Synopsis of the Extinct Batrachia, Reptilia and Aves of North America

By

Edward D. Cope

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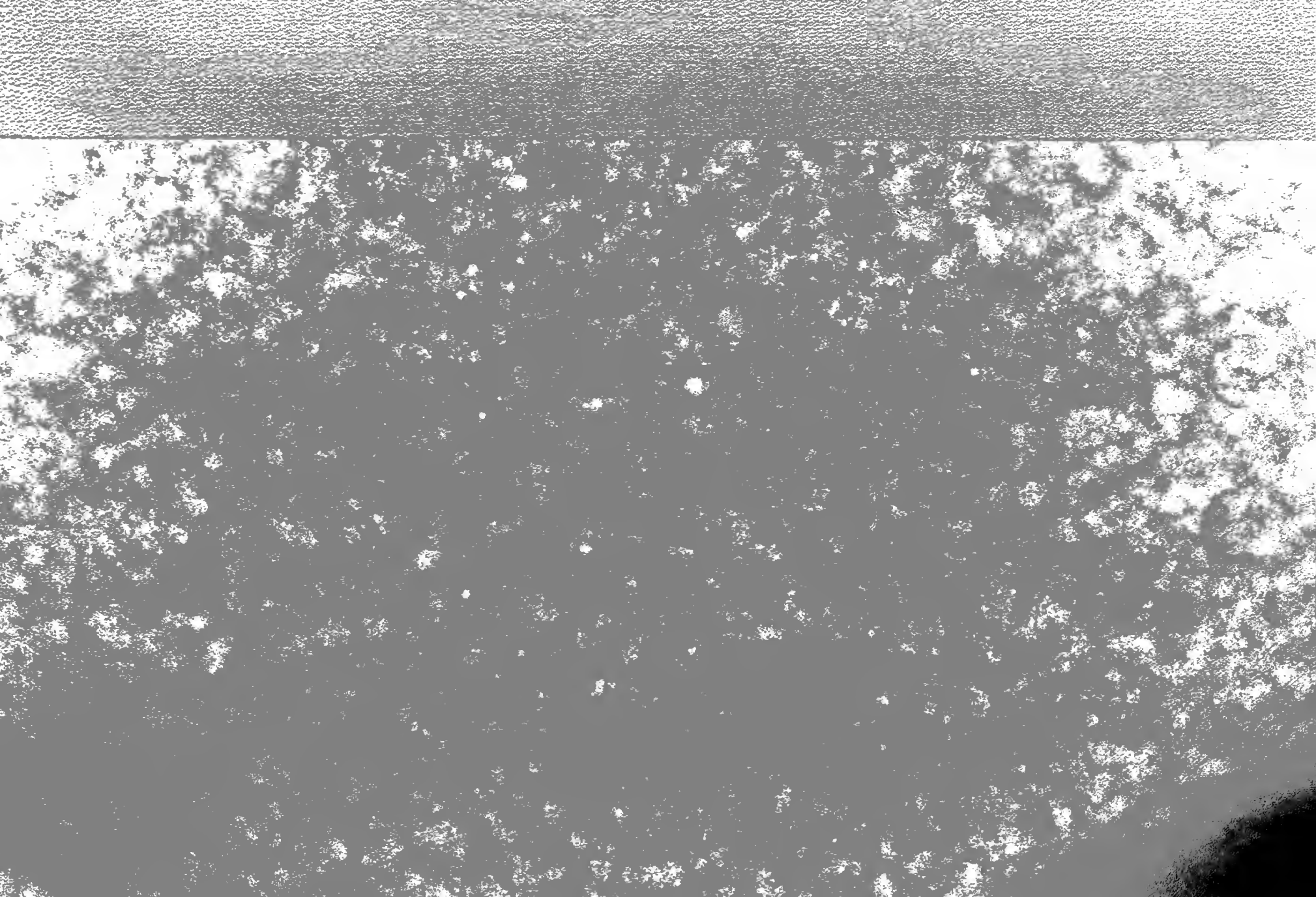

SYNOPSIS

OF THE

EXTINCT

BATRACHIA AND REPTILIA

OF

NORTH AMERICA.

PART I.

By EDWARD D. COPE,

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EXTINCT BATRACHIA, REPTILIA AND AVES OF NORTH AMERICA.

BY EDWARD D. COPE.

Read September 18, 1868, and April 2, 1869.

PREFACE.

It is not designed in the present essay, to give descriptions of the known remains of the Batrachia, Reptiles and Birds, which have been more or less fully made known by others. This is left for the day when our knowledge shall more nearly approach completeness. While the subject is in its infancy, I have thought best to describe only those species and types which are new, and those portions of imperfectly known forms which will throw additional light on their relations and affinities. In adhering to this plan, I have been able to add no little to the history of the Reptiles already described by my predecessors, Leidy, Owen, Dawson, Wyman, Lea, etc. Where, however, I have had nothing to add, I have referred to their published descriptions, which are numerous and well-known. The literature of the subject will then be found under the respective specific heads.

The present Memoir was originally prepared under the title of "Contributions to the History of the Vertebrates of the Mesozoic Periods in New Jersey and Pennsylvania," and presented to the Academy of Natural Sciences of Philadelphia, for publication, Fifth Month, 14, 1867. The more important parts of its contents were at the same time embodied in a series of remarks before the Academy. This essay was withdrawn, owing to delay in the publication, and the remarks made were not printed. An abstract of part

of them was, however, published in the Proceedings of the Academy for the same year, page 234.

Additional material was shortly afterwards sent to the writer, and the important contributions on the Batrachia of the coal measures, and on the Elasmosauridæ, written. The Palaeophis and some of the Testudinata and Pythonomorpha were also added.

In the course of these investigations, prosecuted during the past six years, with reference to the structure and relations of the extinct Reptilia, the following general conclusions have been attained to, besides many of lesser significance.

First: That the Dinosauria present a graduated series of approximations to the birds, and possess some peculiarities in common with that class, standing between it and the Crocodilia.

Second: That serpents exist in the Eocene formations of this Country.

Third: That the Chelydra type was greatly developed during the American Cretaceous, and that all the supposed marine turtles described from it, are really of the first named group.

Fourth: That the Reptilia of the American Triassic are of the Belodon type.

Fifth: The discovery of the characters of the order Pythonomorpha.

Sixth The development of the characters of numerous members of the Batrachian Sub-order Microsauria in the United States.

I must express my obligations to Prof. Geo. H. Cook, of the Geological Survey of New Jersey, who kindly placed the specimens procured during the Survey at my disposal. I am also particularly indebted to Prof. John S. Newberry, of Columbia College, New York, and director of the Geological Survey of Ohio, for the loan of the unique and important material from the carboniferous beds at Linton, Ohio, contained in his private collection. I am under similar obligations to Wm. R. Webb, Superintendent of the Land Office at Topeka, Kansas, for the important type specimens of Polycotylus latipinnis, and to Prof. Agassiz, for the freedom of study and description of the unequalled Mosasauroid material in the Museum of Comparative Zoology, Cambridge. Also to Philip P. Tyson, of Baltimore, for similar advantages, and to Dr. Theophilus M. Turner, of Fort Wallace, Kansas, for the discovery of that extraordinary reptile, the Elasmosarus platyurus, and its shipment in unusually good condition. Dr. E. R. Showalter, of Uniontown, Alabama, has placed me under obligation, in sending the beautiful fossil of Clidastes propython. I must also express obligations to Prof Marsh, of Yale College, Dr. Lockwood, of Keyport, New Jersey, and to other friends.

SYNOPSIS OF THE PRIMARY TYPES EMBRACED IN THIS ESSAY.

The Classes Aves, Reptilia, and Batrachia are those over which the present review extends. The classes of veretebrata not included are: the Dipnoi, Pisces, Elasmobranchi, Dermopteri, and Leptocardii and the Mammalia.

The Aves, Reptilia, and Batrachia are characterized and distinguished from all the other classes as follows: the points wherein they differ from each other are italicized.

BATRACHIA.

Axial element of the brain chamber a single membrane bone, the parasphenoid; occipital condyles two, on the exoccipitals.

Mandible compound, supported by quadratum.

A distinct coracoid bone.

Limbs when present ambulatory, attached anteriorly to a scapular arch which is free from the cranium.

Nervous System. Cerebral hemispheres larger than optic lobes, *not covering the optic thalami, and with the lateral ventricle on their inner side.*

Fornix and arbor vitæ none; *medulla oblongata straight; olfactory lobes terminal, sessile.*

Circulatory System. Heart with two and three chambers.

Three or more aorta bows; aorta with two roots from a ductus communis *and bulbus arteriosus.*

REPTILIA.

Axis of brain case, the basi-occipital and sphenoid elements developed in the primordial cartilage, the first with exoccipitals bearing one condyle.

Mandible compound, supported by quadratum.

Coracoid bone distinct.

Limbs the anterior attached to a scapular arch which is free from cranium.

Metatarsals and metacarpals distinct; carpals and second row of tarsals also distinct; usually the first row of tarsals also.

Pubis not in contact with ischia distally.

Nervous System. Cerebral hemispheres larger than optic lobes, *extending over and concealing optic thalami, and with the lateral ventricles on their outer side.*

Fornix and arbor vitæ none; *medulla oblongata abruptly curved; olfactory lobes terminal pedunculate.*

Circulatory System. Heart with three or four chambers.

Aorta with two roots, and rarely an additional bow; no bulbus arteriosus.

AVES.

Osseous structure as in Reptilia, except metatarsal and usually metacarpal bones are confluent with each other, and with the carpal and second series of tarsal bones; first series of tarsals confluent with tibia.

Pubis turned backwards and more or less confluent with ischium.

Nervous System. Cerebral hemispheres larger than optic lobes, and concealing optic thalami with the lateral ventricle.

Fornix and arbor vitæ present; medulla oblongata bent; olfactory lobes inferior sessile.

Circulatory System. Heart with four chambers.

Aorta with one root turning to the right, no bows, and no bulbus arteriosus.

Class I.—BATRACHIA.

The vomer is double, and usually bears teeth in this class; the premaxillary is single or double.* Teeth never planted in deep alveoli.

There are six orders, as follows:

TRACHYSTOMATA.

Caudal vertebræ and frontal bones distinct. Inferior pelvic elements not confluent.

O. o. maxillaria, prefrontalia, palatina and pterygoidea wanting; nasalia present.

Ethmoid, two lateral pieces, each forming part of palate.

Mandible toothless, condyloid, teeth pleurodont. No "postorbital and supertemporal bones." First pair ceratohyals distinct.

* Two premaxillary bones are usually ascribed to the Batrachia, but in many Salamanders they are confluent. Thus while they are double in Salamandra, they are single in Hemisalamandra, Triton and Diemyctylus. In Amblystomidæ they are double. Among Plethodontidæ, they vary. Of Plethodontine genera Batrachoseps and Stereochila (Cope gen. nov. for *Pseudotriton marginatus* Hallow) have them single, and Plethodon double. Of Spelerpine forms, Maculus (Cope gen. nov. for *Salamandra quadridigitata* Holbr.) Oedipus and Spelerpes have but one, and Geotriton and Gyrinophilus (Cope gen. nov. for *Salamandra salmonea* Storer *Pseudotriton salmoneus* Bd.) have two premaxillaries. Desmognathus and Amphiuma have single premaxillaries.

PROTEIDA.

Caudal vertebræ and frontal bones distinct. Inferior pelvic elements not confluent.
O. o. maxillaria, prefrontalia and nasalia wanting; palatina and pterygoidea present.
Ethmoid* a vertical plate on each side the cerebral lobes.
Mandible toothed, teeth pleurodont. Ceratohyals, first pair connate.
No "postorbital and supertemporal bones."

URODELA.

Usual cranial bones present, but pterygoids reduced or wanting.
No "postorbital or supertemporal bones."
Caudal vertebræ and frontal bones distinct.
Ethmoid, a vertical plate on each side.
Mandible dentigerous; teeth pleurodont.
Inferior pelvic elements horizontal, in contact; no osseous pubis; ilium suspended to a sacral rib.
(Mostly no quadratojugal.)

GYMNOPHIDIA.

Usual cranial bones present and distinct, including frontals and pterygoids.
Caudal vertebræ distinct.
No "postorbital or supertemporal bones."†
Ethmoid annulus surrounding cerebral lobes.
Mandible dentigerous; teeth anchylosed by their bases.‡
(A quadratojugal.)

* Erroneously called orbitosphenoids by me. Journal Acad. 1866, (on Anura.)

† When the temporal fossa is overarched, it is by expansion of the maxillary and quadratojugal. (Stannius says, "Squama temporalis.")

‡ The teeth of Cæcilia are compressed with a trenchant posterior edge, which is crenate after the manner of Megalosaurus, Carcharias, etc. Thus to the numerous genera of Saurians and Selachians possessing this character, must be added a Batrachian.

STEGOCEPHALI.

Usual cranial elements distinct, including frontals and pterygoids, and adding "postorbitals and supertemporals."
Caudal vertebræ?
Orbitosphenoids normal.
Inferior pelvic elements distinct.
Mandible dentigerous; teeth with anchylosed bases, or in shallow alveoli.
Ethmoid. ?
(A quadratojugal.)

ANURA.

Frontal and parietal confluent, nasals wanting or rudimental; other cranial bones present.
Postorbital, supratemporal, and usually nasals wanting.
Ethmoid an annulus (usually complete above) surrounding cerebral lobes.
Caudal vertebræ represented by an elongate compound style.
Inferior elements of the pelvis consolidated into a single vertical mass; ilium attached immediately to sacral vertebræ.

STEGOCEPHALI.

XENORHACHIA.

The vertebral centra not ossified; the teeth simple; no branchial hyal bones; occipital condyles.

