. J.

CŒLOSAURUS. Leidy.

17. Cœlosaurus antiquus.

Page 100, Tibia, from Burlington Co., N. J. Pl. III, Fig. 3.

Page 101, Fragments of a tibia and metatarsal bone, and phalanges, from Monmouth Co., N. J. Pl. XVII, Figs. 7–11.

ASTRODON. Johnston.

18. Astrodon Johnstoni.

Astrodon. Johnston: Amer. Jour. Dent. Science, 1859.

Page 102, Teeth, from Bladensburg, Md. Pl. XIII, Figs. 20–23; Pl. XX, Fig. 10.

TOMODON. Leidy.

19. Tomodon horrificus.

Pages 102, 103, A tooth, from Mullica Hill, Gloucester Co., N. J. Pl. XX, Figs. 7–9.

PLIOGONODON. Leidy.

20. Pliogonodon priscus.

Pliogonodon priscus. Leidy: Pr. Acad. Nat. Sci. Phil. 1856, 255.

Pliogonodon nobilis. Leidy: Emmons, Rep. North Carol. Geol. Surv. 1858, 233, Figs. 43, 44.

Page 103, Teeth, from Cape Fear, North Carolina.

CHELONA.

CHELONE.

21. Chelone sopita.

Pages 104, 105. Pl. XIX, Fig. 5.

22. Chelone ornata.

Chelone ornata. Leidy: Proc. Ac. Nat. Sc. Phil. 1856, VIII, 303.

Page 105. Pl. XVIII, Fig. 10.

EMYS.

23. Emys firmus.

Page 106. Pl. XIX, Figs. 2,

24. Emys beatus.

Pages 107, 108. Pl. XVIII, Figs. 1–3.

25. Emys pravus.
Emys pravus. Leidy : Proc. Ac. Nat. Sc. Phil. 1856, 303.
Pages 108, 109. Pl. XIX, Fig. 1.

PLATEMYS.

26. Platemys sulcatus.
Platemys sulcatus. Leidy : Proc. Ac. Nat. Sc. Phil. 1856, VIII, 303.
Page 109. Pl. XIX, Fig. 4.

BOTHREMYS. Leidy.

27. Bothremys Cookii.
Pages 110–113. Pl. XVIII, Figs. 4–8.

TRIONYX.

28. Trionyx priscus.
Trionyx priscus. Leidy : Proc. Ac. Nat. Sc. Phil. 1851, V, 329.
Pages 113, 114. Pl. XVIII, Fig. 9.

INDEX.

REFERENCES TO THE PLATES.

The specimens figured belong to the Museum of the Academy of Natural Sciences of Philadelphia, unless otherwise stated.

PLATE I.

Figs. 1–6. *Thoracosaurus neocesariensis.*

Fig. 1. Skull of *Thoracosaurus neocesariensis*, from the Cretaceous limestone of Vincenttown, Burlington County, New Jersey. Upper view, one-half the diameter of the original.

Fig. 2. Lateral view of the same specimen.

Fig. 3. Tooth of *Thoracosaurus neocesariensis*, from Burlington County, New Jersey. Lateral view, natural size.

Fig. 4. Tooth, from near Blackwoodtown, Camden County. External view, natural size.

Fig. 5. Tooth, found with that of Fig. 3. Lateral view, natural size.

Fig. 6. Tooth of the same species, from the limestone of Big Timber Creek, Gloucester County, New Jersey. Lateral view, natural size.

Figs. 7–9. Teeth of a *Gavial*, from Blackwoodtown, Camden County, New Jersey. Lateral views, natural size.

PLATE II.

Figs. 1–3. *Thoracosaurus neocesariensis.*

Fig. 1. Inferior view of one-half of the skull, one-third the diameter of nature. From the same specimen as Figs. 1, 2, of the preceding Plate.

Fig. 2. Fragment of the upper jaw, left side, from the Cretaceous limestone near Blackwoodtown, Camden County, New Jersey. One-half the diameter of the original. *a*, *b*. Maxillo-malar suture.

Fig. 3. A dermal plate, from the Green-sand of Mount Holly, Burlington County, New Jersey. One-half the diameter of nature.

Figs. 4–7. Vertebræ of Crocodiles, one-half the diameter of nature.

Figs. 4, 5. Two cervical vertebræ, probably the fourth and fifth, from Barnsboro, Gloucester County, New Jersey. Belonging to the collection of Rutger's College, New Brunswick, New Jersey.

Fig. 6. Cervical vertebra, probably the fifth, from Jobstown, Burlington County, New Jersey.

Fig. 7. Cervical vertebra, from St. George's, New Castle County, Delaware.

Fig. 8. Upper view of a fragment of a small *Gavial* skull, from the Green-sand of Burlington County, New Jersey. One-half the diameter of nature. *a*, Frontal; *b*, orbital margin; *c*, parietal; *d*, coronal suture.

Figs. 9–11. Posterior dorsal vertebræ of *Hadrosaurus Foulkii*, one-third the diameter of nature.

Figs. 9, 10. Lateral view, left side.

Fig. 11. Anterior view of the same specimen as Fig. 9. These figures were accidentally left out of their proper position among the Plates, and have been introduced in Plate II, which was drawn after all the others.

Figs. 12–14. An inferior tooth of *Trachodon mirabilis*, from the Bad Lands of the Judith River, Upper Missouri, of the natural size. The fang is lost.

Fig. 12. External view.

Fig. 13. Lateral view.

Fig. 14. Internal view.

These figures are introduced for comparison with those of the teeth of *Hadrosaurus Foulkii*, and were accidentally left out of their proper place.

Figs. 15, 16. A caudal vertebra of an undetermined Saurian, from a Cretaceous formation of Nebraska, presented to the Academy of Natural Sciences of Philadelphia by Dr. Hiram A. Prout. The figures are of the natural size. Viewed from the extremities the specimen presents a somewhat hexahedral outline. The vertical diameter of the body is greater than the transverse diameter, and is nearly twice as great as its length. The sides are moderately constricted. The anterior surface, as I suppose it to be, is concave, the posterior surface, in a corresponding degree, convex. From the under part of the body project two short, robust processes, with an excavated articular facet for junction with a chevron bone. The measurements of the specimen are as follows:—

	Lines.
Length	10
Breadth	15
Height	19
Depth of concavity in front	2
Width of spinal canal at the middle of the broken abutments of the arch	2½

PLATE III.

Figs. 1, 2. A dorsal vertebra of *Macrosaurus lævis*, from Monmouth County, New Jersey, one-half the diameter of the original.

Fig. 1. Lateral view; *a*, anterior; *p*, posterior.

Fig. 2. Anterior view.

Fig. 3. Tibia of an undetermined Reptile, from the Green-sand of Burlington County, New Jersey, one-half the diameter of the original.

Fig. 4. Fragment of a femur of *Hyposaurus Rogersii*, from near Blackwoodtown, Camden County, New Jersey, one-third the diameter of the original.

Figs. 5–11. Vertebræ of *Thoracosaurus neocesariensis*, one-half the diameter of the originals.

Figs. 5, 6. Cervical vertebra, from Burlington County, New Jersey.

Fig. 5. Inferior view.

Fig. 6. Lateral view; *a*, anterior; *p*, posterior.

Figs. 7–11. Vertebræ from Monmouth County, New Jersey, belonging to the collection of Rutger's College.

Fig. 7. The sixth cervical vertebra, right lateral view.

Fig. 8. The third dorsal, right lateral view.

Fig. 9. The eighth and ninth dorsals, coossified by a large exostosis, right lateral view.

Fig. 10. The tenth dorsal vertebra, right lateral view.

Fig. 11. The first lumbar vertebra, right lateral view; *a*, anterior; *p*, posterior.

Figs. 12–15. Vertebræ of a Crocodile, from Timber Creek, Gloucester County, New Jersey, one-half the diameter of the originals.

Fig. 12. A sixth cervical vertebra, right lateral view.

Fig. 13. A fifth dorsal vertebra, right lateral view.

Fig. 14. Sacrum, inferior view.

Fig. 15. First caudal vertebra, inferior view.

Figs. 16–21. Teeth of *Hyposaurus Rogersii*, the natural size.

Figs. 16, 17. Teeth, from near White Horse, Camden County, New Jersey.
Fig. 16. Internal view of a large tooth.
Fig. 17. External view of a smaller tooth.
Figs. 18–21. Teeth, from near Blackwoodtown, Camden County, New Jersey.
Fig. 18. Internal view of a large tooth.
Fig. 19. Internal view of a larger tooth.
Fig. 20. Anterior view of the same specimen as the last.
Fig. 21. External view of a third specimen.
Figs. 22, 23. Teeth of an undetermined species of Crocodile, from North Carolina. Natural size.

PLATE IV.

Figs. 1–12. *Hyposaurus Rogersii.* Vertebræ and dermal plates, reduced to one-half the diameter of the originals.

Fig. 1. A posterior cervical vertebra, from the vicinity of Blackwoodtown, Camden County, New Jersey. Lateral view. *a*, anterior; *p*, posterior.

Fig. 2. Posterior cervical vertebra, from Tinton Falls, Monmouth County, New Jersey, belonging to the collection of Rutger's College. Lateral view. *a*, anterior; *p*, posterior.

Fig. 3. Fourth dorsal vertebra, belonging to the same individual and collection as the preceding specimen. Lateral view. *a*, anterior; *p*, posterior; *h*, hypapophysis broken off.

Figs. 4, 5. Dorsal vertebra, from the same individual as the specimen of Fig. 1

Fig. 4. Posterior view.

Fig. 5. Lateral view, or left side. *a*, anterior; *p*, posterior.

Figs. 6, 7. Dorsal vertebra, from Burlington County, New Jersey.

Fig. 6. Anterior view.

Fig. 7. View of right side.

Fig. 8. Caudal vertebra, from the same individual as specimens of Figs. 1, 4, 5. View of the left side.

Figs. 9, 10. Caudal vertebra, from the same individual as the last.

Fig. 9. Posterior view.

Fig. 10. View of left side.

Figs. 11, 12. Two dermal plates, from the same individual as the last.

Figs. 13–18. *Discosaurus vetustus.* One-half the diameter of the originals. From the same skeleton as the specimens represented in Figs. 1, 2, 3, 7, 8, 9, Plate V.

Figs. 13, 14. Carpal bone.

Fig. 13. Dorsal or palmar surface.

Fig. 14. View of the thick border, exhibiting the large nutritious foramina.

Figs. 15, 16. Metacarpal bone.

Fig. 15. Palmar surface.

Fig. 16. View of the lower articular end.

Fig. 17. Another metacarpal bone.

Fig. 18. A phalanx.

Figs. 19, 20, 21. Fragments of the right side of the lower jaw of *Bottosaurus Harlani*, one-third the diameter of the originals.

Fig. 19. External view of the right dental bone.

Fig. 20. Upper view of the same specimen.

Fig. 21. External view of the right angular bone; the artist has inadvertently tilted the forepart too much upward.

Figs. 22, 23. Portion of the left dental bone, probably of the young of *Bottosaurus Harlani*, from Monmouth County, New Jersey. One-half the diameter of the original specimen.

Fig. 22. Outer view.

Fig. 23. Upper view.

PLATE V.

All the figures are reduced one-half the diameter of the original specimens.
Figs. 1–12. Vertebræ of *Discosaurus vetustus.*
Figs. 13–19. Vertebræ of *Cimoliasaurus magnus.*
Figs. 1–3. Cervical vertebra of *Discosaurus vetustus*, from Burlington County, New Jersey.
Fig. 1. Lateral view; *a*, anterior surface of body; *p*, posterior surface; *c*, costal pit.
Fig. 2. Posterior view.
Fig. 3. Inferior view; the upper part is the anterior.
Figs. 4–6. Two caudal? vertebræ of *Discosaurus*, from Alabama.
Fig. 4. Lateral view. *c*, costal pit.
Fig. 5. Inferior view of the same specimen.
Fig. 6. End view of a second specimen.
Figs. 7–9. Caudal? vertebra of *Discosaurus*, from Burlington County, New Jersey, found with the specimen above indicated from the same locality.
Fig. 7. End view.
Fig. 8. Inferior view.
Fig. 9. Lateral view.
Figs. 10–12. Caudal? vertebra of *Discosaurus*, from Mississippi.
Fig. 10. Inferior view.
Fig. 11. Lateral view.
Fig. 12. End view.
Figs. 13–16. Dorsal vertebræ of *Cimoliasaurus*, from Burlington County, New Jersey.
Fig. 13. Inferior view.
Fig. 14. End view of the same specimen.
Fig. 15. Lateral view of the same.
Fig. 16. Lateral view of a more anterior dorsal vertebra.
Figs. 17–19. A lumbar vertebra found with the preceding dorsals.
Fig. 17. Lateral view.
Fig. 18. Inferior view.
Fig. 19. End view.

PLATE VI.