MICROSAURIA.

Vertebral centra ossified; no branchial hyoids; teeth simple or with slightly inflected enamel of the basis; occipital condyles.

GANOCEPHALA.

Vertebral centra cartilaginous; branchial hyoids present; teeth with inflected enamel, anchylosed by their bases. No ossified occipital condyles.

LABYRINTHODONTIA Vera.

Vertebral centra osseous; no branchial hyoids; teeth with much inflected enamel, anchylosed in shallow alveoli. Occipital condyles.

Our knowledge of these forms is as yet in many cases too incomplete, to enable us to assert positively as to the structure and position of the teeth, and the preceding arrangement is designed to shadow out the true system, rather than to define the groups exactly. They may be arranged further in the following manner, with reference to the dermal armature.

I. Three large pectoral plates.

α Abdomen with numerous short or long bony scales in close series.

β A bony sclerotic ring.

Teeth simple. *Xenorhachia.* — Amphibamus.

Teeth complex. *Ganocephala.* — Archegosaurus.

ββ No bony ring.

Microsauria. — Colosteus n. gen.; Pholidogaster.; Pteroplax.; Ceraterpeton.; Urocordylus.

II. No pectoral osseous shields.

α Abdomen with oblique series of long or short scales.

Microsauria. — Sauropleura.; Œstocephalus.; Lepterpeton.; Ophiderpeton.; Hylonomus.; Dendrerpeton.

αα No abdominal scales known.

Pelion.; Molgophis.

XENORHACHIA.

This order I proposed for the reception of the genus Amphibamus Cope, in 1865. I proposed to regard as one of its characters, the existence of opisthocœlian vertebræ. Such impressions were observed in the matrix in which the fossil was preserved, as to induce a

belief in the existence of such vertebræ, and the existence of these in a well ossified condition, in the apparently nearly allied genus Raniceps Wyman strengthened such belief. There were actually, however, only osseous neural arches present, and I am now decidedly of the opinion that the vertebral centra were either cartilaginous or annuliform, as in Archegosaurus.

AMPHIBAMUS, *Cope*.

Proc. Acad. Nat. Sci. Philadelphia, 1865. 134.

AMPHIBAMUS GRANDICEPS, *Cope*.

Proc. Acad. Nat. Sci. Philadelphia, 1865, 134. Palæntology, Ill. State Survey, Tab. Carboniferous; Lower Coal Measures; Morris County, Illinois.

MICROSAURIA.

This suborder was established by Prof. Dawson for small lizard-like vertebrates from the Coal Measures, which he thought presented points of affinity to the Saurian reptiles, at the same time recognizing Batrachian characteristics.

These creatures form, in fact, a series closely resembling or parallel with what was probably an immature stage of the Labyrinthodontia. They are, Labyrinthodonts, with simple, or very slightly inflected enamel of the teeth, and with the extent of the exostosis of the cranial bones much reduced. This character has been much overrated by some authors. In the Dendrerpeton obtusum Cope the grooving and pitting exists only on the posterior parts of the cranium, and gradually disappears anteriorly. In the Alligator mississippiensis the same is the case.

The only species, included in this tribe, in which inflections of the enamel have been described is the Dendrerpeton acadianum, and here it is only at the base of the tooth. It is, however, not impossible that this genus should not be associated with Hylerpeton, Œstocephalus, etc.

The genera Urocordylus, Ceraterpeton, Lepterpeton, Ophiderpeton, and others recently described by Prof. Huxley, also belong here.

The genus Brachydectes m. is established on portions of the crania only, while Sauropleura m. is known from portions of all the skeleton except the cranium. There is, therefore, a possibility of a *double emploi* in this case, though not in respect to the species.

PELION, *Wyman.*

Proc. Acad. Natl. Sci. Philadelphia, 1868, p. 211. *Raniceps,* Wyman Amer. Journal Sci. and Arts, 1858, p. 158. Not of Cuvier, (Pediculati.)

PELION LYELLII, *Wyman. Raniceps lyeelii, Wyman, l. c.*

This animal differs from the genus Amphibamus, in the well ossified vertebral axis; no remains of a tail with elevated neural spines exist in the type specimen, nor have ventral scales or sclerotic bones been seen.

Middle Coal Measures, Jefferson county, Eastern Ohio.

HYLONOMUS, *Dawson.*

This genus embraces the smallest species of the order. They all pertain to that interesting Batrachian fauna of the Coal Measures of the Joggins of Nova Scotia, elucidated chiefly through the exertions of Principal Dawson, of Montreal. This fauna embraces six of the Microsauria and one true Labyrinthodont. Of the former, the Hylerpeton dawsonii Owen, is the largest species, the Dendropetons next, and the Hylonomus wymanii is the smallest. As Dr. Dawson has described these curious animals in the "Canadian Naturalist," in detail, I will not repeat them here, but add a list expressing some peculiarities of dentition, which are highly important in the determination of species. This, giving the number of teeth in a line of 1-12th of an inch, has been furnished me by Prof. Dawson.

HYLONOMUS LYELLII, *Dawson.*

Loc. Cit. VIII., 167, — Coal Measures of Nova Scotia.

HYLONOMUS ACIEDENTATUS, *Dawson.*

Loc. Cit. VIII., 258, — Coal Measures; with the last.

HYLONOMUS WYMANII, *Dawson.*

Loc. Cit. VIII., 270, — Coal Measures; with the last.

	No. of Teeth in Line.
Dendrerpeton acadianum.	
Outer series of teeth,	4 teeth in one line to $1\frac{1}{4}$ line.
Inner do.	4 in $2\frac{1}{2}$ lines.
D. owenii.	
Outer Series,	4 in one line.
Inner do.	4 in two to $2\frac{1}{4}$ lines.
Hylerpeton dawsonii,	4 in five lines.
Hylonomus lyelli,	12 in two lines.
H. wymanii,	12 in $1\frac{1}{2}$ lines.

PARIOSTEGUS, *Cope*.

Proceed. Acad. Nat. Sci. 1868, p. 211.

This genus is represented by a large part of the cranium of a batrachian from the triassic coal measures of Chatham county, North Carolina. If not a batrachian, it could only belong to a Ganoid fish, but though some of its characters are somewhat ichthyic, it lacks the following important elements of the Ganoid structure, *i. e.* post and suborbital bones; postnareal cavities, branchiostegal, and arched branchihyal bones. On the other hand it has a large preorbital, bounding the frontal and maxillary to the nares, and the inner border of the orbit, as in Stegocephalous Batrachia; also a postorbital element, contributing to the formation of an extended supratemporal roof.

Contrary to what has been found the case in most genera of Stegocephali, the maxillary appears to extend posteriorly to a free termination, as in modern Salamanders, and the supratemporal bone presents a very prominent, obtuse, arched margin. This margin extends from the orbits on each side, and is inclined towards the posterior part of the cranium. There is therefore no quadratojugal piece.

The maxillary and mandibular pieces are slender, flat bones, as in Menopoma; the form of the posterior or articular portion of the latter cannot be ascertained from the specimen. The more or less exposed part of the median region of the latter, exhibits a succession of shallow transverse notches, enclosing thirteen obtuse elevations. The former resemble rudimental lateral alveolae for minute pleurodont teeth. A few other similar minute ribs, and, perhaps, a minute curved cone without sculpture, are the only other indications of dentition.

The bones of the upper surface of the cranium are more readily interpreted by reference to those of Menopoma. A pair of narrow nasals, acuminate behind, penetrate between the frontals as far posteriorly as the posterior margins of the orbits. The suture between these is very distinct, and entirely straight. The preorbitals extend to above the orbit, and then appear to cease with a transverse suture. Between these and the nasals a broad triangular element enters on each side, not attaining the probable position of the nostrils. Each is divided by a longitudinal groove, which is probably a suture, and which would then divide the frontals from the parietals. The frontal would then divide the parietals entirely, as they do in Menopoma, for the anterior half of their length. This would give the frontals a narrow form, acuminate in front, and bounded behind by a regular coarse, zig-zag transverse suture. The cranium behind this point is rugose, and the surface not well preserved, and it can only be said, that two peculiar grooves converge to a point between the posterior extremities of the frontals, like the boundaries of the supraoccipitals. The posterior boundary of the cranium with the condyles cannot be

readily determined. When the postorbital roof bone is raised up, the meeting of two gular dermal bones, as I interpret them, is seen. One of these is a plate directed backwards and outwards, bearing minute radiating lines on its upper surface. It meets a similar flat plate directed forwards and outwards with similar lines radiating to the circumference. The inner margins of these plates were not seen.

The orbits are remarkably small, and situated probably near the middle of the longitudinal measurement of the cranium. The external nares are not defined, but symmetrical depressions in the position they usually occupy in Salamanders are distinct.

The general form recalls Menopoma, particularly the small orbits. A slender curved bone with a slightly dilated and truncate extremity, lying by the cranium in connection with the mandible, is like a branchihyal of that genus. Nevertheless it cannot be positively assigned to that genus, as numerous cycloid scales of fishes are on the same block.

PARIOSTEGUS MYOPS, *Cope.*

The surfaces of the cranial bones are little sculptured; there are small tuberculiform elevations on the parietal and more numerous ones on the preorbitals. The postorbitals show the strongest markings of elongated pits, which radiate to their circumference, leaving a smooth obtuse border. The nasals present a series of small warts at a little distance on each side of their common suture, and transverse to it. The surface of the maxillary is marked with longitudinal grooves and shallow pits.

No suture separating maxillaries and premaxillaries can be traced with certainty, though the bones of the jaw are interrupted at the usual place of suture, opposite the nostril.

Measurements.	*Lines.*
Length of specimen (including mandible),	18
Width between outer convexities postorbitals,	17
Do. do. inner borders orbit,	11
Do. of same without preorbitals,	8
Do. of nasals at middle,	2.5
Do. of orbit,	1.5
Length of frontal and nasal premaxillary,	11
Do. of supposed branchihyal,	12

The name is derived from the roof-like postorbitals with free lateral margin.

Locality.—Coal bed of the Keuper Triassic, Chatham county, North Carolina. The species was discovered by Prof. Jos. Leidy, who handed it to me for description. It is in the Museum of the Academy Nat. Sciences of this city.

DENDRERPETON, *Owen.*

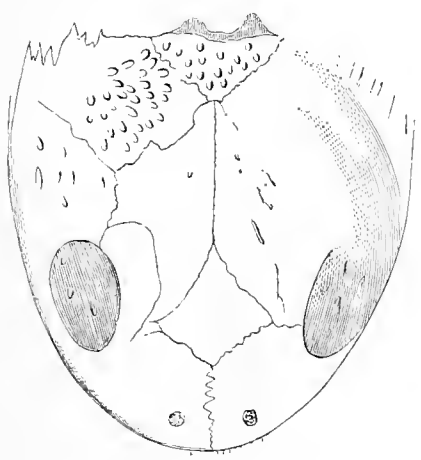
Journal Geological Society, London, 1853, p. 81.

In the form of the cranium this genus differs from Brachydectes and œstocephalus much as Menopoma does from Amphiuma. Two species appear to have left their remains in the coal measures at Linton, Ohio.

There is an internal as well as an external series of maxillary teeth in this genus, and a vomerine patch, according to Dawson. The skin was ornamented with osseous scales of an oval form, some of which were longer than others, and formed crest-like series along the side. In a specimen of the mandible of the D. acadianum, kindly sent me by Prof. Dawson, the inflection of enamel at the base of the tooth is readily observed, but it appears to be as smooth as in any other type of the Microsauria above the alveolar margin.

DENDRERPETON OBTUSUM, *Cope*

Fig. 1.



This species is known by a partially preserved cranium. The superior surface is exposed, the outlines of the jaws and orbits are well preserved, with the occipital condyles. The os quadratum is directed obliquely backwards, and the angle of the mandible extends to a line a little behind that of the occipital condyles. The zygomatic arch exists in a position similar to that in which it may be seen in a few genera of Anura, as Discoglossus and Pelobates. It extends downwards and forwards from the supra-squamosal to the maxillary region, but whether it is homologically squamosal or malar the specimen cannot show. The postorbital is present as well, and with the last, and the supratemporal, forms the bony roof of the temporal fossa. A piece which may be the pre and post frontals combined, borders the inner superior margin of the orbit, it widens posteriorly, where it has contact with the parietal, etc., and narrows in front. Supraoccipitals form together a broad triangle on the upper plane of the cranium, of less extent than the adjoining supratemporal. These elements are pitted, and towards their margins radiate grooved. These sculpturings grow less on the margins of the supratemporal, and the portions of the surface of the more anterior elements remaining, are so slightly marked as to give the impression that the sculpturing in this species is much less than in others of the genus. A few beaded ridges are all that remain on the parietals and postorbitals; the maxillaries have a slightly stronger sculpture seen in a few spots.

The general form of skull is elongate behind, and much shortened in front of the orbits. The orbits are thus altogether in front of a line equally dividing the cranium transversely, while in the D. acadianum they are in the middle of the skull. The outline of the muzzle in our species is then broad, rounded, as in the Menopoma alleghenicnsis, while in the latter it is ovate and produced. It therefore resembles also in its proportions the genus Herpetocephalus Huxl, from the Irish Coal Measures.

The parietal bones extend to opposite the posterior margins of the orbits, are then gradually contracted, and form an acuminate prolongation on each side the wedge-shaped frontals. The prefrontals are thickened on each side the front, behind the external nares. The sutures defining the frontals anteriorly, the nasals, and the premaxillaries behind cannot be made out. The median longitudinal suture is a marked and zigzag one, and can be seen as far

posteriorly as the anterior margin of the orbits. The external nostrils are large and opposite the inner margin of the orbit on each side. This separation of the nares is associated with a greater transverse extent of the premaxillaries than in some of the genera. These have been set with numerous teeth, judging by their small impressions; no larger ones have left traces, and no traces of any on the maxillaries. The teeth of the genera before described are all much larger relatively, indicating still further the diversity between them.