Vertebræ of *Cimoliasaurus magnus*, one-half the diameter of the original specimens. Those from Fig. 1 to 15, inclusive, were obtained together, from Freehold, Monmouth County, New Jersey, and apparently belonged to the same individual. From the collection of O. R. Willis.
Figs. 1–3. Anterior dorsal vertebra.
Fig. 1. End view, exhibiting a want of symmetry.
Fig. 2. Inferior view.
Fig. 3. Lateral view.
Fig. 4. End view of a larger and more anterior dorsal vertebra. It exhibits a want of symmetry.
Fig. 5. Lateral view of a more posterior dorsal vertebra.
Figs. 6, 7. A vertebra from near the end of the dorsal series.
Fig. 6. Inferior view.
Fig. 7. Lateral view.
Figs. 8, 9. A vertebra, probably the last of the dorsal series.
Fig. 8. Inferior view.
Fig. 9. Lateral view.
Figs. 10–12. A lumbar vertebra.
Fig. 10. End view.

Fig. 11. Inferior view.
Fig. 12. Lateral view.
Figs. 13–15. A posterior lumbar vertebra.
Fig. 13. Inferior view.
Fig. 14. Lateral view.
Fig. 15. End view.
Figs. 16–18. A posterior lumbar vertebra, belonging to the same individual as Figs. 13–19, Plate V.
Fig. 16. Inferior view.
Fig. 17. Lateral view.
Fig. 18. End view.

PLATE VII.

All the figures are reduced one-half the diameter of the originals, excepting Fig. 16, which is of the natural size.

Figs. 1–18. Vertebræ of *Mosasaurus*.

Figs. 19, 20. Vertebra of *Macrosaurus*.

Fig. 1. Cervical vertebra of *Mosasaurus*, from Monmouth County, New Jersey. Posterior view. *a*, Articular processes; *t*, transverse process; *h*, hypapophysis; *p*, posterior convex surface of the body.

Fig. 2. Cervical vertebra, from Burlington County, New Jersey. Inferior view. *a*, Anterior concave surface of the body; *p*, posterior convex surface; *t*, transverse process; *h*, hypapophysis.

Fig. 3. Posterior view of the same specimen as the last. *t*, Transverse process; *h*, hypapophysis.

Figs. 4–7. Vertebræ, from Columbus, Mississippi, belonging to Dr. Spillman.

Fig. 4. Cervical vertebra. Inferior view. *a*, Anterior; *p*, posterior.

Fig. 5. Another cervical vertebra, from the same individual as the last. Lateral view. *a*, Anterior; *p*, posterior surface of the body; *h*, hypapophysis; *ar*, articular process; *s*, spinous process; *t*, transverse process.

Fig. 6. Posterior view of the same specimen as the last. *s*, Spinous process; *a*, articular process; *t*, transverse process; *h*, hypapophysis.

Fig. 7. Fragment of a dorsal vertebra, from the same individual as the last. Inferior view. *a*, Anterior; *p*, posterior; *t*, transverse process.

Fig. 8. Dorsal vertebra, from Monmouth County, belonging to Dr. C. Thompson. Posterior view.

Figs. 9–11. Lumbar vertebra, from Burlington County, New Jersey.

Fig. 9. Inferior view.

Fig. 10. Lateral view.

Fig. 11. Posterior view. *a*, Anterior; *p*, posterior; *t*, transverse processes.

Fig. 12. Another lumbar vertebra, from Burlington County. Lateral view.

Fig. 13. Lumbar vertebra, from Freehold, Monmouth County. Lateral view.

Fig. 14. Posterior view of the same specimen. *t*, Transverse process.

Fig. 15. Portion of a series of posterior caudal vertebræ imbedded in a mass of rock, from the Yellowstone River, Nebraska. Lateral view. *a*, Anterior; *p*, posterior; *s*, spinous processes; *c*, chevron bones.

Fig. 16. A posterior caudal vertebra, from the same individual as the last. Lateral view. Natural size. *a*, Anterior; *p*, posterior part of the body; *v*, vertebral arch; *c*, chevron bone.

Fig. 17. Body of a posterior caudal vertebra, from the Cheyenne River, Nebraska. Lateral view. *a*, Anterior; *p*, posterior; *v*, abutment of the vertebral arch; *c*, abutment of the chevron bone.

Fig. 18. Posterior view of the same specimen as the last.

Fig. 19. Supposed vertebra of *Macrosaurus*, from Freehold, Monmouth County. Inferior view. *a*, Anterior concave surface of body; *p*, posterior convex surface; *t*, transverse processes.

Fig. 20. Posterior view of the same specimen as the preceding.

PLATE VIII.

Figs. 1, 2. Humerus of *Mosasaurus*, one-half the diameter of nature, from near Columbus, Mississippi, belonging to the collection of Dr. Wm. Spillman.

Fig. 1. Posterior view.

Fig. 2. Anterior view. *a*, Head of the bone; *b*, greater tuberosity; *c*, lesser tuberosity; *d*, strong impression of muscular attachment. Length of the original specimen about ten inches.

Figs. 3, 4, 5. Proximal extremity of a huge bone, supposed to be of a humerus of the *Mosasaurus*, a little less than one-third the diameter of nature. The original measures eleven inches in length from the summit of the greater tuberosity to the broken end of the shaft. From the Green-sand of Burlington County, New Jersey.

Fig. 3. Posterior view.

Fig. 4. Anterior view.

Fig. 5. Outer or posterior border view. *a*, The head of the bone; *b*, greater tuberosity; *c*, lesser tuberosity; *d*, impression of muscular attachment.

Fig. 6. An isolated bone, probably a radius of a small species of *Mosasaurus*, or of a young animal, half the size of nature. Belonging to Prof. James Hall, and obtained by Messrs. Meek and Hayden, from a Cretaceous deposit of Nebraska. Length of the original specimen about two inches and three-quarters.

Fig. 7. Supposed radius of *Mosasaurus*, one-half the diameter of nature, belonging to the same skeleton and collection as the humerus above indicated, from Columbus, Mississippi. Length of the specimen two inches.

Fig. 8. Supposed carpal bone of *Mosasaurus*, the size of nature. From formation, No. 4, on the Big Cheyenne River; an isolated specimen, discovered by Dr. F. V. Hayden.

Fig. 9. Reptile bone, undetermined, one-half the size of nature. The specimen belongs to Prof. James Hall, and was found by Messrs. Meek and Hayden, five miles below Daurion's Hill Nebraska, among loose fragments at the base of a Cretaceous bluff.

Fig. 10. Reptile bone, undetermined, half the size of nature, found in company with that of Fig. 8. Length one inch and three-quarters.

Fig. 11. Basi-sphenoid bone of *Mosasaurus*, one-third the diameter of nature, from Holmdale, Monmouth County, New Jersey, belonging to the collection of Prof. George H. Cook. Length of original eight inches, breadth at the posterior diverging processes six inches. *a*, Anterior; *b*, posterior processes articulating with the basi-occipital bone.

Fig. 12. Dermal plate of a *Gavial*, from Burlington County, New Jersey, belonging to the collection of the Burlington Lyceum. One-half the natural size.

Fig. 13. Supposed pubic bone of *Hadrosaurus Foulkii*, one-fourth the diameter of the original specimen.

PLATE IX

All the figures are of the natural size.

Fig. 1–11. *Mosasaurus.*

Fig. 1. Inner view of an alveolar fragment, apparently from the upper jaw, from Burlington County, New Jersey. *a*, A nearly entire tooth, exhibiting on the inner side of the crown the subdivisional planes; *b*, exserted portion of the fang, which is coossified with its alveolus and excavated into a large cavity for a successor; *c*, bottom of the cavity, exposed by the loss of a thin plate of bone belonging to the alveolus; *d*, orifice of the cavity at the margin of the jaw postero-internally to the fang of the functional tooth; *e*, portion of the alveolus in front; *f*, exserted portion of the fang of a tooth, the crown of which is broken off; *g*, bottom of the fang exposed by the breaking away of a thin portion of the jaw-bone; the sides of the fang are firmly coossified with the alveolus; *h*, orifice of the cavity for a successional tooth; *i*, thin shell of bone remaining from the fang of a tooth, and closely coossified with the sides of the alveolus.

Fig. 2. Antero-internal view of an anterior tooth, from Monmouth County, New Jersey. *a*, External surface of crown; *b*, internal surface; *c*, fang.

Fig. 3. Antero-internal view of an anterior tooth, from Monmouth County, New Jersey, belonging to Rutgers College. *a*, External surface of crown; *b*, internal surface; *c*, fang.

Fig. 4. Inner view of an anterior tooth, from Monmouth County, New Jersey. *a*, Inner surface of the crown; *b*, impression of cavity for a successional tooth.

Fig. 5. Small fragment of a jaw, with a tooth and portion of another, inner view, from Monmouth County, New Jersey. *a*, Internal surface of the crown exhibiting the divisional planes; *b*, portion of crown of the adjoining tooth; *c*, exserted portion of fang; *d*, portion of fang within alveoli and coossified therewith; *e*, three large cavities for successional teeth; *f*, communication of the latter cavities with the pulp cavities of the teeth in use.

Fig. 6. Tooth, with small attached portions of the jaw, found with that of Fig. 5, and from the same individual. Internal view. *a*, Inner surface of crown; *b*, exserted portion of fang; *c*, portion of fang coossified with the interior of the alveolus; *d*, fragment of outer part of the jaw; *e*, large cavity, apparently for a pair of successional teeth; *f*, large pulp cavity.

Fig. 7. Tooth, internal view, from Monmouth County, New Jersey. *a*, The inner surface of the crown, which is devoid of divisional planes; *b*, fang without trace of coossific attachment.

Fig. 8. Inner view of the crown of a shed tooth, from Monmouth County, New Jersey, belonging to Dr. C. Thompson. It resembles the corresponding part of a Crocodile tooth more than the ordinary forms of the *Mosasaurus* teeth.

Figs. 9, 10. Two teeth, internal view, from Mount Holly, Burlington County, New Jersey. From the color and structural appearance the two teeth look as if they had been derived from the same individual. The crowns bear a close resemblance to the corresponding part of the teeth of the Crocodile. *a*, Impress upon the postero-internal surface of the fang of a cavity for a successional tooth. The specimen, represented by Fig. 9, is a shed crown, as proved by the excavated appearance of the base.

Fig. 11. Shed crown of a tooth, from St. George's, New Castle County, Delaware. Internal view. It strongly resembles a Crocodile tooth.

Figs. 12, 13. Tooth of *Polygonodon vetus*, from Burlington County, New Jersey, from the collection of Prof. Cook.

Fig. 12. Posterior view.

Fig. 13. External view.

PLATE X.

All the figures, representing teeth of *Mosasaurus*, are of the natural size.

Fig. 1. Tooth, from Freehold, Monmouth County, New Jersey, belonging to Dr. C. Thompson. Inner view. *a*, The crown exhibiting divisional planes of the inner surface well-marked; *b*, the osseous fang, longitudinally furrowed, and exhibiting no trace of former attachment with the sides of the socket in which it was inserted; *c*, impression of a cavity originally occupied by a successor to the tooth placed in advance; *d*, deeper cavity for a successional tooth.

Fig. 2. Tooth, from Monmouth County, belonging to Rutgers College. Outer view. The crown exhibiting one of the acute ridges which separate the outer surface *a*, from the inner surface *b*; both the latter present well-marked divisional planes; *c*, the fang, which was coossified with its alveolus, a fragment of the jaw being seen at *d*.

Fig. 3. The shed crown of a tooth, from near Woodbury, Gloucester County, New Jersey. Lateral view. *a*, Outer; *b*, inner surface, separated by a sub-denticulated ridge, and both presenting divisional planes.

Fig. 4. Tooth, from Monmouth County, New Jersey, from the same individual as those represented in Figs. 7–10, and Figs. 5, 6, Plate IX. Internal view. *a*, Inner surface of the crown, which has but one carina; *b*, exserted portion of fang; *c*, bottom of fang, which was coossified with its alveolus; *d*, large cavity for a successional tooth.

Fig. 5. Tooth, the fang broken off, from Monmouth County, New Jersey. Postero-lateral view. *a*, Inner, and *b*, outer surface of the crown, both of which are smooth.

Fig. 6. Mutilated shed crown of a tooth from Burlington County, New Jersey. Inner view. Besides exhibiting the divisional planes it is unusually striated.

Figs. 7–10. Teeth of *Mosasaurus*, from Monmouth County, New Jersey, from the same individual.

Fig. 7. Internal view. The summit of the crown worn off; the fang coossified with the alveolus. *a*, Exserted portion of fang; *b*, inserted portion, coossified with its alveolus; *c*, cavity for a successional tooth hollowed in the fang.

Fig. 8. Internal view of another tooth. The summit of the crown more worn than in the preceding. References the same as in last figure.

Fig. 9. Outer surface of the crown of the same tooth.

Fig. 10. Internal view of another tooth. The fang presents two excavations for successional teeth. *a*, Exserted portion of fang; *b*, inserted portion, coossified with its alveolus; *c*, *d*, cavities for successional teeth; *e*, the pulp cavity exposed.

Fig. 11. Internal view of the crown of a tooth, broken from the fang, from Monmouth County, New Jersey. Both sides of the crown are totally devoid of subdivisional planes.

Fig. 12. Shed crown of a tooth, from St. George's, New Castle County, Delaware. External view.

Fig. 13. Inner view of a specimen similar to the last, from Gloucester County, New Jersey.

Figs. 14, 15. Two teeth, from Freehold, Monmouth County, New Jersey, belonging to Dr. C. Thompson.

Fig. 14. Outer view of one specimen.

Fig. 15. Inner view of the second specimen. *a*, Exserted portion of fang; *b*, inserted portion; *c*, cavity for a successor.

Fig. 16. Tooth, from Mullica Hill, Gloucester County, New Jersey. Outer view. The fang has been broken off.

Fig. 17. Crown of a tooth, from a Cretaceous formation of Alabama. Lateral view. The specimen belongs to Dr. R. W. Gibbes, and is figured (*Mosasaurus* and the allied Genera. Smiths. Cont. Pl. III, Figs. 6–9) by him as characteristic of *Holcodus acutidens*. The outer (*a*) and inner surfaces (*b*), separated by acute ridges in front and behind, are subdivided into planes, which are somewhat depressed and striated.

Fig. 18. Crown of a tooth, from a Cretaceous deposit, marked No. 4, in the section of Dr. Hayden, at the mouth of White River, Nebraska. Lateral view. It resembles the tooth represented in the preceding figure, but is without the subdivisional planes. *a*, Section of the crown in outline; *b*, section at the base of the crown.

Fig. 19. Specimen, from the same locality as the preceding, retaining a portion of the crown and fang. *a*, Section at the broken surface of the crown; *b*, section at the base of the crown

PLATE XI.

All the figures, representing fragments of jaws and teeth of *Mosasaurus*, are of the natural size, excepting Fig. 13, which is one-half the diameter of the original.

Figs. 1–4. Fragments, from Holmdale, Monmouth County, New Jersey, belonging to Prof. Reiley, of Rutgers College.

Figs. 1, 2. Portions of the right pterygoid bone. *a*, *b*, *c*, Remains of the first, second, and third teeth; *d*, the fourth tooth; *e*, *f*, the seventh and eighth teeth.

Fig. 3. Posterior fragment of the right dental bone, containing an entire penultimate tooth. In the specimen the fang of the tooth is visible through the large foramen beneath, but has been inadvertently left out by the artist.

Fig. 4. Fragment of the left side of the lower jaw, inner view, containing the antepenultimate tooth entire. *a*, Cavity for a successional tooth; *b*, exserted portion of the fang of the tooth in advance, the crown having been broken off; *c*, its successor exposed by the destruction of the inner wall of the cavity containing it; *d*, minute successor included within the former, and accidentally

exposed by fracture and loss of portion of the tooth ; *e*, vasculo-neural foramen in the outer parapet of the jaw.

Fig. 5 Fragment of a pterygoid bone with a penultimate tooth, inner view, from Monmouth County, New Jersey. The tooth resembles the corresponding one in the specimen represented in Fig. 1. *a*, Cavity for the successional tooth.

Fig. 6. Fragment of a lower jaw, inner view, from Monmouth County, New Jersey. *a*, Tooth, the fang of which is coossified with its alveolus ; *b*, successional cavity ; *c*, fang of the tooth in advance, the crown having been shed ; *d*, fully developed crown of a successor included within its cavity ; *e*, cavity for a successional tooth ; *f*, portion of a vacant alveolus.

Fig. 7. Outer view of the successional tooth removed from the preceding specimen.

Fig. 8. Fragment of a lower jaw, inner view, from Monmouth County, New Jersey. The inner wall of the jaw was removed by accident, and exposes the fangs of the teeth, successional cavities, and dental canal. *a*, Remains of a fang coossified with its alveolus, and deeply excavated for the reception of a successional tooth; *b*, tooth in advance, the crown broken off, the fang entire and loose in its socket, from which it may be lifted out; *c*, cavity for a successional tooth; *d*, fang firmly coossified with its socket, and deeply excavated into a cavity containing a successor; *e*, fang of a tooth loose in its socket.

Fig. 9. Outer view of the successional tooth seen in place in the preceding specimen.

Fig. 10. Inner view of a tooth, with a small portion of the jaw, from Monmouth County, New Jersey, belonging to the collection of Mr. Willis. *a*, Exserted portion of the fang; *b*, inserted portion coossified with its socket; *c*, cavity for a successor.

Fig. 11. Inner view of a successional tooth, from Marlboro, Monmouth County, New Jersey, belonging to Rutgers College. It is totally devoid of subdivisional planes.

Fig. 12. Crown of a tooth, broken from its fang, outer view, from Monmouth County. It exhibits only the faintest trace of subdivisional planes.

Fig. 13. Anterior extremity of the right side of the lower jaw, external view, half the diameter of nature. From Freehold, Monmouth County, New Jersey. From Dr. Thompson's collection.

Fig. 14. Pterygoid bone, with teeth, inner view. Specimen obtained in Mississippi, and belonging to Dr. Spillman. *Holcodus?*

Fig. 15. Crown of a tooth of *Mosasaurus*, inner view, from Burlington County, New Jersey. An acute ridge exists alone along its concave border.

PLATE XII.

Vertebræ of *Hadrosaurus Foulkii*, one-third the diameter of the original specimens.

Figs. 1–3. Cervical vertebræ. Left lateral view. The side of the specimen of Fig. 1 is mutilated by a large excavation. That of Fig. 2 is less mutilated in the same manner. That of Fig. 3 is broken at the posterior inferior part.

Fig. 4. An anterior dorsal vertebra. Left lateral view.

Fig. 4, *a*. Posterior view of the same specimen.

Figs. 5–8. Dorsal vertebræ from the middle of the series.

Figs. 9, 10. Anterior caudal vertebræ.

Figs. 11–16. Middle caudal vertebræ.

Figs. 17–20. Posterior caudal vertebræ.

Fig. 20, *a*. End view of Fig. 17.

PLATE XIII.

Figs. 1–19. Teeth of *Hadrosaurus Foulkii*, of the natural size.

Figs. 1–4. A nearly perfect unworn inferior tooth.

Fig. 1. Inner view.

Fig. 2. Outer view.

Figs. 3, 4. Lateral views. *a*, Crown, on the inner surface invested with enamel; *b*, fang, grooved on the inner part for adaptation to the outer border of a successional tooth; *c*, surface, impressed apparently by contact with the side of the apical half of the crown of an infero-lateral successional tooth; *d*, portion of the denticulated enamel border of the crown magnified about six diameters.

Figs. 5–7. An inferior tooth with the apical half of the crown worn off.

Fig. 5. Outer view.

Fig. 6. Inner view.

Fig. 7. Lateral view. *a*, Triturating surface of the crown; *b*, cutting edge of the triturating surface.

Figs. 8, 9. An inferior tooth with the summit of the crown worn off.

Fig. 8. Outer view.

Fig. 9. Lateral view.

Figs. 10–13. A superior unworn tooth, with the greater portion of the fang lost.

Fig. 10. Outer view of the crown invested with enamel.

Fig. 11. Inner view.

Figs. 12, 13. Lateral views. *a*, Surface impressed by the apical half of the lateral successional teeth; *b*, surface impressed by the outside of the apex of the successional tooth above or in the same line; *c*, strong carina of the external enamelled surface of the crown.

Figs. 14–17. A superior tooth with the summit of the crown worn off. References as in the preceding tooth.

Figs. 18, 19. Ideal representation of the supposed arrangement of the teeth of *Hadrosaurus* in the relationship of the functional and successional teeth.

Fig. 18. External view of the relationship of the inferior teeth. *a*, Triturating surfaces of the teeth; *b*, teeth with the apical half of the crown worn away; *c*, tooth with its apex *d*, worn off; *e*, tooth worn away to the fang.

Fig. 19. Internal view of the relationship of the inferior teeth. *a*, Inner cutting edge of the triturating surfaces; *b*, teeth with the apical half of the crown worn away; *c*, an unworn tooth; *d*, tooth with the crown little more than half developed.

Figs. 20–23. Mutilated tooth of *Astrodon Johnstoni*, natural size, from Bladensburg, Md., belonging to Dr. C. Johnston.

Fig. 20. Outer view.

Fig. 21. Inner view.

Figs. 22, 23. Lateral views.

Figs. 24–26. Fragments of the jaws of *Hadrosaurus*, one-half the diameter of the originals.

Fig. 24. Inner view of a fragment of the lower jaw, exhibiting the alveolar grooves.

Fig. 25. Outer view of the same specimen, much mutilated.

Fig. 26. Inner view of a fragment supposed to belong to the upper jaw.

Figs. 27, 28. Supposed sacro-vertebral body of a young *Hadrosaurus*, from Monmouth Co., New Jersey, one-half the diameter of the original.

Fig. 27. Side view.

Fig. 28. Inferior view.

PLATE XIV.

Hadrosaurus Foulkii. Bones of the limbs, one-fourth the diameter of the originals.

Figs. 1–4. The left humerus.

Fig. 1. Posterior view.

Fig. 2. Anterior view.

Fig. 3. External view.

Fig. 4. Upper extremity. *a*, Head; *b*, internal tuberosity; *c*, external tuberosity; *d*, deltoid attachment.

Fig. 5. Anterior view of the left ulna.

Fig. 6. Anterior view of the left radius.

Figs. 7, 8. Metatarsal bone.
Fig. 7. Upper view.
Fig. 8. Lateral view.
Figs. 9, 10. Another metatarsal.
Fig. 9. Lateral view.
Fig. 10. Inferior view.
Figs. 11, 12. Phalanx.
Fig. 11. Upper view.
Fig. 12. Lateral view.

PLATE XV

Hadrosaurus Foulkii. Figures one-fourth the diameter of the original
Figs. 1–6. The left femur.
Fig. 1. Anterior view.
Fig. 2. External view.
Fig. 3. Internal view.
Fig. 4. Posterior view.
Fig. 5. Upper view.
Fig. 6. Lower view. *a*, Head; *b*, trochanter; *c*, process of the shaft; *d*, internal condyle; *e*, external condyle; *f*, canal between the condyles in front; *g*, canal between the condyles behind.
Figs. 7, 8. Lateral and superior views of a metatarsal bone, supposed to belong to the same animal, from Freehold, Monmouth County, New Jersey.

PLATE XVI.

Bones of the left leg of *Hadrosaurus* one-fourth the diameter of the originals.
Figs. 1–6. The tibia.
Fig. 1. Anterior view.
Fig. 2. Internal view.
Fig. 3. External view.
Fig. 4. Posterior view.
Fig. 5. View of the head from above.
Fig. 6. Inferior view of the tarsal extremity.
Figs. 7, 8. The fibula, without the upper extremity
Fig. 7. External view.
Fig. 8. Inferior view of the tarsal end.

PLATE XVII

Figs. 1–3. Left humerus, resembling that of *Hadrosaurus*, from Monmouth County, New Jersey, one-fourth the diameter of the original.
Fig. 1. Posterior view.
Fig. 2. Anterior view.
Fig. 3. External view.
Figs. 4, 5. Supposed ilium of *Hadrosaurus*, one-fourth the diameter of the original
Fig. 4. Anterior view.
Fig. 5. Sacral border.
Figs. 6, 7. Fragments of a tibia, of *Coelosaurus*, from Monmouth County, one-half the diameter of the originals. From the collection of Mr. Willis.
Fig. 6. Fragment of the upper extremity.

Fig. 7. The lower extremity.

Figs. 8–11. Bones of the toes, found with the preceding fragments, one-half the diameter of the originals. From the collection of Mr. Willis.

Fig. 8. Lateral view of the fragment of a metatarsal bone.

Figs. 9, 10. Upper view of two phalanges.

Fig. 11. Lateral view of another phalanx.

Figs. 12, 13. *Mosasaurus.* From the Yellowstone River, Nebraska.

Fig. 12. Supposed ulna, one-half the diameter of the original.

Fig. 13. Phalanx, the size of nature.

PLATE XVIII.

Figs. 1–3. *Emys beatus.* From Gloucester Co., N. J. One-half the size of nature.

Fig. 1. Plates of the carapace. *a,* First vertebral plate; *b, c,* third and fourth vertebral plates; *d,* fragment of the first left costal plate; *e, g,* portions of the second and third right costal plates.

Fig. 2. Inner view of the second right costal fragment, exhibiting at *f* the rudiment of a costal process.

Fig. 3. First left marginal plate. The upper border of the figure is the outer or free margin of the specimen.

Figs. 4–8. *Bothremys Cookii.* The size of nature. From Gloucester Co., N. J. Collection of Prof. Cook.

Fig. 4. Lateral view of the skull.

Fig. 5. Lateral view of the mandible.