A fragment of mandible remains, but without teeth or external surface. It shows a large internal canal.

Measurements.	*Lines.*
Total length cranium,	25.5
Width do. three lines behind orbits,	24
Do. between orbits,	7.5
Do. do. nares,	5
Do. occipital condyles,	2.2
Do. of supraoccipital bones,	6
Do. of right parietal,	6
Extent of premaxillaries,	8.7
Length orbit,	6

From the Coal Measures at Linton, Columbiana county, Ohio. Discovered by Dr. Jno. S. Newberry. When the remainder of the skeleton of this species is known, its generic relations will be better established.

Another cranium accompanies the collection, which belongs to a species distinct from the last. The muzzle is not so broadly rounded and the premaxillary teeth are relatively much larger. The sculpture is more delicate with the ridges more acute. The orbits and nares are not defined. The maxillary is well preserved for a length of an inch; its teeth are smaller than the premaxilliries; I count four in a line; crown simple conic. External surface of maxillary not very strongly sculptured.

This species cannot be referred to its genus without further material. I therefore do not name it.

DENDRERPETON ACADIANUM, *Owen.*

Quart. Journ. Geol. Soc. X., 1853, 81. Dawson, Loc. Cit.
Coal Measures. Joggins, of Nova Scotia.

DENDRERPETON OWENII, *Dawson.*

Canadian Naturalist and Geologist, VIII., 161.
Coal Measures: as the last.

HYLERPETON, *Owen.*

HYLERPETON DAWSONI, *Owen.*

Journ. Geol. Loc. Lond. Loc. Cit. Dawson, Canadian Naturalist and Geologist, VIII., 272.
Carboniferous Coal Measures. The Joggins, Nova Scotia.

BRACHYDECTES, *Cope.*

Proceed. Ac. Nat. Sci., Phila., 1868, 214.

This genus is indicated by two rami of a mandible and a portion of a premaxillary only. These, when compared with those of Œstocephalus, and Dendrerpeton, from the same locality, and with others described by authors, are so much stouter, *i. e.*, shorter and more elevated, that they evidently belonged to a genus not hitherto known. The genus further differs from Oestocephalus, in having the teeth of equal size to the posterior parts of the series, that is, to the base of the elevated coronoid process. The teeth are elongate cylindric cones, with their acute tips turned a little posteriorly. The fractured ones display a large pulp cavity. The three premaxillaries preserved are similar, but without curvature of the tips. They do not exhibit striæ or any other sculpture.

So far as the remains known go, the genus is nearer Hylerpeton than any other. According to Dawson that genus is provided with a large canine-like tooth, at the anterior extremity of the maxillary, on the inner row, which is inserted into a distinct socket. No such tooth appears among those of this genus. The latter does not give any indication of the very elevated coronoid process of Brachydectes, though the external portion of the dentary bone in that region being lost, little can be said about it. Prof. Owen's plate indicates a ramus whose depth at the last tooth enters $8\frac{1}{2}$ times the total length. In our species this depth enters about 5 times.

BRACHYDECTES NEWBERRYI, *Cope.*

This species is represented by one nearly perfect ramus mandibuli, one dentary bone, and one premaxillary, probably not complete.

The dentary bone appears to have been attached by suture to the articular and angular, as its free margin has very much the outline of that suture in Amphiuma and lizards. The coronoid process would also seem to be a part of the same bone as in Amphiuma and Menopoma, and not composed of a coronoid bone as in lizards. It rises immediately behind the last tooth, and displays no suture.

The lower portion of the dentary is prolonged into an acute angle. This is separated by a deep and wide concavity from the superior posterior prolongation, which is obtuse and rises at once into the coronoid process. Teeth on this dentary seven; the same number is on the preserved ramus; this number is suspected to be complete or nearly so. The teeth terminate at the obvious termination of each ramus, which is, it is true, slightly obscured. These teeth are the longest of the Microsauria in relation to the depth of the ramus, equalling the largest in Œstocephalus. They are doubtless exposed, as are some of those of the last named genus, by the splitting away of the outer parapet of the dentary bone. As no traces of alveoli have been thus rendered visible, I suspect the dentition to have been acrodont, as in some existing Batrachia.

No external surface of the mandible remains, but there are no impressions of sculpture on the matrix. A little external face of the premaxillary displays none.

Measurements.	*Lines.*
Preserved length of ramus (imperfect),	11
Depth at last tooth,	2
Length of exposed tooth,	1.7
Length dentary,	7.5
Depth at coronoid,	3.5
Do. at first tooth,	1.3

In the mandibular ramus of the Hylerpeton dawsoni, there are according to Owen at least nine teeth; in the present species there are but seven.

SAUROPLEURA, *Cope*.

Proceed. Acad. Nat. Sci. Phil. 1868, p. 215.

This genus embraces a single species only, as I at present understand it. The extremities are well developed, and the body is stout and lizard-like. It is represented by but one individual which has been spread over a surface of the coal slate, exhibiting ventral armature, dorsal region with ribs, and anterior and posterior limbs. Of skull and caudal vertebræ nothing remains.

The dermal riblets are arranged as in Urocordylus, *i. e.* in parallel lines directed obliquely forwards and continuous on the median line, forming there a chevron directed forwards. The striæ are not so closely placed as in O. pectinata, but are separated by grooves wider than themselves.

The humerus, ulna and radius, are rather stout, and of a size relative to the body, as in common types of existing sauria; the ulna and radius separate. There is no carpus, but five well developed digits have phalanges in the following numbers, commencing on the inside, 3, 4, 5, 6, 5. The last phalange of the second is obscured, and it is not positive that the number is as given; it is more probable than that it should have been 3. The outer toe has been more slender than the others; the distal phalanges of all the toes are short conic, as in Salamanders. Thus this form differs much from Amphibamus, where the numbers are 3, 3, 4, 5, 4, showing a lower development of limbs.

The ribs are long and curved as in Reptiles, and judging by their distances the vertebræ are short; the latter are not well defined but there is no indication of prominent spines of any kind.

The pelvic bones and portions of those of the hind limbs are present, but so obscured and confused as not to be made out. Enough remains to show that the hind limbs are considerably longer than the anterior.

SAUROPLEURA DIGITATA, *Cope.*

Proc. Acad. Nat. Sci. Philadelphia, 1868. 216.

This species had a length of body about equal to that of a fully grown Chamæleo vulgaris of the largest size or of a half-grown Menopoma. Thirteen ribs on one, and several on the other side, are preserved; where they terminate, probably at the pelvic region, some small or rudimental ribs project from the two or three first caudals. Three ribs and their interspaces extend over five lines. The humerus is broken, but its length can be clearly made out to be seven lines; it has no condyle, and is dilated at both extremities. The ulna and radius are distinct, truncate, hollow, and dilated at the ends. Length of ulna 5.1 lines, distal width 1.8 lines. Carpus not ossified. The fourth toe is considerably longer than the others, the fifth is next and reaches the basal third of the antepenult phalange of the fourth; the third is very little shorter; the first is not quite so long as the first two of the third. The bones of the hind limb are not readily distinguished. They are evidently much longer and larger than the anterior; no part of a foot is preserved.

This form is probably allied to Urocordylus. It has relatively much stronger ribs in relation to the vertebræ than we have seen in that genus, and there is no evidence of the existence of the vertebræ characterizing the latter. The limbs are relatively much stronger than in Œstocephalus, and it lacks the peculiar dermal armature of that genus.

ŒSTOCEPHALUS, *Cope.*

Proceed. Acad. Nat. Sci. Phila., 1868. 218.

This genus is represented by a more complete series of remains than any other of the Linton bed.

As before remarked, it represents in many respects, the Ophiderpeton of Huxley, and has been alluded to by Dr. Newberry as allied to it. It however, differs markedly in the narrow lanceolate form of the head, with probable accompanying peculiarities of detail, and in the presence of limbs, which have not been found in the Irish genus. The form of the head is somewhat nearer that of Lepterpeton Huxl., but the remarkable form of the spines of the caudal vertebræ so characteristic of the American genus, are not found in Lepterpeton. In this latter respect it is allied to the Urocordylus of Huxley, recently discovered in the Coal Measures in Leinster, Ireland. It differs only in the presence of elongate lizard-like ribs and in the absence of "oat shaped scales" of the lower surfaces.

It is a matter of much interest in American Palæontology that this remarkable type should be found to occur in our Coal Measures. It was first announced by Dr. Newberry at the meeting of the American Association for the Advancement of Science for 1867. (See p. 144), as an ally of Urocordylus and Ophiderpeton.

The forms discovered by Dr. Newberry have an interesting relation to those of Ireland, such as types of the present period frequently present.

The characters of Oestocephalus are: neural and hæmal elements of the caudal vertebræ, elongate, distally, dilated and grooved, attached by contracted bases. Ventral aspect defended by a close series of oblique dermal rods on each side, which meet anterior-

ly on the median line. Limbs distinctly developed. Ribs long, well developed. Scales none.

In more detail, we have an elongate lanceolate head with little or no sculpture of the external surface of the bones. The angles of the mandibles are much prolonged backwards as in Apateon and frogs, and the well developed ribs commence but a short distance behind the head. The vertebræ are slender, and furnished with well developed diapophyses.

The neural spines of dorsal vertebræ in O. remex are flattened and expanded in the line of the vertebral column, and weakly grooved to their superior margin. Their character has not been observed in the other species.

The neural and haemal spines of the caudal vertebræ are prolonged, and remarkably sculptured by longitudinal grooves, which are most distinct towards their terminations. They are much flattened to support an oar-like tail.

Anterior limbs have been seen in two species, and posterior in one other. Though they all probably possess two pairs of limbs, this point is not entirely established, leaving the homogeneity of this genus still somewhat uncertain.

A pair of symmetrical bones whose impressions are seen posterior to the occipital bone appear to be the coracoid, and one of them is followed by a second element, which is probably the humerus. A third piece follows, which is ulna, or radius; the second bone of the forearm is lost, but some impressions, which appear to be those of a digit, are visible.

The skin has been occupied by a great number of closely packed, curved, spine-shaped scales. They have occupied the ventral integument, passing from the median line of the belly outwards and posteriorly, having acute tips which may or not have penetrated the skin on each side. No such tegumentary spines protected the dorsal region.

The three sculptured dermothoracic plates common to so many of this order, have not been seen in this genus.

As compared with Sauropleura, this genus is more elongate and snake-like, and with much weaker limbs; these characters are not sufficient to distinguish it alone, but as no dilated neural spines nor similar abdominal armature are discoverable in the former, I prefer to keep them separate for the present.

OESTOCEPHALUS REMEX, *Cope.*

Sauropleura remex, Cope. Proc. Ac. Nat. Sci., Philada., 1868, p. 217. *Oestocephalus amphiuminus*, Cope, l. c. p. 218.

Additional specimens received from Dr. Newberry enable me to combine the caudal vertebræ described as above under the genus Sauropleura, with the remainder of the skel-

eton which was the type of the present genus. The species thus constituted is represented by five specimens and their reverses, and a fifth may be added with much probability.

They indicate an animal of the average size of the Amphiuma means.

The extremities of the vertebræ are deeply concave, but the centra are so long as to prevent the concavities entering more than one-fifth of the latter, each. The diapophyses are behind the middle, and are broad, curved backwards, and acuminate as in Amphiuma. The centra have a prominent median line below, with a longitudinal concavity on each side. Five of them a little exceed an inch in length. Neural spines moderate. The humerus is longer than the coracoid, and is considerably dilated distally; the coracoid slightly dilated at its superior extremity. The dermal armature commences immediately behind the head, and forms a band of 14 lines in width; measuring across the spine-like scales, in a width of a line, four cylinders may be counted. The external portions are curved backwards, the interior nearly straight, those of the anterior series more delicate than the posterior.

The head is wedge-shaped, with regularly acuminate sides. The top of the cranium is somewhat broken in the specimen: the portions preserved are smooth, and the longitudinal suture is distinct for a considerable distance. The angle of the mandible is produced considerably behind the occiput, and is enlarged and rounded. The end of the muzzle is broken away, and the region of the orbits so fractured as to render their precise location uncertain. The superficial layer of the cranial bones is nowhere clearly visible, so that it cannot be ascertained whether it is sculptured or not. The quadrate bone projects well posteriorly. Some fragments indicate small cylindric teeth, as in Amphibamus, but they are not characteristic.

Measurements.	*Lines.*
Length cranium without muzzle.	17.3
Width do posteriorly,	11.5
Length of the coracoid,	2.1
Length humerus,	2.5
Length of sixth vertebra from skull,	3
Extent diapophyses,	3.5
Width centrum,	1.5

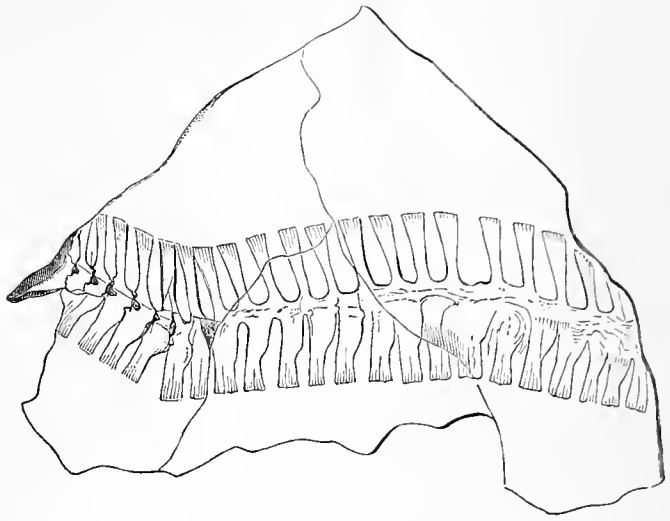
The characters of the genus are further shown by a part of another individual in the same coal slate matrix. The cranium and anterior portion of the vertebral column only are preserved, the latter so much injured as to render the vertebral characters very obscure. As in the other, the bristle-like scales extend along the dorsal region to near the cranium. The anterior $\frac{2}{3}$ of the ventral side shows a large number of oval scale-like bodies, which belonged undoubtedly to the animal, and were probably dermal scales. They are, however, neither regular in form nor position. Close behind the head two or three long bones of the fore limbs have been exposed. They are slender and similar to those of the last specimen.