Fig. 6. Upper view of the skull.

Fig. 7. Inferior view of the skull. *a,* Deep funnel-shaped pit of the maxilla.

Fig. 8. Upper view of the mandible. *b,* Deep pit opposed to that of the upper jaw.

Fig. 9. Outer portion of a left costal plate of *Trionyx priscus,* of the natural size. From Monmouth County, N. J. Collection of Prof. Cook.

Fig. 10. Portions of two marginal plates of *Chelone ornata,* of the natural size. From Burlington County, N. J. The margin to the right is the free one.

Figs 11–14. Teeth of *Bottosaurus Harlani,* of the natural size. From Burlington County, New Jersey.

Fig. 11. Outer view of a tooth.

Fig. 12. Posterior view of the same.

Fig. 13. Outer view of a large tooth, belonging to the Burlington County Lyceum of Natural History.

Fig. 14. Outer view of a small tooth.

PLATE XIX.

Fig. 1. Plates of the sternum of *Emys pravus,* one-third the diameter of the original. From Tinton Falls, Monmouth County, New Jersey, and belonging to the collection of the New Jersey Geological Survey. *a,* Position of the entosternal bone; *b,* the right hyosternal bone; *c,* portion of the left hyposternal; *d,* position of the right hyposternal; *e, f,* fragments of both xiphisternals.

Figs. 2, 3. Plates of the carapace and sternum of *Emys firmus,* one-half the diameter of the originals. From Tinton Falls, Monmouth County, New Jersey, and belonging also to the preceding collection.

Fig. 2. Greater portions of the sixth and seventh marginal plates of the left side. *a,* Sixth; *b,* seventh marginal plate.

Fig. 3. Portions of the left hyosternal and right hyposternal plates. *a,* Position of the entosternal; *b,* left hyosternal, broken at its outer part; *c,* position of the right hyosternal; *d,* portion of the right hyposternal; *e,* position of left hyposternal; *f, g,* position of xiphisternals.

Fig. 4. Three marginal plates of the left side of *Platemys sulcatus*, one-half the diameter of the originals. From Tinton Falls, Monmouth County, New Jersey, and belonging to the same collection as the preceding.

Fig. 5. Four marginal plates of the left side of *Chelone sopita*, one-half the diameter of the originals. From Mullica Hill, Gloucester County, New Jersey. *a*, Portion of a marginal plate; *b, c, d*, the three succeeding plates; *e*, large notch between two of the plates; *f*, suture for articulation with the next plate; *g* rounded unarticulating border; *h*, inner border of the plates; *i*, outline of the scutes.

Fig. 6. Anterior extremity of the upper jaw of *Mosasaurus*, from Monmouth County,New Jersey, one-half the diameter of the original. From the collection of Rutgers College. *a*, Intermaxillary, occupied by two teeth on each side; *b*, portion of the right maxillary; *c*, fore part of the maxillary, imperfect; the space which was originally occupied by a tooth being now filled with an artificial cement.

Fig. 7. *Mosasauroid* tooth, natural size, from near Marion, Alabama. The specimen from which the tooth was drawn belongs to the Smithsonian Institution, and strongly resembles, in general appearance, *Mosasauroid* fossils from near Columbus, Mississippi.

Fig. 8. Tooth of *Piratosaurus plicatus*, of the size of the original. From the Red River of the North, and belonging to the collection of the Smithsonian Institution.

PLATE XX.

Fig. 1. Transverse section of a tooth of *Hadrosaurus Foulkii*, highly magnified. *a*, Enamel; *b*, isolated streak of the same; *c*, the interior dentine; *d*, exterior layer of vaso-dentine.

Fig. 2. Transverse section of a small portion of the vaso-dentine of the tooth of *Hadrosaurus*, more highly magnified. *a*, The dentine; *b*, network of vaso-dentinal tissue.

Fig. 3. Diagram representing the arrangement of structure seen in a vertical section of the teeth of *Mosasaurus*. *a*, The crown, composed of interior dentine with a thin investment of enamel; *b*, the fang, composed of cementum; *c*, the pulp cavity; *d*, the communication of the latter with the exterior occupied by a coarser structure of cementum, pervaded by large vaso-neural canals; *e*, line of cessation of the dentine; *f*, cavity for a successional tooth; *g*, position from which the section was taken forming the subject of the next figure.

Fig. 4. Section from the tooth of *Mosasaurus*, taken from the position marked *g* in the preceding figure, and highly magnified. *a*, dentine of the crown; *b*, cement of the fang.

Fig. 5. A smaller section similar to the last, more highly magnified. *a*, dentine; *b*, cement.

Fig. 6. A similar section still more highly magnified. *a*, dentine; *b*, cement.

Figs. 7–9. Tooth of *Tomodon horrificus*, from Mullica Hill, Gloucester County, New Jersey, of the natural size.

Fig. 7. Outer view.

Fig. 8. Inner view.

Fig. 9. Lateral view.

Fig. 10. Transverse section of the tooth of *Astrodon Johnstoni*, highly magrified, from a preparation made and loaned by Dr. Christopher Johnston.

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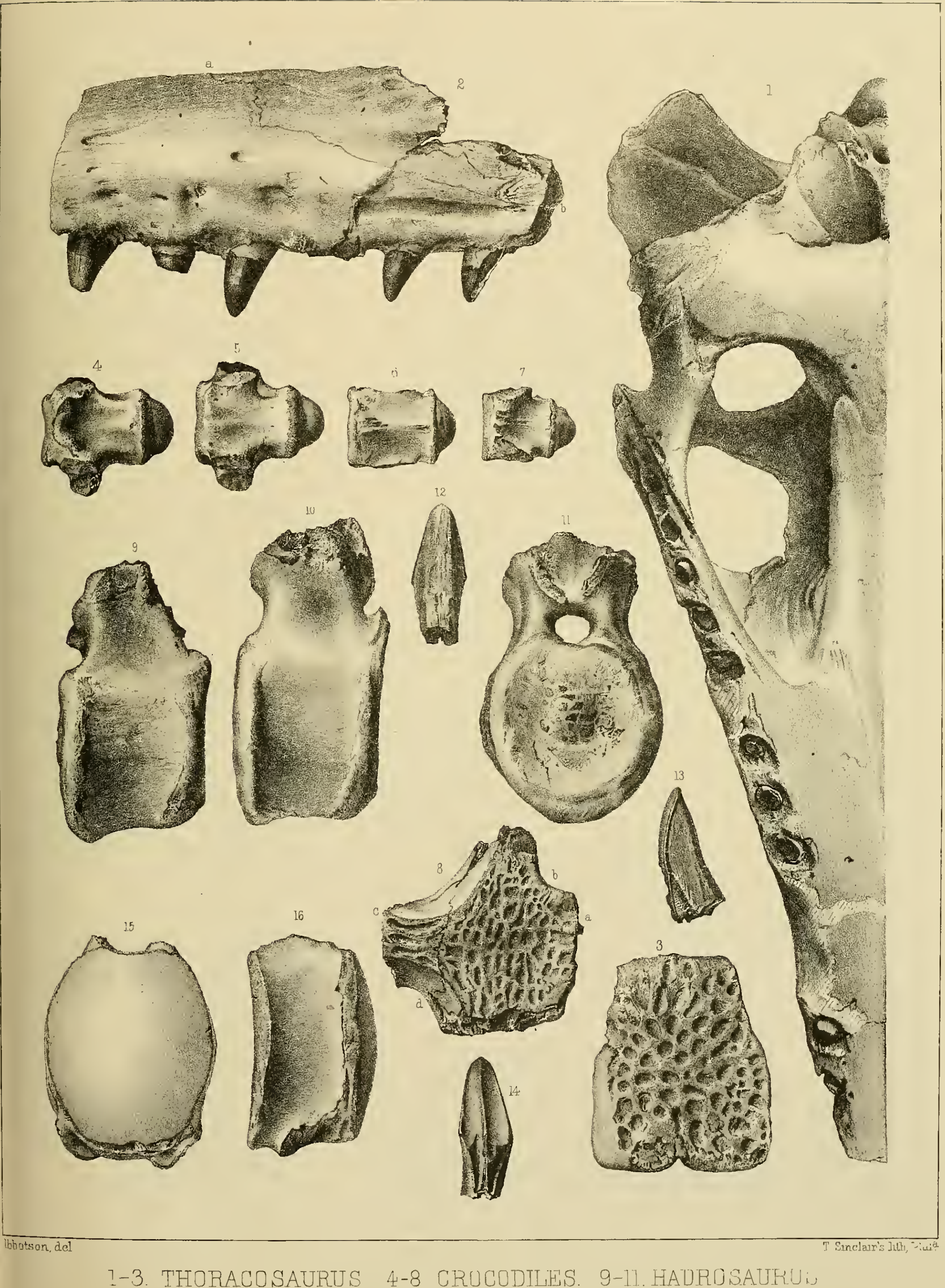
WASHINGTON CITY,

MAY, 1865.

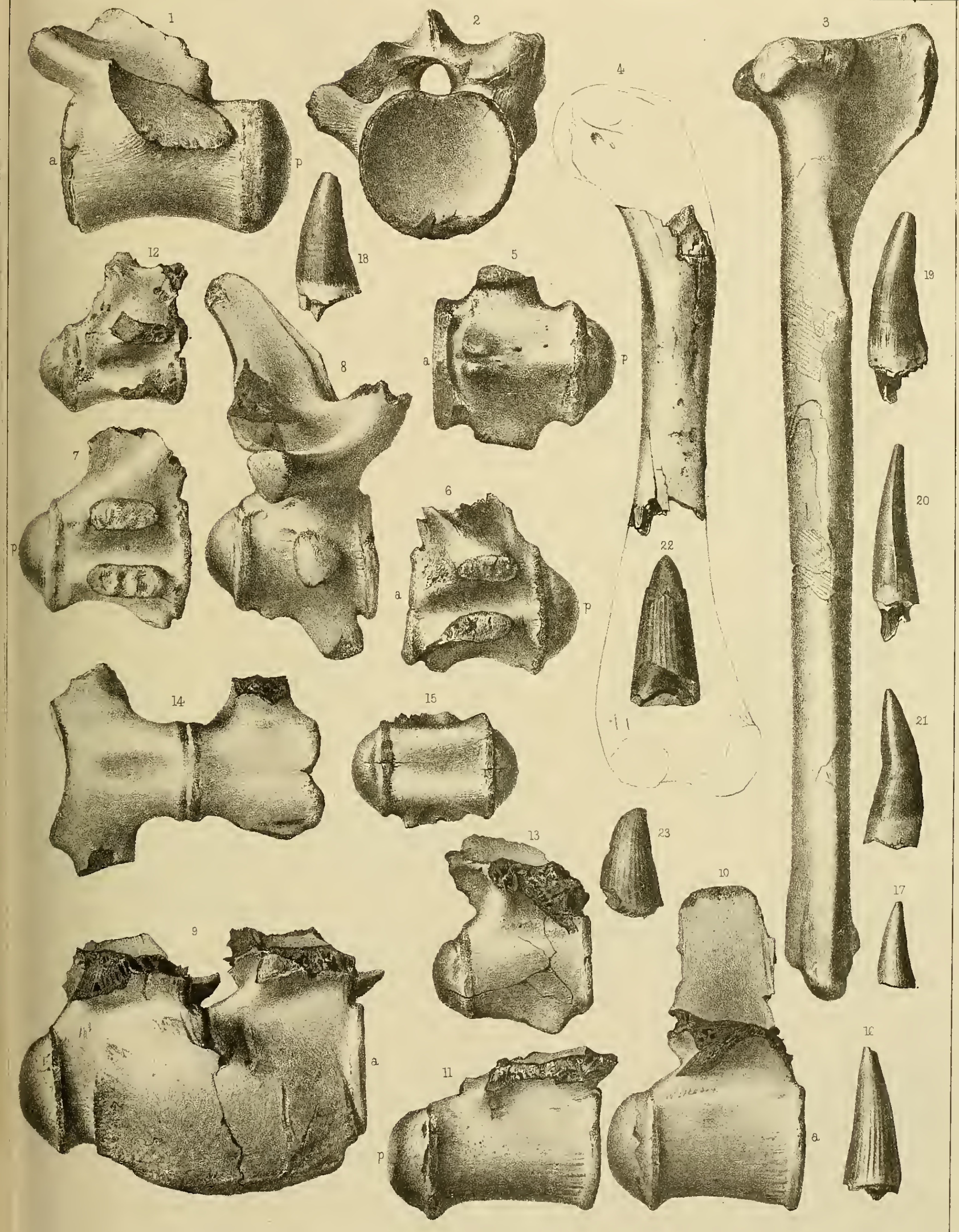
1–6. THORACOSAURUS NEOCESARIENSIS 7–9. GAVIAL, from New Jersey.



Ibbotson, del

T. Sinclair's lith, Phila.

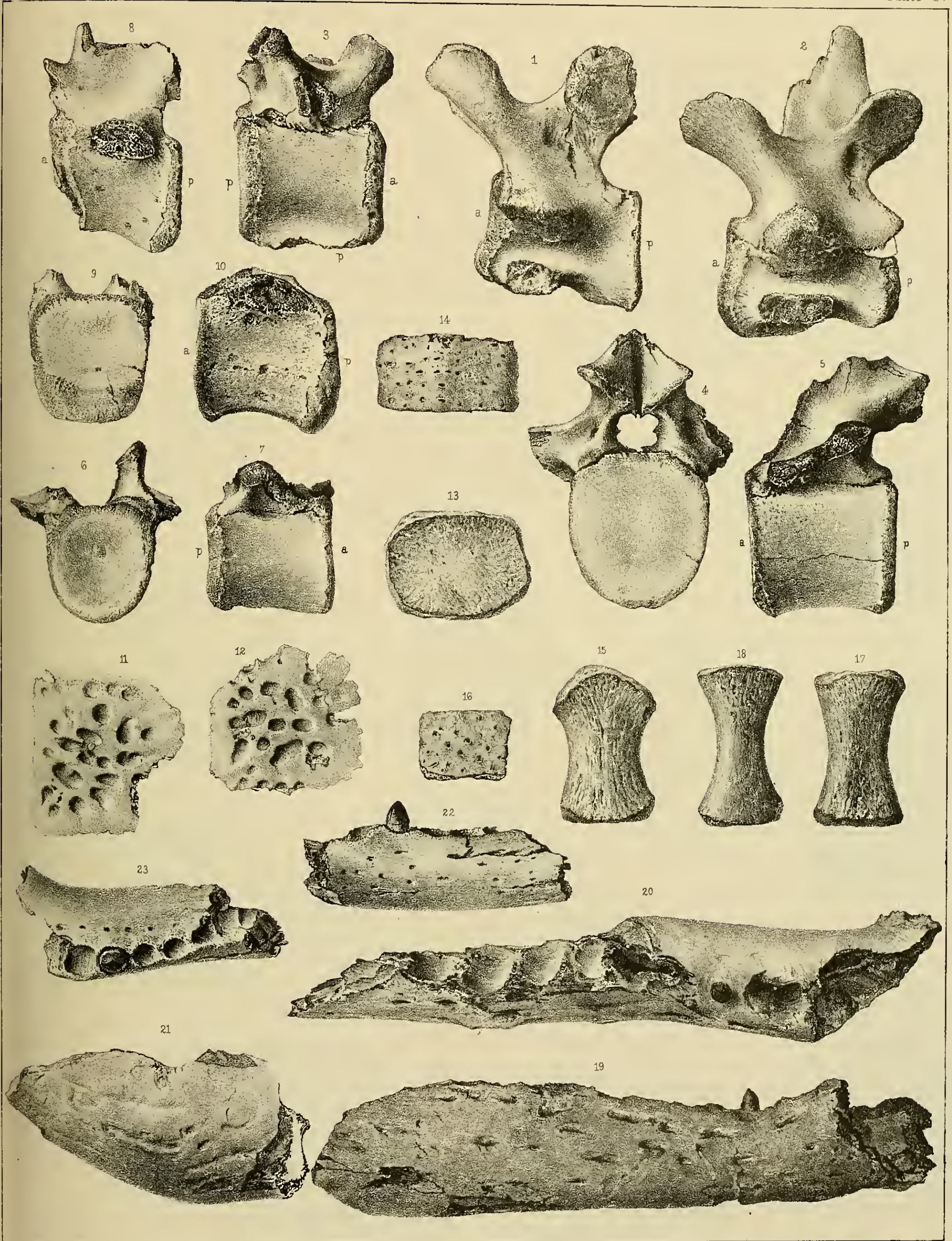
1-3. THORACOSAURUS 4-8 CROCODILES. 9-11. HADROSAURUS
12-14 TRACHODON. 15-16 Undetermined



bbotson, del.

T. Sinclair's Lith. Phila

1, 2 MACROSAURUS. 3 TIBIA, undetermined. 4, 16-21 HYPOSAURUS. 5-11. THORACOSAURUS.
12-15 CROCODILE from New Jersey. 22, 23 CROCODILE from North Carolina.