The cranium, though without the muzzle, shows its long wedge shape. The maxillary bone cannot be distinguished, nor can the orbits be made out. One ramus mandibuli is pretty well preserved; it shows no coronoid process. Thirty-one teeth may be counted on a portion a little more than one-third its length. The anterior eleven of these are abruptly longer and stouter than the others. They are all, except a few most anterior, in pairs, *i. e.*, with a slight vacancy between every two. The larger ones where broken at the bases exhibit a moderate pulp cavity; the smaller, a large one extending to near the lip. Several, though not all of the larger teeth, display a shallow groove on the external face to near the tip, which is probably owing to pressure and a partial crushing. The points of the larger teeth are more abruptly acute, and turned abruptly backwards. A portion of their increased length (.35) is to be attributed to the splitting off of the external dentary margin, and the exposure of the roots. No alveoli are shown, and the dentition is probably by anchylosis of expanded base as in true Labyrinthodonts.

A third series, Nos. 26, 29, Mus. Newberry, of dorsal vertebræ is without head or limbs. The vertebræ are elongate, three of them extending over 2.10 mm. The neural spines are longer than high, and are nearly in contact at their margins; each is marked by about five obtuse vertical ribs. A fractured section of the abdominal dermal spines in place, displays at least six superimposed layers of them.

This species is larger than the O. pectinatus, and about equal to the Urocordylus wandesfordii Huxl. The caudal spines differ in the greater attenuation of the neural series, and the presence of a basal lamina on the haemal. The caudal region is represented by a portion of the vertebral column three inches in length. In this space may be counted twenty-four vertebræ. Such of the latter whose outlines are visible, display centra characteristic of the genus; their terminal concavities conic, with apices meeting in the centrum, medially; zygapophyses rudimental if present.

Fig. 2.



CAUDAL VERTEBRÆ, NAT. SIZE.

Characteristic of the species are the remarkable length and slenderness of the fan-shaped neural and haemal spines, and the absence of an acute serration on their margins. In this species the spines have a laminiform expansion at the base in their plane. In the other species here described these spines are not only relatively broader and more fan-shaped, but they are acutely serrate on the margin and constricted at the base.

In C. remex the dilate haemal spines are a little more than three times as broad distally, as they are long, while the neural spines are a little narrower. The haemal spines stand about the middle of the centrum. The basal half is furnished with an anterior ala, which leaves the anterior margin rather abruptly and extends to the next spine in advance. It returns gradually to the centrum and is separated from the articular face of the latter by a notch. A similar ala exists on the posterior margin of the haemal spine, which extends for a shorter distance above the base, and is narrower than the anterior. Each spine presents a median groove on its surface, which extends half way to the base or further; on each side of this are some three other grooves which extend but a short distance; surface otherwise smooth. The ends of the grooves slightly notch the truncated end of the spine.

The neural spines are on the posterior portions of the centra, and not in contact with the bases of those adjacent. They are without the dilatations of the haemal spines, and are directed rather more obliquely backwards. They are similarly grooved, though without that so distinctly median, seen in the haemal series.

Both neural and haemal spines become stronger towards the anterior part of the vertebral column. There appear to be no zygapophyses nor diapophyses, nor rudiments of ribs. The centra are rather stout and somewhat constricted medially. There are no traces of dermal armature of any kind.

Measurements.	*Lines.*
Length of a posterior centrum,	1.2
Depth do. do. do.	1
Length haemal spine of adjoining vert.,	4.4
Basal width,	1.4
Median width,	.9
Distal width,	1.1
Length of a more anterior haemal spine,	4.3
Distal width do. do. do.,	1.5
Length anterior neural spine,	4
Width do. do.	1.4

From the Coal Measures, the Bituminous basin at Linton, Columbiana County, Ohio, near the Ohio River. Prof. J. S. Newberry.

ŒSTOCEPHALUS PECTINATUS, *Cope.*

Sauropleura pectinata, Cope, loc. cit., 1868, 218.

This speeies is represented by portions of the vertebral columns of four individuals. In two of these, vertebral centra are discoverable, in one quite definitely. They are slightly constricted medially, and without ridge or process.

The neural and haemal spines of superior and inferior lines are similar, and in the specimens undistinguishable. The dilated portions form nearly equilateral triangles, which stand on moderately short pedicels. They are weakly ridged, and each ridge is prolonged into a narrow acute tooth, beyond the margin of which eleven may be counted on one of the best preserved. The longitudinal striae are terminated near the pedicel by two others which cross obliquely from each side and meeting present an appearance similar to an overlapping of each margin. The edges of the spines form a continuous line.

As in the other species, there are no indications of other processes, nor of dermal scales.

The smallest of the specimens shows that in front of the region furnished with the peculiar spines described, the body is furnished with a mass of bristle or hair-like scales. The grooved neural spines are slightly displaced anteriorly, and the bristle-like mass looks like a continuation of their striae, and it is not easy to find any line of demarkation between them. The serrate spines are further forwards on one side than the other. These linear scales were arranged as in other genera, in lines which converge forwards to the median line. They are somewhat obscured in the specimen, but it cannot be determined that they are continuous on the median line. Whether this is the posterior or anterior portion of the body cannot positively be determined from the specimen; it is, however, most likely the posterior, for near the posterior portion of the striate surface a weak pair of limbs is given off on each side. On the right, a moderately stout femur is followed by a broken tibia and fibula, and by five slender, closely oppressed metatarsals. The last are about 2-5 as long as the space between them and the femur: beyond them a few slender phalanges are moderately distinctly defined. The tibia is more distinct on the left, but no tarsus or phalanges; some of the metatarsals are preserved here also. Length of limb to end of metatarsals equal to five vertebræ in juxtaposition, measured along the edges of the neural spines. The limb has been slender, especially the hand.

The above specimen enables me to assign as the ventral armature of this species a closely packed series of V-shaped grooves which lie in connection with an obscure vertebral column, on the block containing one of the typical specimens of this species. They are not continuous with any of the series exhibited on other parts of the block: some of these at least are the doublings of the slender animal, and this ventral portion has been displaced. The grooves are like the impressions of haemapophysial rods, vastly more numerous however than the number of vertebræ; they are really the dermal armature. Huxley figures a portion of this as on the block with the Urocordylus wandesfordii, but does not refer it to a precise relation to the animal. A few well developed ribs are preserved with this portion, the only ones I can refer to this species. The vertebræ are partly enclosed in matrix, partly impressions. The neural spines, though expanded anteroposteriorly, are less elevated than in the caudal region, and have left no traces of their characteristic ribs or serration.

The number of spines in the type specimens is six in a half inch; in the smallest, just described, ten in the same distance. The height of the spine in the former 1.15 lines.

MOLGOPHIS, *Cope.*

Loc. Cit. 1868, 220.

This genus is established on remains represented by three specimens, which are two series of dorsal vertebræ, with ribs, and a series of caudals. One of the dorsal series embraces sixteen vertebræ, the other fourteen, the caudal series, twenty-two.

From its serpentine form this genus may be compared with the Dolichosoma of Huxley, though a close relation does not exist between them. In the Irish genus, the

series of caudal vertebræ is quite short, and the ribs are short and but little curved. In Molgophis the tail has been like that of an elongate serpent, and the ribs are as well developed as those of many reptiles.

Though no limbs or arches can be certainly found, a rather quadrate, parallelogrammic piece, about as long as the diameter of a vertebra, may be found. This is however very doubtful.

The characters of the genus are: a long serpentine body, without dermal armature, so far as discoverable; the vertebræ large and broad with very prominent zygapophyses and moderate neural spine, those of the caudals without narrowed bases (and grooved or serrate edges, most probably). Limbs and cranium unknown.

This genus differs from Urocordylus in its caudal vertebræ, and from Ophiderpeton in its dorsals: the latter in their zygapophyses projecting laterally resemble those of Amphiuma. It differs from Œstocephalus in the absence of ventral dermal bands and in the longer body, without indication of limbs. The size of the vertebræ would indicate a body of the size of a rattlesnake, (*C. horrida*,) and therefore too large for the species named Brachydectes *newberryi*.

The ribs are long, and though the head is not bifurcate, there appear to be both tubercle and head on the dilated extremity. They show themselves where crushed to have a large median vacuity.

MOLGOPHIS MACRURUS, *Cope*.

The neural arches viewed from above have a posterior V-shaped outline, from the fact that the broad zygapophyses meet on the median line, and spread out distally over the broad anterior ones adjoining. The latter appear to be somewhat concave, and to border the former exteriorly as well as inferiorly. The base of the neural spine extends to the posterior emargination, but not quite to the anterior. The breadth of the dorsal vertebra above is equal from the emargination behind to the anterior margin of the anterior zygapophysis.

The caudal series must have been very long, as there is very little diminution in the size of the vertebræ throughout the series preserved. They present much the same form as the dorsals, but are more contracted medially, and the zygapophyses have a more transverse direction. There may indeed be a diapophysial element beneath these, but the two cannot be distinguished if so. They are connected by longitudial impressions, indicating the existence of the tendinous bands in the longitudinal muscles seen in Amphiuma, or the osseous spicules in the same situation in birds. The neural spines indicated by their narrow bases, occupied the length of the neural arch, and remind one of Amphiuma.

The ribs are long for a Batrachian, but shorter than in a reptile. They are well curved, chiefly near the proximal extremity. The longest I can find measured by a chord, equals two vertebræ and two-fifths. Three vertebræ measured along the median line above equal eleven lines; one of these is 3.6 lines in width above: width of a (?) posterior caudal 3 l.

This animal has been like Amphiuma a snake-like Batrachian, but probably of even more elongate form. How near its affinities to this genus may be, cannot be ascertained, owing to want of important parts of the skeleton, but it differs in the important feature of the large, well developed ribs.

GNOCEPHALA.

COLOSTEUS, *Cope*.

This genus is proposed for Ganocephala, allied to Apateon (*Archegosaurus*) but differing as follows:

There are no traces of vertebral centra or spines, or of ribs, in portions of six individuals preserved. No sclerotic bones can be found in one cranium partially preserved. There appears to be two pairs of very short limbs. The usual three sculptured pectoral bones are present, consisting of a rhombic medial, and a pair of half rhomboid laterals. The abdominal region is protected by series of scales which extend obliquely forwards to the medial line, where they meet, forming chevrons. They are closely approximated, and are composed of rhomboidal scales which have a convex external and internal face, in transverse section, and which overlap at the extremities, and are in contact by faces which are oblique in both the longitudinal and transverse directions.

The exact form of the muzzle cannot be made out. It is, however, not elongate, nor yet of the broad rounded form of Pelion. Several teeth are preserved. There are two kinds, which occupy the margins of the maxillary and dentary bones. The anterior teeth appear to be longer than the posterior, though the latter are mostly broken off. Most of the teeth are coarsely incised sulcate for perhaps their basal half. Two long teeth behind their distal extremity of the dentale, are on the other hand very finely and sharply striate for their basal half; the tip is subcylindric, and very prolonged and acute. A small, dagger-shaped tooth near the base of one of the posterior, may belong to the successional, or to a small outer series. A series, of four elevated tooth bases, with a broken crown, of much smaller size than those of the jaws belongs to the vomerine or a palatine series. The row is single and uniform.

The superior face of the cranium is injured, but the component bones appear to have possessed a radiating sculpture of no great distinctness.

The form of the body seems to have been long and fish-like, with little contraction near the limbs. Caudal extremity is not preserved. There were probably two pairs of very weak limbs, of which three metacarpals of the anterior are preserved. A narrow longitudinal bone extends posteriorly from the lateral pectoral bone. Its extremity is broken, but a flat, narrow, longitudinal bone, with a dilated extremity curved outwards, may belong to it, or be the humerus. I find no distinct traces of branchial arches.

The affinities are thus obviously to Apateon, and it is not beyond possibility that future investigations may prove it is the same, though this is not probable at present.

Portions of seven individuals of one species, and of one individual of another, were discovered by Prof. John S. Newberry at Linton, Ohio. They differ as follows:

Pectoral bones with strong elevated radii and very weak reticulation in the centre of the median. The abdominal scales thick, many in a transverse series.

C. CRASSISCUTATUS.

Pectoral bones nearly as above; the abdominal scales slender, not more than three in a lateral transverse series.

C. MARSHII.

Pectoral bones—the lateral finely pitted, the pits becoming elongate towards the margin.

C. FOVEATUS.

COLOSTEUS CRASSISCUTATUS, *Cope.*

One of the specimens of this species consists of a supero-lateral view of a crushed cranium and anterior part of the body. The median pectoral bone appears as a sagittiform plate with thin edges, rounded lateral angles and a thin median prolongation behind. The greater part of the borders of the right orbit are distinct, and display the continuity of the malar and supratemporal regions. The ramus mandibuli is longer than the cranium proper. The number of the teeth cannot be determined, but they are rather large, and traces of their existence do not extend behind the orbits. The length of the long anterior mandibular tooth is .5mm., and the diameter at the base .1mm. Diameter of base of a superior maxillary .2mm. The approximate length of the mandibular ramus is .0715m. long; longitudinal diameter of the orbit 72mm.; length of median pectoral plate .036m.; width of same .019m.