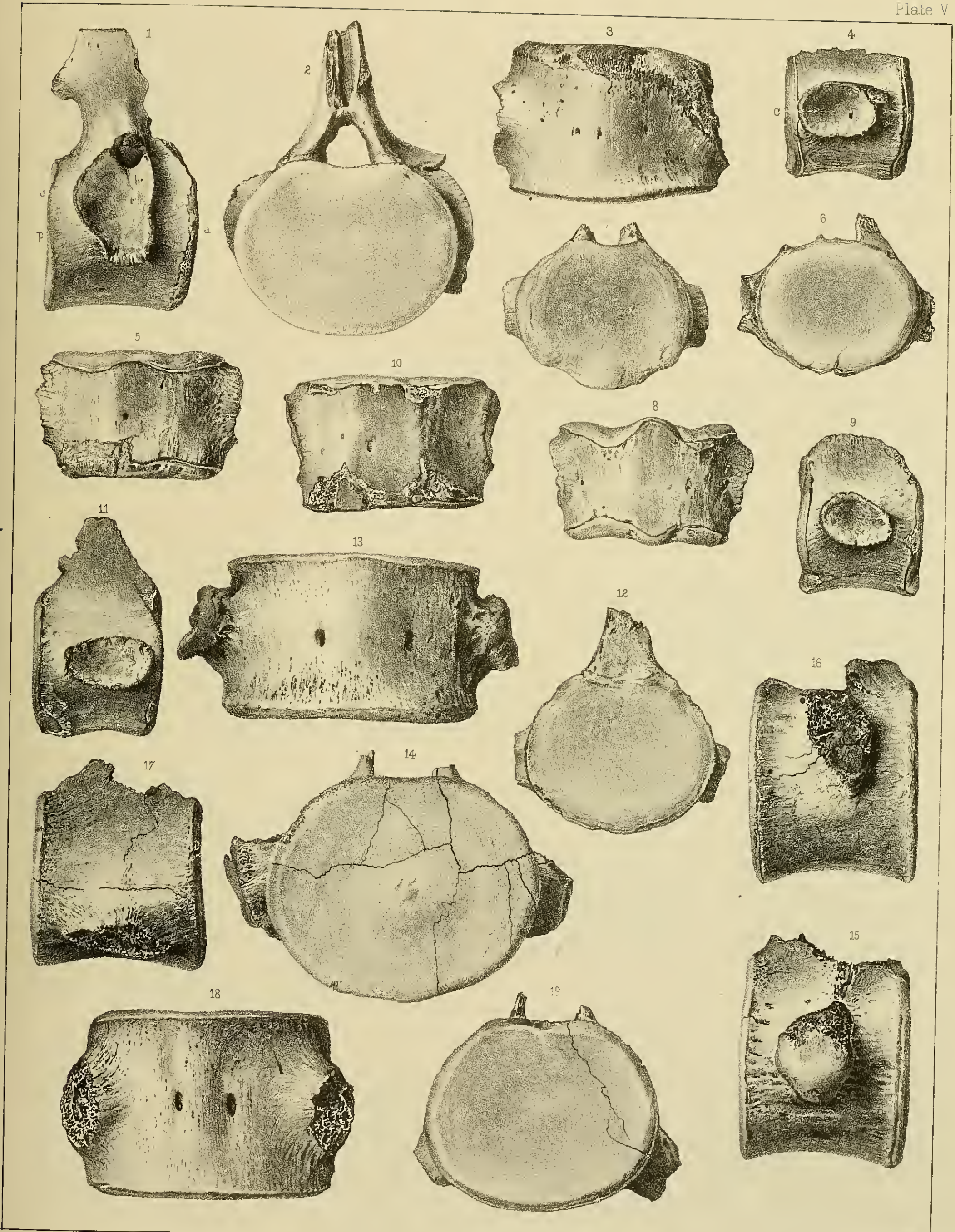


Ibbotson, del

T Sinclair's lith, Phil^a

1-12. HYPOSAURUS ROGERSI 13-18 DISCOSAURUS VETUSTUS

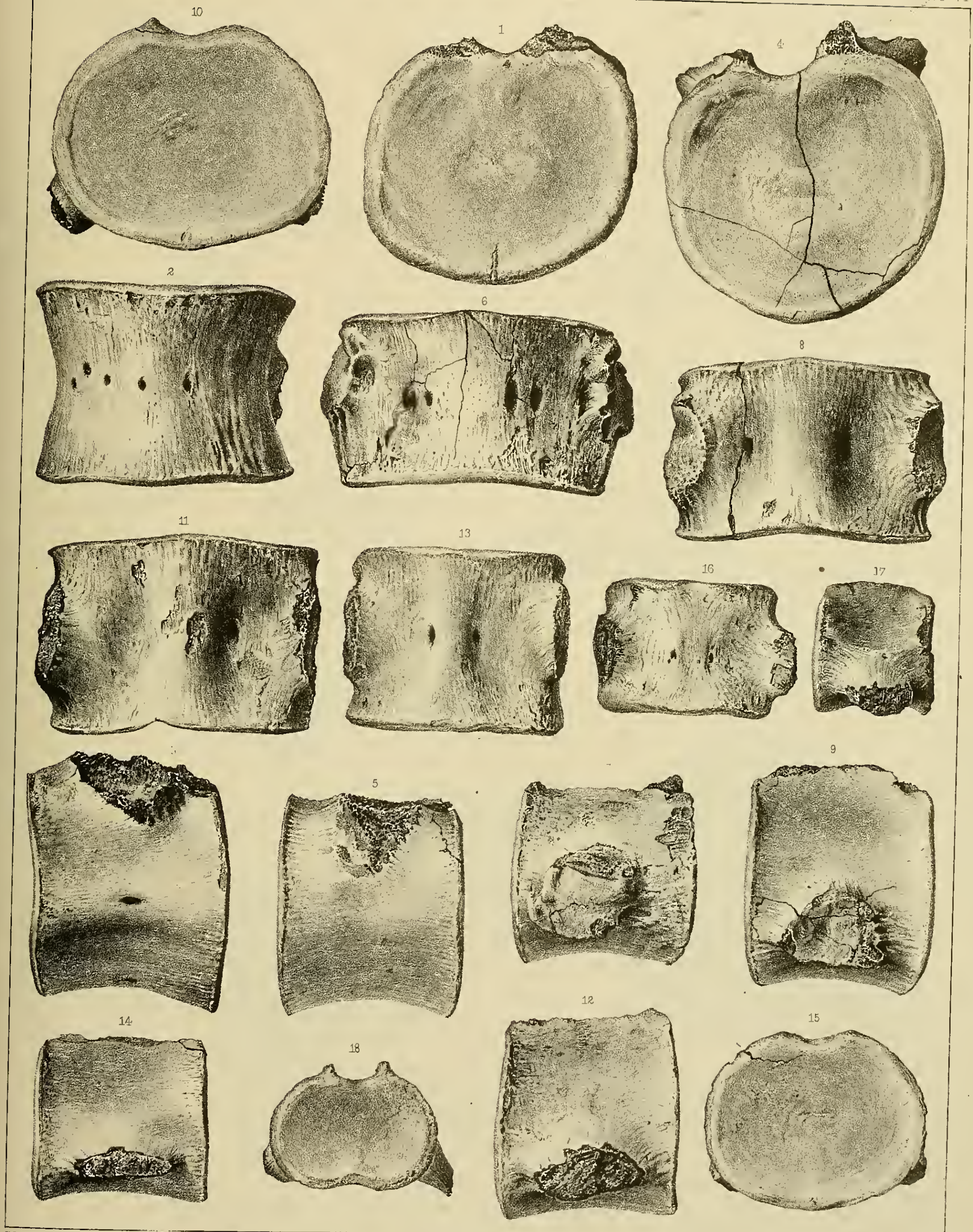
19-23 BOTTOSAURUS HARLANI



T. Sinclair's lith. Phil[a].

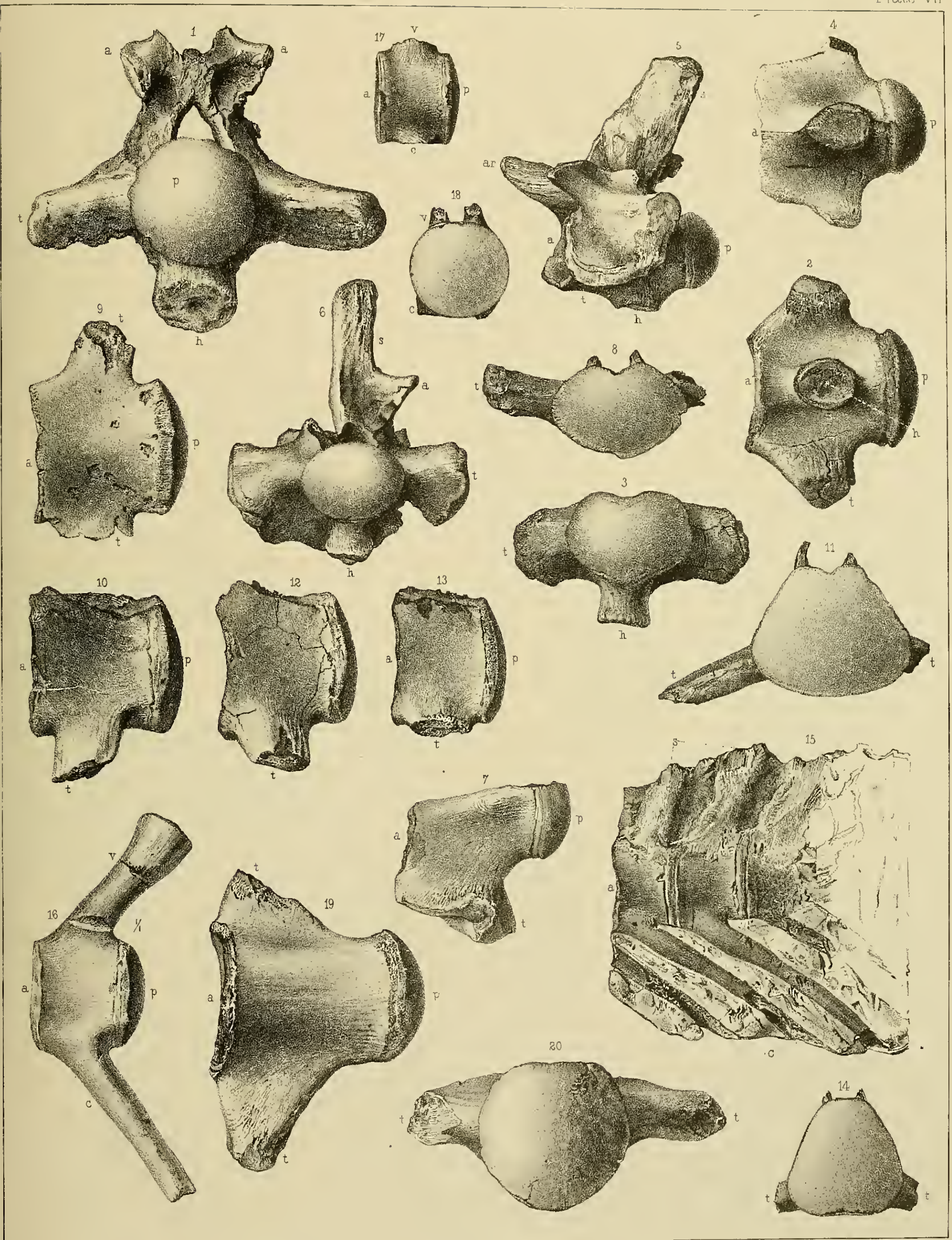
1-12 DISCOSAURUS VETUSTUS. 13-19 CIMOLIASAURUS MAGNUS.

Plate VI

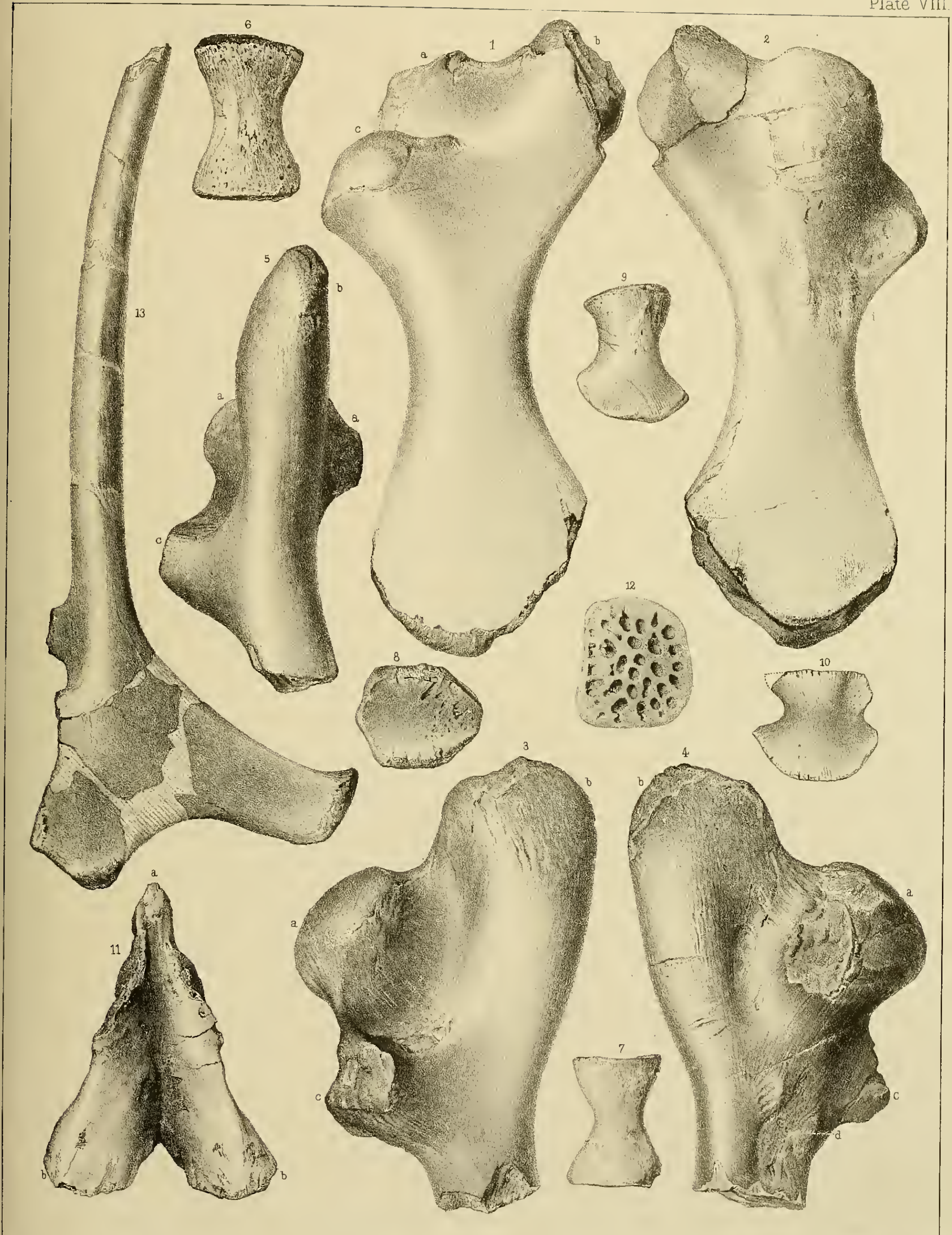


Ibbotson, del. T. Sinclair's lith, Phil^a

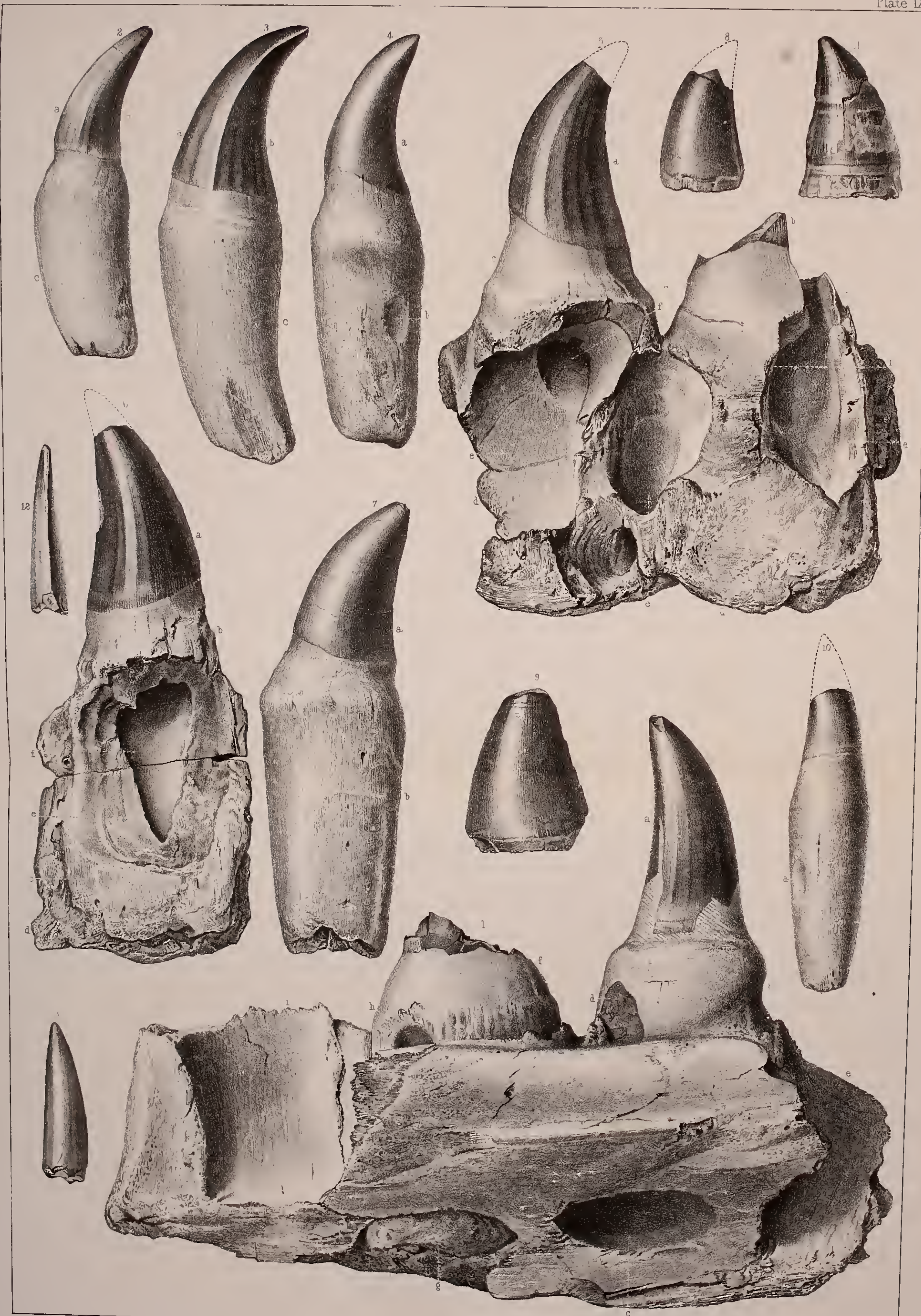
CIMOLIASAURUS MAGNUS.



FIGS. 1-18 MOSASAURUS. 19-20 MACROSAURUS.



1-11 MOSASAURUS. 12 GAVIAL. 13 HADROSAURUS.



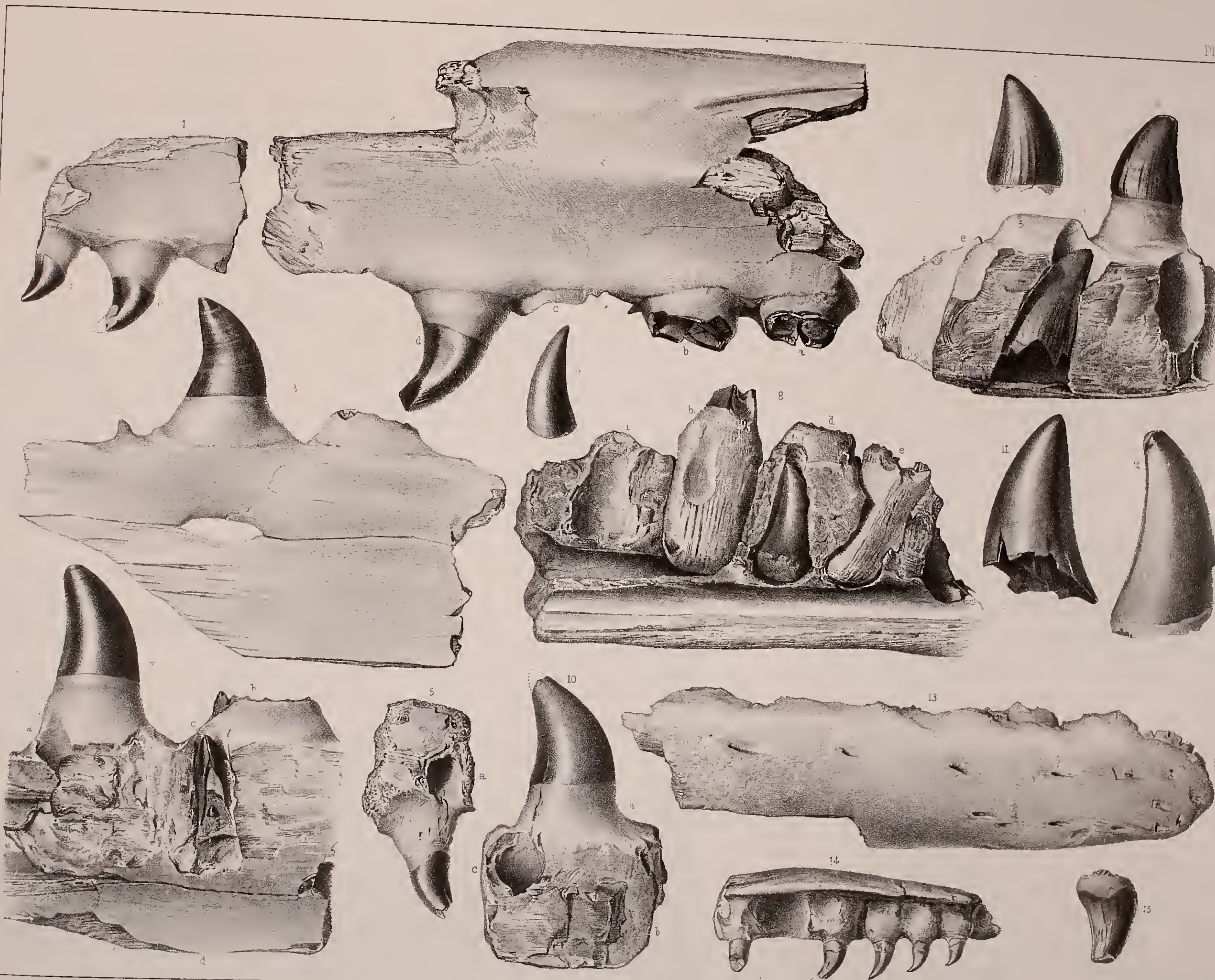
1-11 MOSASAURUS. 12-13 POLYGONODON VETUS

Plate X

MOSASAURUS

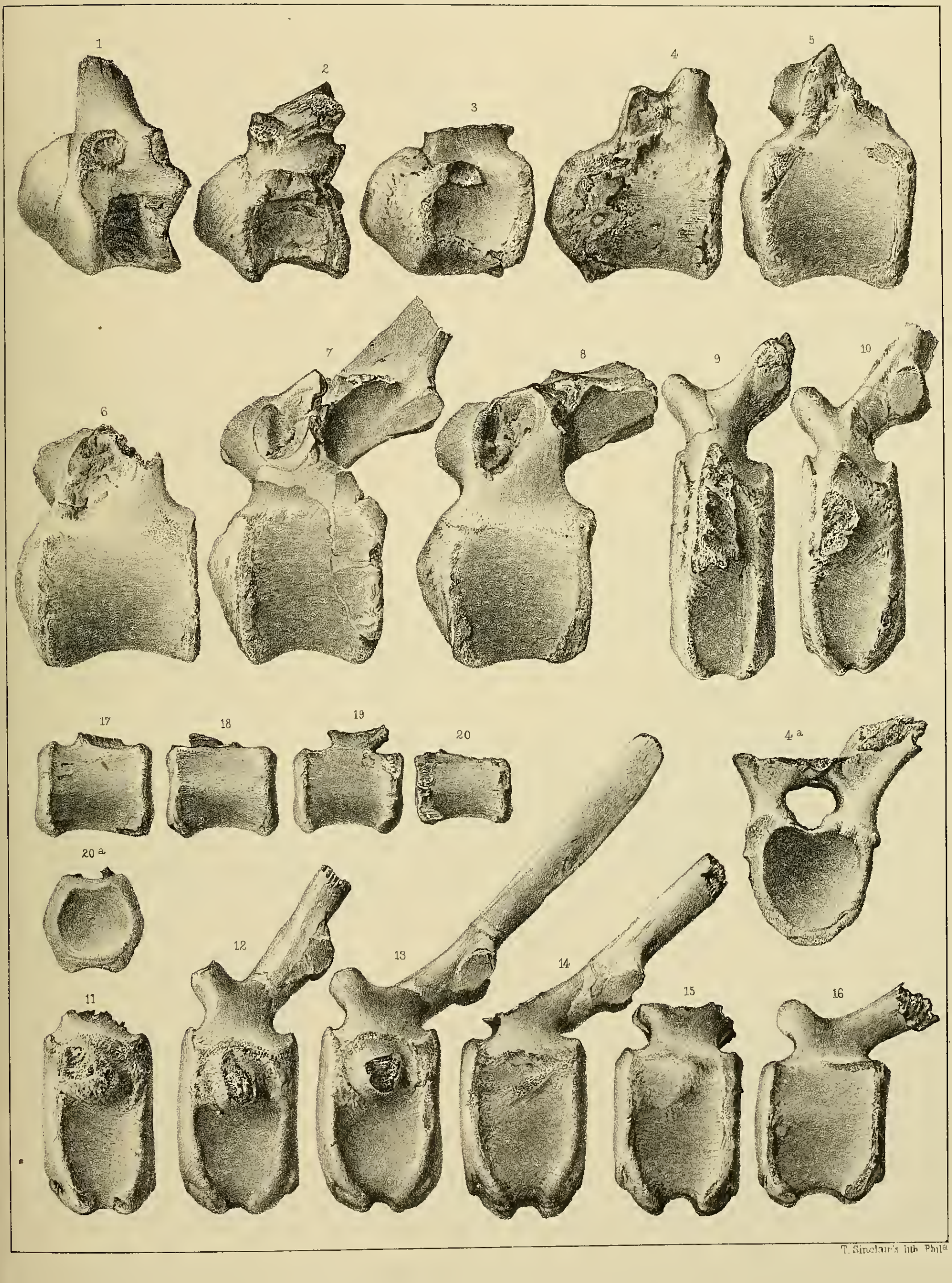
I.

Phil[a]

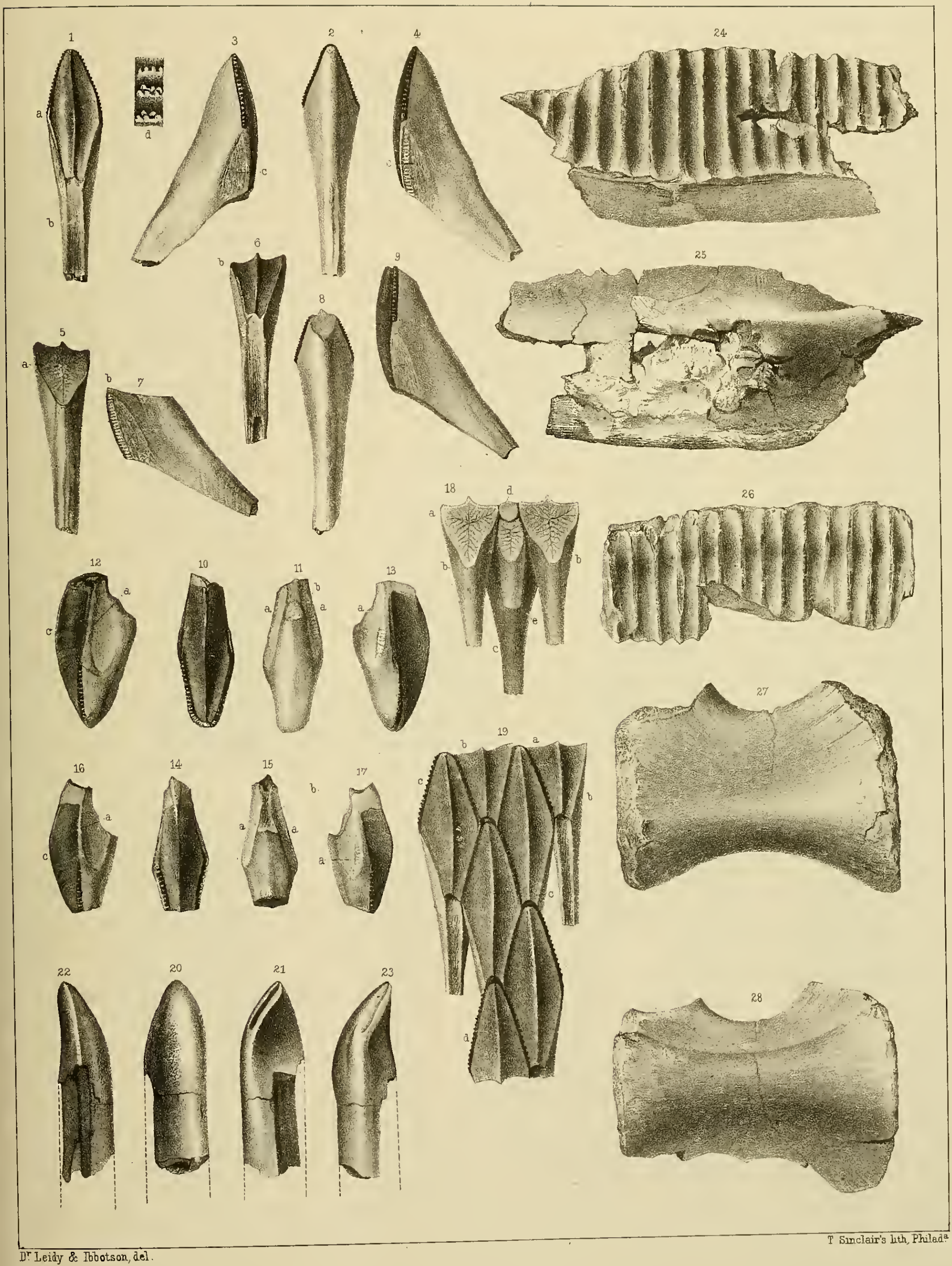


MOSASAURUS.

T. Sinclair's lith. Phila.



HADROSAURUS FOULKII.



1-19, 24-28 HADROSAURUS. 20-23 ASTRODON.