Other specimens (Nos. 4 and 10 coll. J. S. Newberry) show that the abdominal scutellation commences immediately behind the pectoral bones. Those near the median line are similar to the external, and they unite in a zigzag line. The depth of these scales is oblique, and is somewhat greater than the width. Thus one angle projects, and gives the surface a somewhat ribbed rather than continuous character. The following measurements express their dimensions relative to other portions of the body.

	M.
Width of median pectoral.	.0138
Do. three pectorals restored,	.054
Do. scale band,	.064
Scales in .01m. transversely to series,	5.2
Do. longitudinally do.,	1.75
Radii of lateral pectoral crossed by .01m.,	7
Length ulna and radius,	.0108
Do. metacarpus,	.006

The above measurements express the small size and weakness of the fore limb. Another specimen (No. 18) in which the impressions of the scales are of the same size as those of the preceding, the impression of what may be femur and ulna and radius are visible, which are of considerably smaller size than the one above mentioned. They are but doubtfully these elements.

	M.
Length proximal element,	.004
Do. two distal do.,	.0038

A median pectoral plate of a seventh and much larger individual than the preceding is prolonged anteriorly and posteriorly. The broad posterior portion is transversely ribbed, the ribs weaker and interrupted medially. Length .063m.; with .04m.

This very interesting form is part of the unique and important collection made by Prof. J. S. Newberry, at Linton, Columbiana County, Ohio.

COLOSTEUS FOVEATUS, *Cope.*

A very elegant sculptured median pectoral plate represents this Batrachian. It is larger than most of those of C. radiatus, but smaller than the one last described. The posterior and median parts of the plate are pitted to the number of six in five mm. The pits are separated by sharply defined ridges. They elongate towards the anterior parts of the plate, resembling elongate hexagons, and the ridges approaching radii, though not more elevated than the cross septa. The bevelled margins are rugose also, except at the edges.

	M.
Length of the bone,	045
Greatest width.	.025
Width posterior margin,	.021

From Linton, Columbiana County, Ohio. Prof. J. S. Newberry, Coll. No. 20.

COLOSTEUS MARSHII, *Cope.*

Sp. nov.

This species is represented by a specimen of very much smaller size than either of the preceding. That it is not the young of C. crassisentatus is indicated by the peculiar form of the dermal ventral scales, and by the greater anterior prolongation of the median ventral dermal bone.

The specimen is lying on its back, displaying the ventral armature somewhat disturbed, and broken through in some places, where the vertebræ and ribs would be discerned if they existed. The head is turned abruptly to one side, and is apparently right side up. Several of its elements are scattered on adjacent portions of the block.

The head is of an elongate lanceolate form. The upper surface of the frontal bones is punctate-rugose in relief, with short radii towards the margin. The distal two-thirds of the mandible is narrow wedge-shaped; the external surface is coarsely pitted. There are no teeth preserved. The sutures of the cranial bones are of the squamosal type or fish-like.

The three thoracic shields are considerably displaced. The lateral are subtriangular, and are strongly ridged towards the inner margin. The median shield is short spatulate, the narrow portion directed anteriorly; the posterior rounded. It is coarsely pitted medially, and coarsely and strongly radiate ridged to the margin. Immediately behind these plates the dermal armature commences. It consists of elongate, narrow, subcylindric scales, which are arranged end to end, in series which meet on the median line, converging anteriorly, as in the other types here described. At first sight they resemble the long rod-like pieces of Œstocephalus, and careful examination is needed to detect the interruptions caused by the sutures of the scales. The latter are several times as long as wide, and appear to be terminated by oblique faces as in the typical species.

The trace of limbs is only seen in a short impression resembling that of a humerus behind the thoracic buckler. Nothing can be found pertaining to posterior limbs, but some laminæ and impressions in the position of pelvis, but not immediately connected with the other portions of the skeleton, may belong to the latter arch.

Measurements.	*MM.*
Length of body to buckler,	4.2
Width of ventral armature,	.8
Impression of humerus, (or coracoid,)	.2
Length median thoracic plate,	1·15
Width " " "	.51
Length fragment under jaw,	.75
Depth do. at middle.	.15
Width end muzzle,	.29

This species, like the preceding, is from Dr. Newberry's collection, (No. 13,) and from the Linton coal bed, Southeastern Ohio. I have dedicated it to Prof. Othniel C. Marsh, Professor of Palæontology in Yale College, Connecticut.

LABYRINTHODONTIA.*

DICTYOCEPHALUS, *Leidy.*

DICTYOCEPHALUS ELEGANS, *Leidy.*

Proc. Ac. Nat. Sci., 1856, 256, Emmons' Geology Nor. Amer. p 59. Tab.
Triassic Coal Beds, Chatham County, North Carolina.

BAPHETES, *Owen.*

BAPHETES PLANICEPS, *Owen.*

Quart. Journ. Geol. Soc. Lond., X., 1853, Tab. (XI notes.)
Carboniferous Coal Measures of the Joggins, Nova Scotia.

EUPELOR, *Cope.*

EUPELOR DURUS, *Cope.*

Mastodonsaurus durus, Cope. Proc. Acad. Nat. Sci. Philadelphia, 1866. 249.

A portion of the table of the cranium of a large labyrinthodont accompanied other fragments of the same in a bed of hard black shale, according to Wheatley's section of the Trias at Phœnixville, Pa., (in Silliman's Journal Sci. Arts, 1861, 45.) about 181 feet from the top of the series, while a tooth formerly described with it is from near 83 feet higher, in "the Plant bed." The Belodon comes from the same as the last.

The largest fragment is eight inches long and eight and one-half wide, and is a portion of the table of the cranium exhibiting the usual medial depression and embracing portions of the postorbital and parietal bones; one of the former is four inches six lines long; both are pitted medially (about 3½ pits in an inch) and marked with short coarse sulci posteriorly. The parietals are two inches nine lines wide behind, and four inches wide between the anterior parts of the postorbitals. On what is probably the posterior part of the interorbital region (a small part of the posterior margin of the left orbit is preserved) commence two smooth, shallow sulci 1 in. 2 l. apart, which are probably the posterior extremities of the superficial channels of the face of the Labyrinthodonts. Between them the surface is pitted (four or five to the inch). The parietal bones are throughout longitudinally sulcate (four and one-half to the inch), with obtuse ridges between. The parietal fontanelle was not discoverable, nor could the form of the orbits be certainly determined, though they were probably not large.

From the Triassic Red Sandstone near Phœnixville, Chester County, Penna. Discovered by Charles M. Wheatley.

Teeth subcylindric, with large pulp cavity at the basis only: external surface without grooves; dentine divided by numerous flat vertical laminæ of a dense substance, probably enamel, which radiate from very near the pulp cavity to the external enamel layer.

I have been much puzzled with the teeth which I described (*l. c.*) in the above language, as typical of this genus. Their constitution has been chemically altered, and the section exhibits the radii of a denser material which unites at right angles with a sheath of the same substance which envelopes the tooth externally.

The teeth are of various sizes, sometimes two inches long and more slender in proportion to the length than those of the Mastodonsaurus jægeri and salamandroides; they are cylindrical, gently curved and acuminate without external sulci: of the minute sculpture little can be said, but the casts of the surface are smooth. The roots exhibit a short conic pulp cavity. In a few weathered sections the denser radii are well displayed.

They are not convolute as in Labyrinthodonts, but perfectly straight and convergent to a minute central vacuity. In a tooth four lines in diameter there appear to be five principal radii, which though exceedingly delicate may sometimes be seen in longitudinally fractured specimens.

*The *Centemodon sulcatus* Lea which I referred here in my synopsis of Extinct Batrachia, Proceed. Acad. Nat. Sci., 1868, may be placed among the Thecodonts. I was induced to place it here by Lea's ascription of sulci and pulp cavity to the tooth, which I did not understand properly.

These I suspected to indicate the positions of inflections of enamel, as it is difficult to imagine such regularly radiating fractures. I cannot however, be entirely sure that this is the case. Under a low power neither the radii nor interspaces exhibit any structure; the small pulp cavity is filled with the sandstone matrix in which the tooth is enclosed. It may be supposed that the relatively denser structure of the enamel has been preserved in the slow alteration which the composition of the tooth has undergone. They thus project on weathered or ground surfaces.

The species to which these teeth pertain was originally described by the writer as a Mastodonsaurus. The latter genus however exhibits external grooves where the inflections of enamel enter and separate the dentine. These inflections, as is well known from the figures and descriptions of Professor Owen, are more or less convoluted, some of them very highly so. The laminæ of the teeth of the Eupelor cannot be looked upon as inflections of enamel, but rather as branches. They are exceedingly thin, and our sections do not demonstrate them to be double. If they are double, they are very much more attenuated than the external enamel stratum. They may be distinguished in a section of the wall of the pulp cavity at the base of the root as well as elsewhere.

The fluted tooth referred to in my original description, in which this structure is observable, belongs apparently to a Thecodont, perhaps to Belodon: other teeth of this genus which I have seen present the same peculiarity. As the tooth from which the description of Eupelor was derived, is from the same stratum as the Belodon and Clepsysaurus, and some distance above the horizon of the cranial bones described, after an examination of the series in possession of Wheatley, I am disposed to refer all these teeth to the Thecodonts, and restrict the name Eupelor durus m. to the cranial bones only.

Class II.—REPTILIA.

The following preliminary table exhibits the more essential characters of the orders of Reptilia, as understood by the writer:*

I. Supratemporal and postorbital bones present; extremital portions of limbs not differentiated; quadrate bone united by sutures.

ICHTHYOPTERYGIA.

II. No supratemporal or postorbital bones; extremital portions of limbs differentiated.

A The quadrate bone united by suture to the proötic, the opisthotic and the quadratojugal bones.

a The scapular arch continuous, including the sternum, which is anterior and simple.

ARCHOSAURIA.

aa Scapular arch not continuous, sternum inferior, extending posteriorly, composed of at least eight elements: dorsal vertebræ sacrum-like.

TESTUDINATA.

AA The quadrate bone not united with the proötic, and articulating freely with the opisthotic; no quadratojugal. (Streptostylica.)

Sacrum from three to five vertebræ; anterior extremities excessively elongated for flight; acetabulum complete; pubes longitudinal, distinct; exoccipital not distinct.

PTEROSAURIA.

*Many of these groups correspond with those proposed by Prof. Owen.

Opisthotic united with exoccipital; brain case not closed before proötics; palatines united all round; sacrum of two or one vertebra; pubes transverse.

LACERTILIA.

Opisthotic distinct and distally free from the cranium; brain case partly closed before proötic, palatines united.

PYTHONOMORPHA.

Opisthotic distinct, free from cranium except proximally; brain case nearly closed anteriorly, palatines attached behind only.

OPHIDIA.

ICHTHYOPTERYGIA.

Elements of the limbs beyond the humerus not differentiated, in indefinite number.
Postorbital and supertympanic bones over the temporal fossa.
Quadratum solidly united by suture with the proötic opisthotic and quadratojugal.
Sacrum none.
Pubes and ischia transverse and in contact. Neural arches free.
Premaxillary divided.

ARCHOSAURIA.

Elements of the limbs, of the pes and manus differentiated, in definite number.
" Postorbitals and supratemporals " of Owen wanting.
Quadratum immoveably united by suture with opisthotic, proötic and quadratojugal.
Sacrum of from one to six vertebræ.
Neural arches attached by suture in most.
Premaxillary divided.
Cranial walls cartilaginous anteriorly.
Palatine bones in contact with maxilliaries, and united by suture with them.
Circulatory System (known only in the Crocodilia). Heart with complete septum of the ventricles; a communication between aorta roots.
Nervous System (known only in the Crocodilia). Cerebellum with small lateral lobes and weak plicae.

TESTUDINATA.

Parts of limbs differentiated.
Dorsal vertebræ without mobility: no clavicle, a procoracoid continuous with scapula: ilium vertical, acetabulum complete.
Sternum not in connection with coracoid, composed at least of eight or more bilateral elements, and extending posteriorly to beneath the pelvis.

Teeth none.
Quadratum immoveably fixed by articulation with the large pro and opisthotics.
Cranial cavity not ossified anteriorly; no ali or orbitosphenoid.
Palatine bones attached anteriorly.
No postorbital or supratemporal elements.
Two sacral vertebræ: ischia and pubes more or less transverse, the latter sometimes not in contact.
Costal and vertebral elements usually united into a dorsal shield: dorsal corium ossified.
Circulatory and Nervous Systems, much as in Lacertilia.

PTEROSAURIA.

Limbs differentiated, one digit excessively elongated for aerial progression.
Postorbital and supratempoial roof wanting.
Sacrum of from three to five vertebræ.
Inferior pelvic elements distinct, the pubes set parallel, directed forwards and not joined.
Neural arches consolidated.
Palatine elements united; one premaxillary.

LACERTILIA.

The distal parts of limbs differentiated; no supratemporal or postorbital bones.
Quadratum not in contact with proötic, articulating freely with opisthotic; no quadratojugal.
Opisthotic sessile not distinct.
Sternum composed of but two elements, which are continuous with remainder of scapular arch.
Cranial cavity not ossified anteriorly to proötic.
Palatine bones solidly attached to maxillæ; a symphysis mandibuli.
Squamosal usually present; premaxillary usually single.
Limbs ambulatory, when present.
Sacrum of two vertebræ, when present; ribs single headed.
Neural arches not united by suture, chevron bones present.
Pubes and ischia transverse, united in pairs.
Circulatory System. Heart with imperfect septum atriorum, no communication between aorta roots.
Nervous System. Cerebellum without lateral lobes or plicae.

PYTHONOMORPHA.

Characters of skeleton as the preceding, except: opisthotic distinct, prolonged from the cranial walls as suspensorium of the quadratum.

No symphysis mandibuli.

Squamosal present; premaxilliary single.

Cranium with alisphenoid and parietal developed in front of proötic.

Limbs inflexible, natatory; sacrum none; chevron bones.

Neural arches not attached to centrum by suture.

Pubes and ischia wanting. (?)

OPHIDIA.

Characters of Lacertilia except: opisthotic free, distinct from the cranium except proximally, supporting quadratum; no squamosal.

Cranial cavity largely ossified anteriorly.

Palatine bones free from other elements except pterygoids.

No symphysis mandibuli.

Sternal and pelvic arches wanting; no limbs except rarely rudiments posteriorly; no sacrum.

Vertebræ united by double articulation; neural arches continuous with centra; no chevron bones.

Circulatory and Nervous Systems, in important features as Lacertilia.

ICHTHYOPTERYGIA.

ICHTHYOSAURUS, *Conybeare.*

Leidy says with reference to the species here described, "They have an affinity to *Ichthyosaurus* and *Eosaurus*, nor am I prepared to prove that they do not belong to one of these."

ICHTHYOSAURUS GRANDIS, *Leidy.*

Chonespondylus grandis, Leidy. Proc. Acad. Nat. Sci., Philada., 1868—178.

Humboldt Co., Nevada.

EOSAURUS, *Marsh.**

This genus, as suggested by Huxley, may be the type of a peculiar division of the Batrachia. There appears to be some probability of this being found to be the case, though present evidence is in favor of Prof. Marsh's location here.

EOSAURUS ACADIANUS, *Marsh.*

Amer. Jour. Science, xxxiv. 1862, 1 Tab. I, II.

Coal measures: Joggins of Nova Scotia.

ARCHOSAURIA.

This great order of Reptilia corresponds with the *Monimostylica* of Müller, without the Testudinata. The latter differ too much in the vertebral and sternal structure to be retained in it.

The important feature which characterizes the order, the close sutural attachment of the quadrate bone, may be readily understood by comparison of the accompanying figures of Nothosaurus from the Muschelkalk of Germany, and Mecistops intermedius Graves,† recent, from the Orinoco, with the plate of Clidastes propython, at the end of the volume.

The order embraces that large series of forms which seem to be equidistant between all the extremes of the Reptilian type. It therefore is not a strictly homogenous group; yet its subdivisions do not appear, with present knowledge, to be sufficiently marked, to render it proper to esteem them of equal value with the other orders here enumerated. This is a usual difficulty of classification; we express it, and do not remove it, by admitting the existence of a protean type in a genus of species, a family of genera, a class of orders, etc., etc. The suborders are as follows:

Limbs without flexible articulation; natatory; no femoral trochanters; no sacrum.
A procoracoid united with scapula; a distinct episternum.
Ribs single headed.

* The following species have been described by Leidy, who refers them to Reptilia with doubt, and says they may be fishes. As this point remains undecided, I can only allude to them here.

CYMBOSPONDYLUS, *Leidy.*

Proceedings Acad. Nat. Sciences, Philada., 1858.—178.

CYMBOSPONDYLUS PISCOSUS, *Leidy, l. c.*

? Triassic of Humbuldt Co., and of the Toiyabe Range, Nevada.

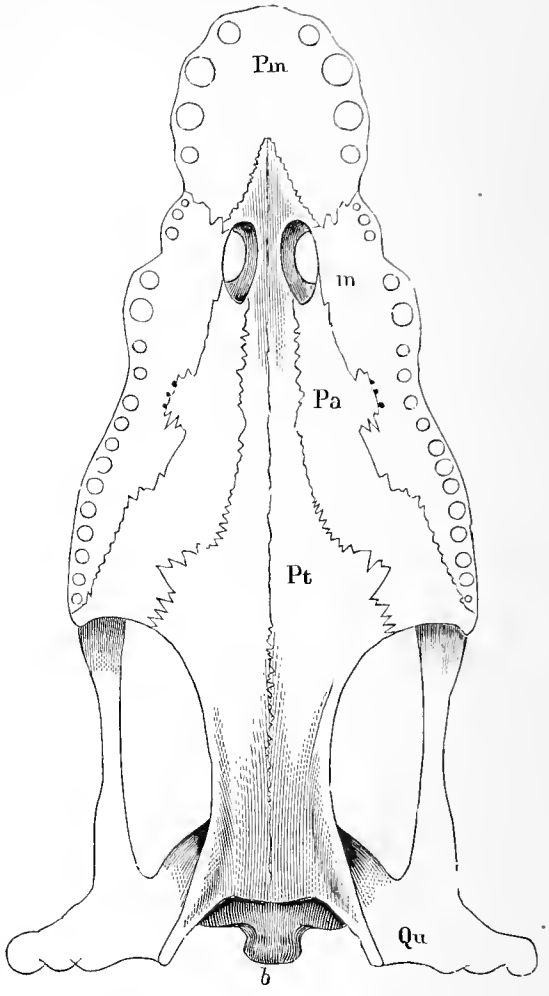
CYMBOSPONDYLUS PETRINUS, *Leidy, l. c.*

? Triassic; Humboldt, Nevada.

† This cut is taken from the type specimen of *Mecistops bathryhynchus*, in Mus. Academy. The Nothosaurus is the N. audriani or a nearly allied species. I am not quite positive that the number of alveoli on the maxillary bone is exactly correct.

Fig. 3.

Fig. 4.



NOTHOSAURUS ? ANDRIANI.

External nostrils posterior.
Pubes entering acetabulum, transverse, united medially.
Vertebræ with zygapophyses only.
Ribs single-headed. Chevron bones present.

SAUROPTERYGIA.

Fig. 5.

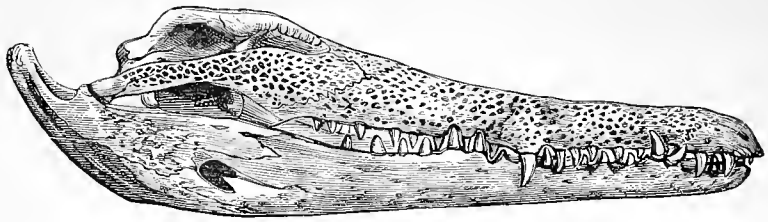
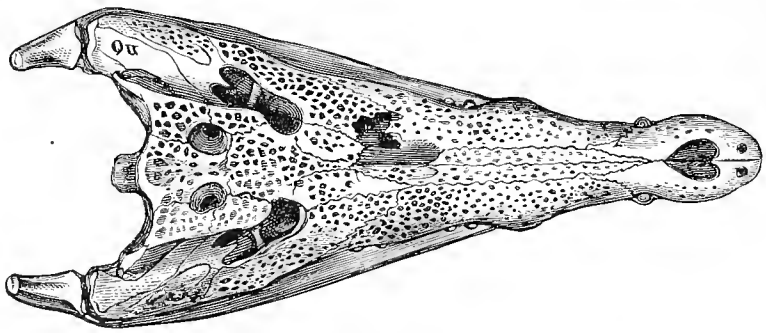


Fig. 6.



MECISTOPS INTERMEDIUS.

Limbs ambulatory, no third trochanter.
Sacrum of two vertebræ.
No procoracoid or clavicle.
Ribs mostly double-headed.
External nostrils anterior.
Pubes longitudinal, not entering acetabulum; free distally.
Zygapophyses only; chevron bones

CROCODILIA.

Limbs ambulatory; a third trochanter on femur.
Sacrum of two or three vertebræ; acetabulum entire; pubes united.
Ribs double-headed.
External nostrils posterior.
Zygapophyses only and chevron bones.

THECODONTIA.

Limbs ambulatory or prehensile.
Ilium horizontal, supporting a long sacrum of five or six vertebræ, the anterior derived from the lumbar series.
The acetabulum thrown forwards, and not complete, but perforate.

Ischium long longitudinal, posterior, supporting the pubis in front on a process.
Ribs free, double headed.
Neural arches united by suture; chevron bones present.

DINOSAURIA.

Limbs ambulatory.
External nostrils anterior.
Inferior pelvic elements in contact transversely, acetabulum imperforate.
Sacrum of six vertebræ.
Neural arches attached by suture.
Premaxillary single or double;
Teeth wanting or represented by a pair of tusks, or canines.
No columella. ANOMODONTIA.

Limbs ambulatory.
External nostrils anterior.
Inferior pelvic elements in contact transversely.
Sacrum of two vertebræ.
A columella.
Clavicle, episternum and xiphisternum present, united.
Chevron bones. RHYNCHOCEPHALIA.

The important modification in the mode of articulation of the quadrate bone, which characterizes this order has been overlooked in most of the systematic arrangements of the extinct and living Reptilia. The subordinate forms differ in important points, but the groups Sauropterygia, Thecodontia, and Crocodilia, appear to be related by a close bond, as for example the marine, the terrestrial, the Sphargid, and the Pleurodire tortoises. The extremities are modified for all modes of progression, except that of flight, in both; while as much gradation between these types is seen in one as in the other. In the characters of the anterior and posterior nasal openings, there is a great range in these types, but the transitions in these respects occur successively from Crocodilus to Teleosaurus,* to Belodon, to Plesiosaurus and Nothosaurus.

An important definitive character is found in several types of the Archosauria. The pterygoid bones are prolonged anteriorly between the palatines, and frequently as far as the vomer, completely separating the palatines. The latter then lie exterior to the pterygoids and between them and the maxillaries. When they bear teeth the latter form a series within and parallel to that of the maxillary bone.

This structure occurs in Sauropterygia, as Nothosaurus, (see fig. 4.) and in Rhynchoce-

*See Huxley on relations of Plesiosaurus to Teleosaurus, Journ. Geol. Soc. Lond.

phalia (Sphenodon Hyperodapedon.) I have not observed it in any of the Crocodilia, but the palatal roof of several genera of this order is unknown. No such structure is known among the Streptostylicate Reptilia.

This order appears first in time, in its Sauropterygian and Thecodontian representatives in the Trias, and in the genus Protorosaurus Meyer, even in the Kupferschiefer, a member of the Permian. At the same time it is the only one of the characteristically extinct types, which remains to the present day. This it does in the Rhynchocephalia and especially the Crocodilia, the most persistent reptilian type. It must also be observed that the Trias of Scotland has yielded a type (Leptopleurum), which Huxley refers to the Lacertilia.

SAUROPTERYGIA.

POLYCOTYLUS, *Cope.*

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

The animal thus indicated is of interest in American vertebrate palæontology, as the first true Plesiosauroid discovered within our limits. That its affinities are nearer to Plesiosaurus than to Elasmosaurus will be apparent from the following description.

There are wholes or portions of twenty-one vertebræ, of which but two retain their neural arches, and six are represented by neural arches only. Four centra may be referred to the caudal series, the remainder to the dorsal; there is nothing to indicate the characters of the cervical vertebræ. All of these vertebræ, except the distal caudals, are remarkable for their short anteroposterior diameter and deeply concave articular faces. This concavity is not however of an open conic form, as in Ichthyosaurus, but is flattened at the fundus, thus exhibiting a small slightly disciform area. The usual pair of venous foramina appears on the under side of the centum. The neural arch is continuous with the latter, and exhibits no trace of connecting suture. The diapophyses arise from the neural arch in all the dorsals; they are compressed and vertical in section. The arch is of course narrow anteroposteriorly, and presents a pair of moderately prominent zygapophyses in each direction, the posterior as usual articulating downwards, the anterior upwards. On some of the vertebræ they become closely approximated. The neural spines are narrow anteroposteriorly, but much stouter transversely than in Elasmosaurus; they are strongly grooved at the base, both anteriorly and posteriorly, most so posteriorly.

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

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

Of the phalanges there are individuals from three series. Portions of flat bones, perhaps, belonging to the pelvic arch, indicate, as do all the other pieces, that the bony structure in Polycotylus is more massive than in Elasmosaurus, if the only known species

has not attained such huge dimensions as some of the latter. These fragments do not throw much light on the structure of the pelvic arch.

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

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

First; the deeply biconcave, and very short vertebral centra.

Second; the tibia broader than long, resembling those of Ichthyosaurus.

Third; the coalescence and depression of some of the cervicals.

Fourth; the continuity of the neural arches.

Fifth; the continuity of the diapophyses of the caudals.

The only genus with which this genus compares nearly, is the Thaumatosaurus of Meyer. This is known but by a few fragments, and of these, but few are present in the Kansas animal. The character on which I rely at present to distinguish them, is the much less concavity of the dorsal vertebræ in Thaumatosaurus. This is however, not entirely satisfactory. Thaumatosaurus oolithicus Meyer is from the lower oolite of South Germany.

The bones are thoroughly mineralized, and the adherent matrix is a light yellow chalky limestone, similar to that which yielded the fine fragments of the Macrosaurus proriger. This, Dr. Leconte informs me, is probably Meek and Hayden's upper Cretaceous No. 3, and is a higher horizon than that near Fort Wallace from which Dr. Turner procured the Elasmosaurus platyurus. The specimens were all taken out under the direction of W. E. Webb, of Topeka, from the same spot; from every point of view there is reason to believe that they belong to the same animal.

POLYCOTYLUS LATIPINNIS, *Cope*.