T Sinclair's lith. Phil^a

HADROSAURUS FOULKII

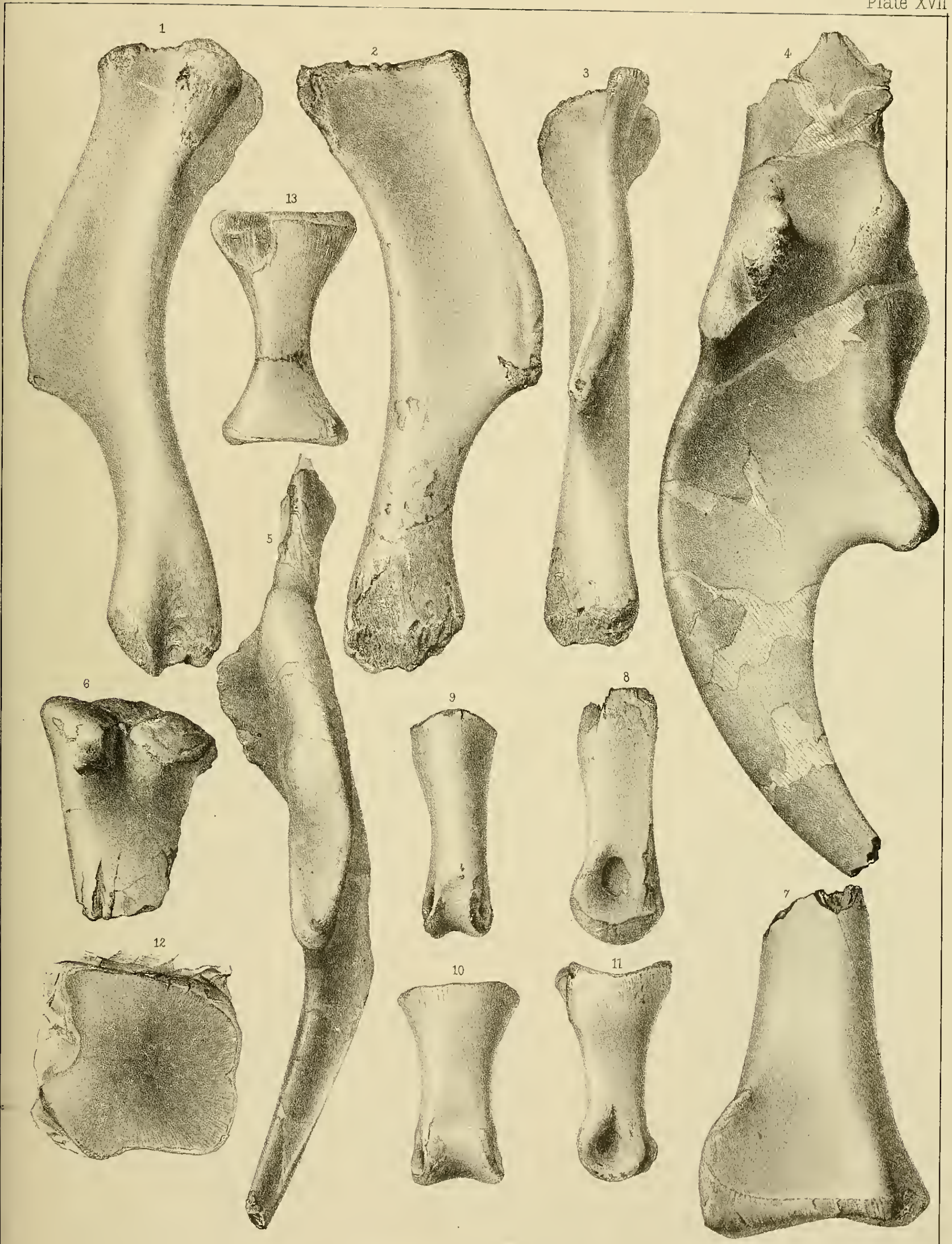
HADROSAURUS FOULKII

A J Ibbotson del

T Sinclair's lith Philad^a

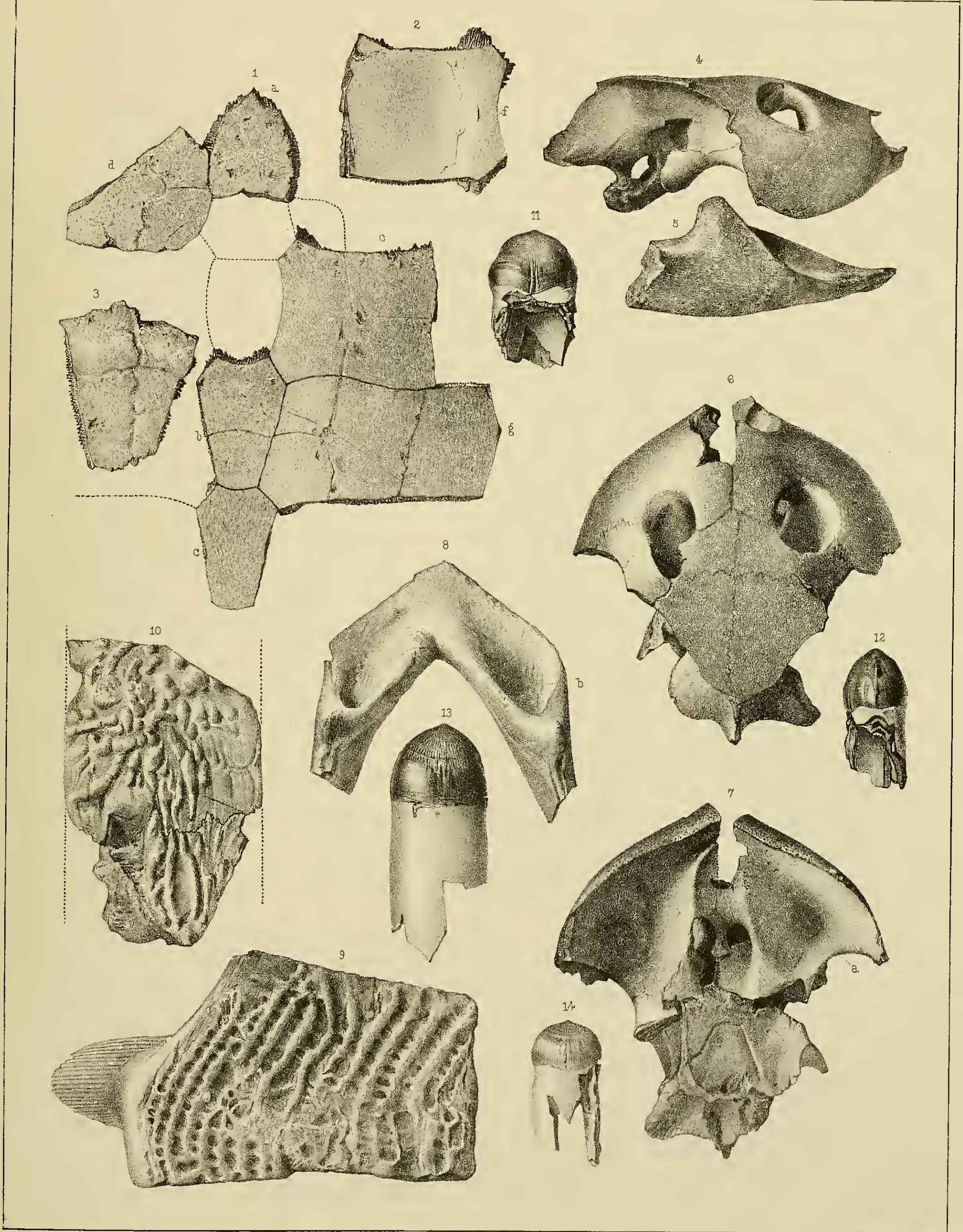
HADROSAURUS FOULKII

Plate XVII



T. Sinclair's lith, Phila.

1-3 HUMERUS. undetermined. 4-5 HADROSAURUS. 6-11 undetermined. 12 MOSASAURUS.

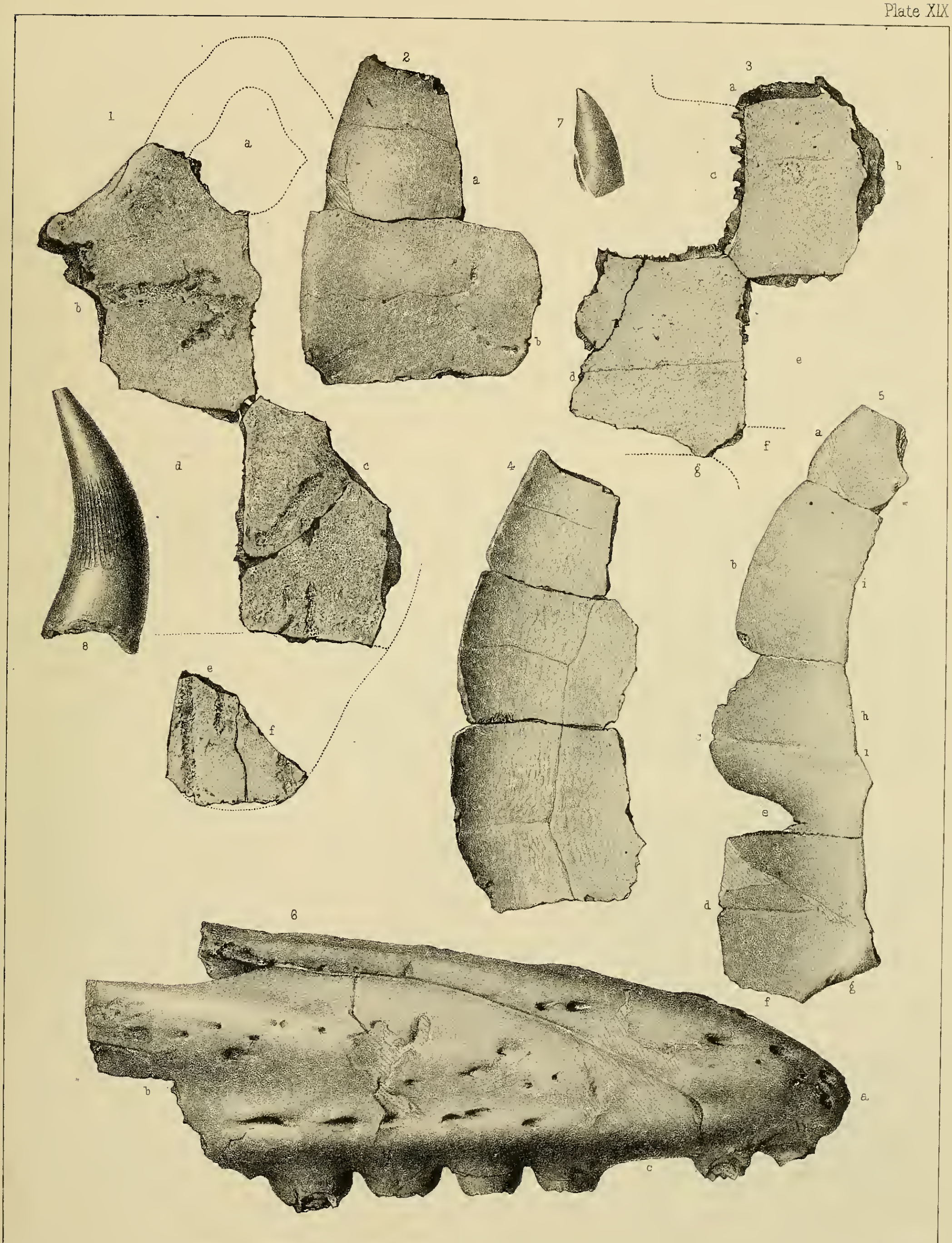


Ibbotson, del

T. Sinclair's lith, Phila.

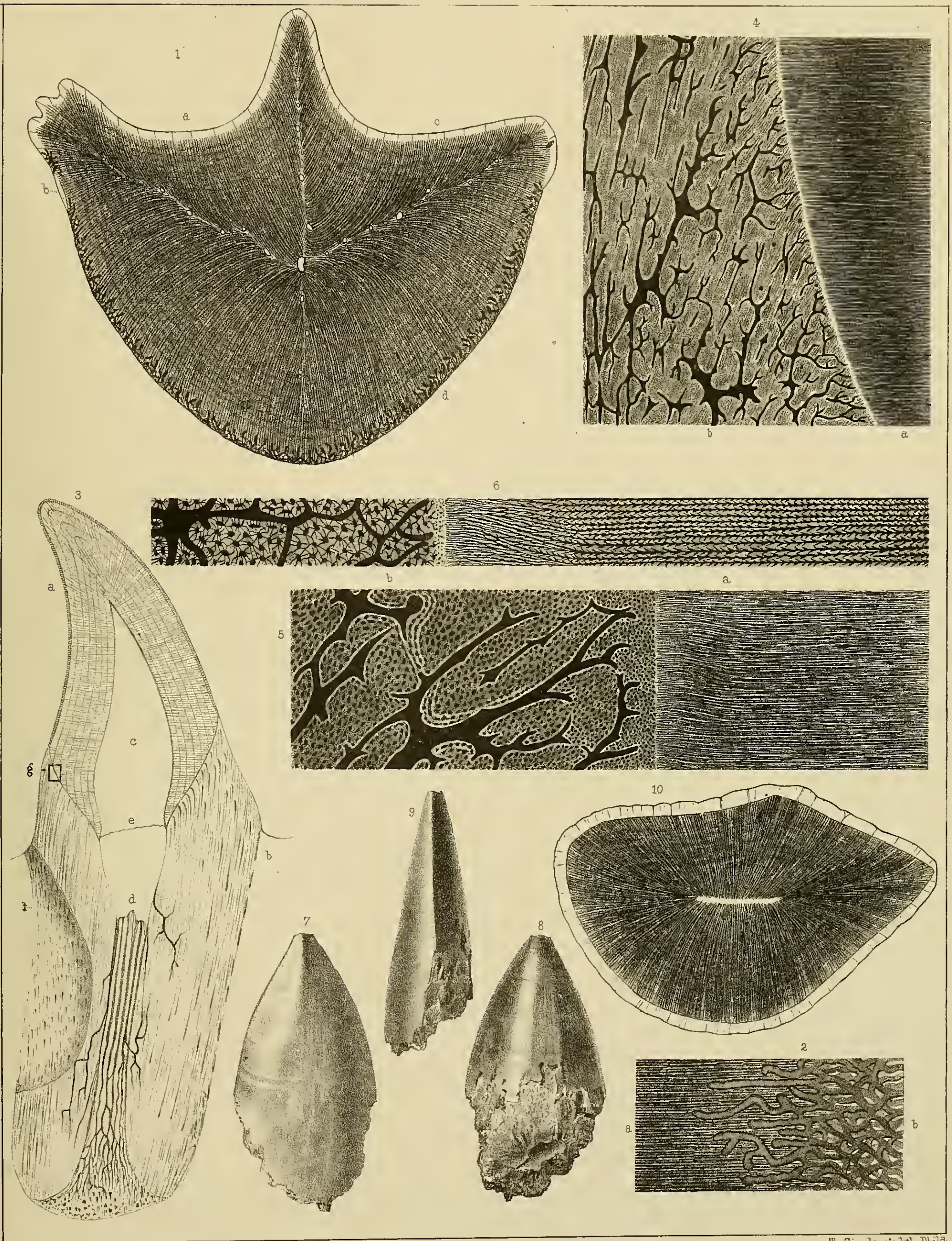
1-3 EMYS BEATUS. 4-8 BOTHREMYS COOKI. 9 TRIONYX.
10 CHELONE. 11-14 BOTTOSAURUS.

Plate XIX



Ibbotson, del. T. Sinclair's lith. Phil^a.

1 EMYS PRAVUS. 2,3 E. FIRMUS. 4 PLATEMYS SULCATUS.
5 CHELONE SOPITA. 6,7 MOSASAURUS. 8 PIRATOSAURUS.



Dr. Leidy, del.

T. Sinclair's lith, Phila.

1, 2 HADROSAURUS. 3-6 MOSASAURUS. 7-9. TOMODON. 10 ASTRODON.