The anterior dorsal vertebræ have the centra slightly compressed or vertically oval, while the posterior are more rounded. The anterior caudals appear to have been round or nearly so; they are somewhat distorted by pressure. The sides of the centrum are slighly concave in the longitudinal direction; below, there is no carina, but at least two venous foramina. There is another large foramen on the side of the centrum, usually not far from the neural arch; there are usually other smaller foramina below this. The bases of the diapophyses are longitudinally grooved behind, and separate a concavity of the arch in front of them from one behind. In the most median, the most elevated diapophysis stands about equally on the neurapophysis and the neural spine above it. The diapophysis are vertically compressed, and the costal articulation of the only one preserved, is in the same plane. The margins of the external surfaces are not coarsely striate as in many Sauropterygia. The venous foramina of the distal eoössified cervicals are in pairs, and of a large size. In the proximal caudals the diapophyses are above the middle of the sides of the centra. In one the basis of a chevron is preserved. It is cylindric and striate. The zygapophysis

on the hinder aspect of a dorsal has a discifonn articular surface directed ontwards and downwards: the prominence of its upper face is continuous with the lateral ridge of the neural spine. The anterior uplooking surface is equally small and little divergent.

	Inches.
Vertical diameter centrum dorsal,	3.42
Transverse " " "	2.7
Antero-posterior diameter centrum dorsal, (below,)	1.85
Vertical diameter centrum dorsal, (poster,)	2.98
Transverse " " "	2.9
" " neural canal,	.86
Longitudinal diameter base neural spine,	1.22
" " " diapophysis	1.2
Length between extremities zygapophyses, (dorsal,)	2.26
Depth of cup of vertebræ,	.63
Length centrum anterior caudal,	1.73
Distance between bases chevron bone, (caudal,)	2.58
Length two coossified caudals,	2.5
Width anterior in front,	1.7
Depth " "	.9

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

The portion of ilium preserved is an extremity. It is flat on one side and convex on the other. The shaft is solid. The articular extremity is oblique, and presents a truncate extremity, which is at right angles to a short recurved margin, which has been an insertion or articulation; the flat surface is rugose distally. Long diameter of extremity, 2 in. .75; of shaft, 1.9 in. The articular faces of the extremity of the femur are at an open angle with each other, and are strongly concave in transverse section. The femur is here very flat, with narrow margins: it becomes stouter with diminishing width. Distally the surface is marked by grooves and small foramina. What may be tibia is the basal frustrum of a wedge; the articular faces broad, the outer margin narrowed; the faces slightly concave. The inner margin is shorter than the outer, and the distal part of it presents a broad articular face. Some of the tarsal bones have been already described. There are thirteen metatarsals and phalanges. They are of stout proportions and are considerably constricted medially. Those of one series are square in section; those of another, transverse; those of the third transverse with one edge thinned or acuminate in section. Some of each form are more elongate than others.

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

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

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

William E. Webb of Topeka discovered the specimens on which this species rests, and liberally forwarded them to me for examination and description.

ISCHYROSAURUS, *Cope*.

Ischyrotherium Leidy. Trans. Amer. Philos. Soc, 1860, 150.

This genus has been referred by Leidy to the Mammalia, and to the order Sirenia, with doubt. Having access to a part of the remains on which it was established, I have arrived at the conviction that it really represents an aquatic Saurian more or less distantly related to Plesiosaurus. My reasons for regarding it as Reptilian and not Mammalian are: first, the articulation of the neural arch with the centrum; second, the absence of epiphyses; third, the absence of articulation for the head of the rib on the centrum; fourth, the lack of tuberculum on the ribs.

With respect to the first of these characters, it may be remarked that it never exists in mature Mammalia, and disappears at an early period of the development of all, except in certain seals and the Echidna, where the consolidation of the neural arch is a little delayed. As to the epiphyses, there is no trace of their suture to be found on fractured surfaces, supposing their existence to be indicated by the series of foramina extending on the inferior surface of the centrum near each articular extremity. These foramina are, I believe, merely the ruptured coarse cells, which can be found near the articular faces in the vertebræ in all Sauropterygia. They are unusually small in this genus, appropriately to the denser structure of the bones as compared with other sea saurians. The articulation of the rib takes place at the extremity of a long diapophysis, and there only, there being no pit for the *capitulum*. This does not occur in Mammalia, but is highly characteristic of the lower groups of the Reptilia, especially the Sauropterygia. The lumbar series in Cetacea presents a somewhat similar structure. The vertebræ in question are referred by Leidy to this position, but they are clearly median dorsals, from the elevated position and length of the diapophyses. The simple form of the ribs, some of which are from the same part of the column, is quite unknown among Mammalia.

There are other significant characters of less value, which point to the saurian affinities of this genus, and confirm the preceding. These are the very small size of the neural canal, the cylindric or thickened form of the neural arch, and the strong venous foramina

penetrating the centrum, which, though not wanting in such mammals as Basilosaurus and its allies, are neither so numerous nor situate so near the neural arch as here. (See Leidy's fig. 11.)

The ribs, as remarked by Dr. Leidy, are remarkably dense. He observes that "from the solidity of structure and cylindroid form of the ribs, I suspect *Ischyrotherium* to be more nearly allied to the Manatee than to any other animal." This consideration does not affect the affinities here accepted as true. The structure is remarkable, and differs from that of Manatus and Squalodon much as Reptiles do from Mammals, in its homogeneity, or when interruption of the same occurs, in its appearance as irregularly disposed cells, and in the lack of a concentric structure of any kind. In the Mammalian genera in question, as well as in Basilosaurus* this concentric structure is eccentric in relation to the circumference of the rib.

The genus Mesosaurus Gervais, according to plate XLII of his Zoologie et Palæontologie Generale (the letter press has not yet reached me), presents ribs of similar form to those of Ischyrosaurus, but whether of similar structure I cannot ascertain.

Leidy concludes his description of this genus with the following remarks: "Although I have supposed the remains * * to indicate * * an animal allied to the Manatee, * * I have suspected that they have belonged to an aquatic reptile unlike any known." * * Entertaining the opinions that I do respecting the relations of the genus, I have thought that the name applied by Leidy, which is appropriate only to a mammal, should be changed. I therefore call it Ischyrosaurus, maintaining the first etymology so far as practicable.

I refer it to the Sauropterygia, as the parts resemble Plesiosaurus more nearly than those of any other American genus. The density of the osseous structure and the cylindric form of the ribs, will distinguish it from Plesiosaurus; from Polycotylus the form of the vertebræ separates it at once.

I suppose that this type may have been of estuary habits, and took its food in proximity to land. The density of the bones is not known in, nor is it appropriate to, animals of the open ocean. The presence of Hadrosaurus (Thespesius) occidentalis in the same beds, is further evidence of the proximity of land.

ISCHYROSAURUS ANTIQUUS, *Leidy.*

Ischyrotherium antiquum, Leidy. Proc. Ac. Nat. Sci., Phila., VIII, p. 89. Trans. Amer. Philos. Soc. 1860, 150 Tab. X, figs. 8-17.

The dorsal vertebræ of this species present plane articular extremities. The centrum is not constricted medially, but presents a shallow concavity round its median portions. The sutural articulation of the neural arch is shallow, sub-ovate, and extends throughout the length of the centrum. The diapophyses are compressed cylindric. The

* See Owen on this genus.

articular face is a transverse oval. The size of the animal is similar to that of the Plesiosauri of medium dimensions, perhaps ten feet in length, admitting elongate neck and tail, of which there is no evidence.

Position.—Bed Q. Hayden's Section of Great Lignite basin of Nebraska. (Trans. Am. Philos. Soc., 1860, 135.) perhaps of the Cretaceous age; from the Moreau River.

PLESIOSAURUS, *Conyb.*

I refer the following species to this genus provisionally, and with doubt.

PLESIOSAURUS LOCKWOODII, *Cope.*

This reptile is represented by but few remains, which are in the private collection of Dr. Samuel Lockwood, of Monmouth County, N. J. A single dorsal vertebra, which he kindly lent me for description, presents characters which are so marked when compared with other marine Sauria as to require notice.

The centrum is of the general form of Plesiosaurus and Cimoliasaurus, and the arch has a sutural attachment as in the former. The suture is the surface of a sub-round pit, almost like that of Ichthyosaurus, and not like that typical of Plesiosaurus, or the young of Cimaliosaurus magnus. In the latter the suture is an oval concavity which extends throughout the length of the centrum. The pit in this species measures little more than one-third the length of the centrum. The floor of the neural canal is quite flat. The sides of the centrum are strongly and regularly concave, rather less strongly below than laterally. The margins flare regularly, and are not striate grooved or ribbed as in many species. There is a strong venous foramen a short distance below the neural arch and two medially below.

The species is further characterized by the regularly concave articular faces, without median plane or prominent portion, as in Cimoliosaurus species. They are more concave than those of the Elasmosauri also. The form of the surface is entirely circular.

	In.	*Lin.*
Width articular surface,	2	8
Depth " "	2	7.8
Width pit neural arch,		8.4
Length centrum,	1	11.6

This species I have dedicated to its discoverer, Dr. Lockwood, who has contributed in various ways to the progress of Natural Science.

It is the earliest sea saurian from this country, as it was derived from the clays which underlie the lower green sand bed. It was dug from a brick clay pit near Matteawan, Monmouth County, N. J.

CIMOLIASAURUS, *Leidy.*

Cimoliasaurus and Discosaurus, Leidy. Proceed. Academy Nat. Sci., Phila., 1851, 325—1854, 72, tab. ii, figs. 4, 5, 6, and 1851, 326; Cretaceous Reptiles, 22 and 25, tabs. IV., V., VI. *Brimosaurus* Leidy, Pr. A. N. Sci., Phila., 1855, 472.

This genus has been chiefly illustrated by Leidy, who has described remains of its species from the cretaceous deposits of many of the States east of the Mississippi. It has remained for the discovery of Elasmosaurus to prove that the two supposed genera named by Leidy, are really one, his supposed caudals of *Discosaurus** being really caudals of Cim-

* This genus was originally proposed on two vertebræ from Georgia, and a vertebra from New Jersey described by Dekay. He afterwards added vertebræ from Alabama, Mississippi and New Jersey. Some of these were regarded as cervicals; they are, however, anterior caudals. As Leidy observes, there are several species among them, and it may be, several genera, but as the genera cannot be distinguished by the caudal vertebræ, it appears to me that *Discosaurus* cannot be preserved. While distinguishing the genus from Cimoliasaurus, Leidy adds, "The supposed caudals of Discosaurus I have suspected to be anterior cervicals, notwithstanding the apparent provision for the articulation of chevron bones. If all the vertebræ 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.*" In case of their identity, it may be observed, Leidy refers them all to *Discosaurus.* Cimoliasaurus was, however, proposed first.

oliasaurus, the supposed caudals of the latter proving to be its cervicals. Characters distinguishing it from Plesiosaurus have never been pointed out, and it is here retained apart from it on the supposition that its scapular arch is constructed on the same principle as that of Elasmosaurus, a point, however, which has not been ascertained.

This genus is not as well known as Elasmosaurus, owing to the fragmentary condition in which it is usually found. Its marked character is its short depressed cervical region, as compared with the excessively long and compressed one of Elasmosaurus. It also differs from it in the apparent continuity of the series of diapophyses from the dorsal to the cervical series. In Elasmosaurus these processes are wanting on the anterior dorsals. They are very elongate on the other hand, on the posterior dorsals of Elasmosaurus; in Cimoliasaurus we have as yet no evidence as to their length, as they are broken in our specimens.

Fig. 13.

Fig. 14.

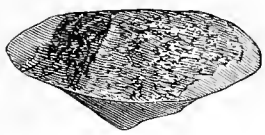


Fig. 15.

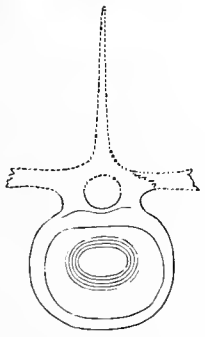
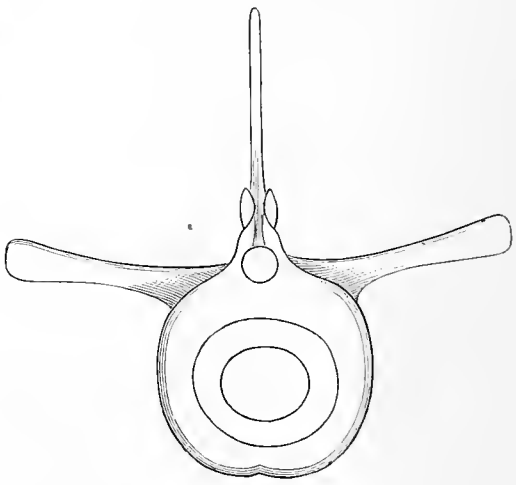


Fig. 16.



The rapid diminution in dimensions of the cervical series in Cimoliasaurus indicates a short neck, and far less slender general form. Leidy suggests from the absence of sacral characters, that posterior limbs have been probably wanting in this genus: the same vertebral characters are seen in Elasmosaurus, but it has a large pelvic and scapular arches; the presence of limbs in it cannot be doubted. The femur of Cimoliasaurus is described below, and is the only limb bone yet assignable to a species of this genus. It resembles that of Plesiosaurus. It is thicker and shorter however than in any species of the latter genus, and is quite short. The distal extremity is thick, and presents pits for the attachment of the articular cartilage; the faces for both ulna and radius are extensive, and indicate a large manus and elongate limb. The rotundity of the head indicates extensive rotation; and we may be satisfied that the animals of this genus were furnished

with powerful propelling flippers. The preceding cut illustrates its form and size in relation to the posterior dorsals from nearly the same position in the C. magnus and Elasmosaurus platyurus.

The general characters of the cervical and dorsal series are very similar to those of Elasmosaurus, but they all exhibit considerably larger neural canals. In the immature individual, the neural arch of the dorsal vertebræ is not coössified, but is separated by suture as in Plesiosaurus.

That there are several species of this genus is suggested by Leidy, and seems probable to the writer. As one of these has been already named, the characters of those which appear distinct may be pointed out.

Anterior caudals, articular faces with rounded margins; antero-posterior diameter greater, 2 in., width, 2 in. 7 l. Pit of diapophysis 1 in. 3 l.

C. VETUSTUS.

Anterior caudals, articular faces with acute marginal angle, antero-posteriorly shorter 1 in. 7 l. by 2 in. 6 l. in width; pit 11 l. Cervical with straight sides and broader form; width 31.2 l. by 24.5 long, the ?diapophysis narrow and stout.

C. MAGNUS.

Anterior dorsals shorter and higher than in C. magnus, the posterior cervicals, therefore shorter than in the same; diapophysis of first dorsal longer.

C. GRANDIS.

Posterior cervical with neural canal as large as C. magnus, but centrum four times as large, and a strong longitudinal ridge half way between pleurapophysis and neural arch, giving pentagonal section: 45 l. long by 52 l. wide; hence longer.

E. ORIENTALIS.

CIMOLIASAURUS VETUSTUS, *Leidy.*

Discosaurus Leidy, Proc. Acad. N. Sci., 1851, 326. Cretaceous Reptiles, N. A., 22. *Plesiosaurus*, DeKay Ann. Lyc., N. Y., 1828, 165, Tab.

If the vertebræ from Alabama from Jos. Jones, described by Leidy in the Cretaceous Reptiles as No. 1, are typical of this species, they present certain peculiarities which distinguish them from those of an individual of C. magnus which I describe below; perhaps the species are distinct.

Cretaceous Alabama, ? Mississippi and ? New Jersey.

CIMOLIASAURUS MAGNUS, *Leidy.*

Pr. A. N. S., Phila., 1851, 325, 1854, 72. Cretaceous Rept. N. A. 25, tab. 00.

This species has hitherto been known from vertebræ only. In connection with vertebræ of this species, I procured a long bone which has a near resemblance to the femur of Plesiosaurus. It indicates a paddle for motion in the water, as has already been mentioned.

The distal breadth is equal to $1\frac{3}{5}$ the length. It is distal compressed, but thick and with rounded margins. The proximal portion is slightly reverted to the condyle, and compressed nearly at right angles to the distal extremity. The condyle is flattened convex and oval in circumference. The tibial and fibular articular faces form a strong angle with each other, and are pitted rugose for the cartilaginous articulation.

	In.	*Lin.*
Distal breadth,	4.	9.
Breadth at neck,	2.	8.5
Diagonal across condyle,	3.	
Length,	9.	11.

It is seen, therefore, that this bone is remarkably robust, much more so than in the Plesiosauri of adult age. That the individual to which it pertained is not mature, appears from the dorsals accompanying, in which the neural arch is not fully ossified to the centrum. We can regard the species as a robust and powerful animal, in which bulk is more prominent than length.

	In.	*Lin.*
Anterior dorsal, length centrum,	2.	5.1
Width do.,	3.	7.
Depth do.,	2.	10.
Length articulation for neurapophysis,	1.	11.
Width do. do.,	1.	1.

The centrum is much constricted medially and the diapophyses are given off from the neurapophyses, the lower margin corresponding with that of the bottom of the neural canal. This specimen is from Barnesboro, and was submitted to me by Prof. Cook, State Geologist.

Locality: the Cretaceous Green Sand of New Jersey; upper bed.

CIMOLIASAURUS GRANDIS.

Brimosaurus grandis, Leidy, Proceed. Ac. Nat. Sci., 1854, 72; tab. I., II.

From Cretaceous of Clark County, Arkansas (near Greenville).

I have not seen any part of this, the largest species. It is, from Leidy's figures and description, distinguished by the relatively greater width and height of its vertebræ, and has been therefore a shorter and more massive animal than its congeners. As nothing beyond Leidy's description is known of it, I append the latter.

It was represented by vertebræ from near Greenville, Clark County, Arkansas. They had been kindly loaned by W. T. Roberts, an agent of the Arkansas Mining Company, who had discovered them with numerous others. Dr. L. stated that, in his visit to St. Louis, Mr. Alb. Koch, the industrious collector of fossil remains, had exhibited to him a collection of bones from the same State, and apparently of the same animal, which he was on the eve of sending to Berlin. The specimens are remarkable for the robust transverse processes, which project laterally from the lower part of the body, and terminate in a large facet for the articulation of a rib. The bodies are cylindroid, and are terminated by slightly concave or nearly flat articular surfaces. The sides of the body are moderately concave, and have an acute margin at the articular surfaces. On each side of a median prominence of the under side of the body a large vascular foramen exists. These vertebræ resemble those of Cimoliasaurus magnus from the

green sand of New Jersey, described previously in the Proceedings of the Academy of Natural Sciences, but in that the large transverse process is cylindrical, while it is compressed cylindroid in the Ark. saurian, and probably the latter belongs to a distinct genus, for which the name Brimosaurus is proposed. The bones are imbedded in a hard limestone with mollusca, and they probably belong to the cretaceous or to the eocene period. One of the most perfect of the vertebræ presents the following measurements:

	Inches.
Length of the body,	$3\frac{3}{4}$
Depth articular surfaces,	5
Breadth do. do.,	6
Length of the neural arch,	3

Dr. Leidy proposes to consider this species as the type of a genus distinct from the present, because its diapophyses are compressed in section, while those of Cimoliasaurus are cylindroid. I think this difference depends on the position in the vertebral column. These processes descend on the anterior part of the column and become more flattened, until they resemble diapophyses of ordinary cervicals. This vertebra therefore was an anterior dorsal.

ELASMOSAURUS, *Cope.*

Leconte's notes on Geology of the route of the Union Pacific Railroad, 1868, p. 68. Cope, Proceed. Acad. Nat. Sciences, 1868, p. 92.

This genus has been more completely preserved to us than any other American representative of the order, and hence may be accepted as most clearly expressive of its characters. In the interpretation of these, however, considerable difficulty has been experienced, as the structure form appears, at first sight, to reverse to a remarkable degree, the usual proportions of known reptiles.

The determination of the anterior extremity of the vertebral column has been rendered certain by the fortunate completeness of the cervical series, as the extraordinary length of the latter, equalling three times that of the body, renders the most careful scrutiny necessary.

The neural arches are every where continuous with the centra, without sign of suture, and are externally plane. The neural canal is exceedingly small for the size of the vertebræ, especially on the lumbars and caudals.

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

The cervical vertebræ are not only more numerous, but become anteriorly much smaller and more attenuated than in its allies of the same family. They are remarkably com-

pressed, the centra much longer than deep, and deeper than wide, and with smooth concave sides.

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

Most of the cervicals possess two venous foramina below; the dorsals two, and most of the caudals one.

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

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

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

The pelvic arch is more extended than the scapular, and strongly resembles the pelvic arch of other Plesiosauridæ. The scapular arch is peculiar; the clavicuti are broad flat bones resembling the pubes of certain tortoises, while the coracoids are much like the coracoids of Plesiosaurus.

The scapular arch is remarkable for the resemblance of coracoids to those of Plesiosaurus. The clavicles have a greater transverse extent than the former, and have a very extensive line of union medially, and a narrow posterior prolongation which meets a similar anterior one of the coracoids, separating the intervening foramina. They appear to form about one third of the walls of the glenoid cavity, and have a constricted base as in some Plesiosauria, applied to the extremity of the coracoid. The form of the glenoid cavity cannot be readily ascertained from the absence of the scapula. What we have of

it would suggest the existence of a fore limb, of comparatively little power, though no remains of such have been found. The acetabulum is smaller than the glenoid cavity; this point, with the obvious source of propulsive power in the tail, renders it probable that the posterior limbs were the weaker of the two, if any existed. But there is no trace of sacrum nor of any modified diapophyses for support of an ilium.

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

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

The question as to the presence of *posterior limbs* remains unsolved. Dr. Turner having made a second careful search, and renewed excavations at the original locality, failed to find any bones which can be assigned to humerus, ulna, radius, carpus or phalanges, or similar elements of the hind limbs. This is the more remarkable, as the pelvic and scapular arches were further completed, and an additional number of ribs obtained. The inferior and lateral regions of the trunk, being then so abundantly discovered, what are we to think of the entire absence of the usually numerous elements of extremities? The glenoid cavity is a rather angular cavity, and both were filled with solid argillaceous matrix. The acetabula are not cup-like, but merely exposures of the marrow, plane extremities of the pubes and ischia; they were covered with thin layers of gypsum; the pieces of the ilia were found imbedded in the mass of matrix which occupied the pelvic arch.

The allied genus Cimoliasaurus Leidy possesses a femur, as described under head of that genus; it is of shorter and thicker form than in most Plesiosauri.

The skeleton so nearly complete would indicate no violent disturbance of the carcass; but if there were, it would be an unusual accident that all of the four limbs should have been removed from their sockets, without leaving even fragments.

This genus is well distinguished from Plesiosaurus by the peculiarity of the scapular arch. The mesosternum appears to be coössified with the claviculi, and the three elements form a broad breast-plate. If the clavicnlus was ever united with the scapula as in Plesiosaurus, no evidence of it can be seen in the specimen. Both the clavicular and mesosternal elements are broader and more extended anteriorly.

The American genera of Elasmosauridæ may be compared as follows:

Posterior cervical vertebræ without diapophyses: cervicals longer, compressed, neck very elongate.

ELASMOSAURUS.

Posterior cervical vertebræ with diapophyses: cervicals quadrate, shorter, depressed, rapidly diminishing in size, hence the neck shorter.

CIMOLIASAURUS.

Prof. Owen figures and describes (Reptiles of the Cretaceous, Palaeontogr. Soc.) a vertebra which very closely resembles the cervical of Elasmosaurus. He considers it to be the cervical of a peculiar Plesiosaurus, which he calls P. constrictus, remarking, at the same time, its remarkably inferior pleurapophyses. This I believe to be a species of Elasmosaurus or an ally, and to be called for the present Elasmosaurus constrictus.

ELASMOSAURUS PLATYURUS, *Cope*.

Leconte's Notes loc. cit. Proceed. Acad Nat. Sci., 1868, l. c. 92.
Discosaurus carinatus, Cope. Leconte's Notes, l. c.

This, after Mosasaurus the most elongate of the sea saurians yet discovered, is represented by a more than usually complete skeleton in the Museum of the Academy of Natural Sciences in this city. It was found by Dr. Theophilus H. Turner, the physician of the garrison at Fort Wallace, a point situated 300 miles westward from Leavenworth on the Missouri river, and some distance north from the Smoky Hill Fork of the Platte river. Portions of two vertebræ presented by him to Dr. Leconte when on his geological tour in the interest of the U. S. Pacific Railroad Company, were brought by the latter gentleman to the Academy, and indicated to the writer the existence of an unknown Plesiosauroid reptile. Subsequent correspondence with Dr. Turner resulted in his employing a number of men, who engaged in excavations, and succeeded in obtaining a large part of the monster. Its vertebræ were found to be almost continuous, except a vacancy of some four feet in the interior dorsal region. They formed a curved line, a considerable part of whose convexity was visible on the side of a bluff of clay shale rock, with seams and crystals of gypsum. The bones were all coated with a thin layer of gypsum, and in some places their dense layer had been destroyed by conversion into sulphate of lime.

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

In removing the matrix from beneath the vertebræ, scales and teeth of some six species of Physoclyst and Physostomous fishes were found, including an Enchodus and a Sphyraena, the latter indicating a new species, which I have called S. carinata. These animals had doubtless been the food of the Elasmosaurus.

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

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

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

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

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

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

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

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

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

	Present.		*Lost.*		*Total*
	No.	*Length In.*	*No.*	*Length In.*	*lengths.*
Cranium,				24	24
Cervicals,	68½	257.5	3½	22.3	279.8
Dorso-lumbars,	14	55.10	10	37.6	93.4
Caudals,	21	60.4	30	60.	120.4
Total,	103½		43½		517.6

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

Measurements.

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

	In.	*Lin.*
Length of sixty-third cervical,	4	9.2
Depth articular face of the centrum,	3	8.
Width " " "	3	10.2
Total elevation ninth do.,	2	9.
Length ninth caudal,	1	7.5
Transverse diameter articular face,	1	6.
Vertical " articular face do.,	1	27.
Length head of rib,	1	9.7
Width " "	1	3.
" shaft "	1	10.5

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

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

The posterior cervicals are not readily distinguished from the anterior dorsals. In the latter the ribs appear to be present, of reduced length, judging from the smaller size of the remaining heads. The articular pits continue to descend till their lower marginal ridge is the inferior lateral angle of the vertebra. On such vertebræ the inferior surface is flat. The neural spines on dorsals and posterior cervicals are of great height as well as antero-posterior width, and they allow a very narrow interval between them.

	In.	*Lin.*
Antero-posterior diameter ?12th dorsal,	3	7.2
Transverse diameter articular surface,	4	10.
Vertical do. do.,	4	2.5
Neural canal and spine (latter broken),	5	3.5
Length diapophysis 12th dorsal,	4	
Width diapophysis at middle,	1	10.

	In.	*Lin.*
Antero-posterior diam. ?11th dorsal,	3	4.5
Transverse posterior of articular face,	5	3.
Vertical do. do. do.,	3	10.
Transverse posterior of neural canal,		10.2
Transverse posterior of articular face, 3d dorsal,	5	2.5
Elevation centrum, arch and spine, 2d dorsal,	11	9.
Elevation upper edge zygantrum 2d dorsal,	6	
Length zygantrum, upper edge, do.,	1	10.2
Length centrum, last cervical,	4	
Width centrum articular face cervical,	5	3.
Elevation neural arch and spine cervical,	7	9.
Antero-posterior width neural spine of cervical at zygapophysis,	3	7.

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

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

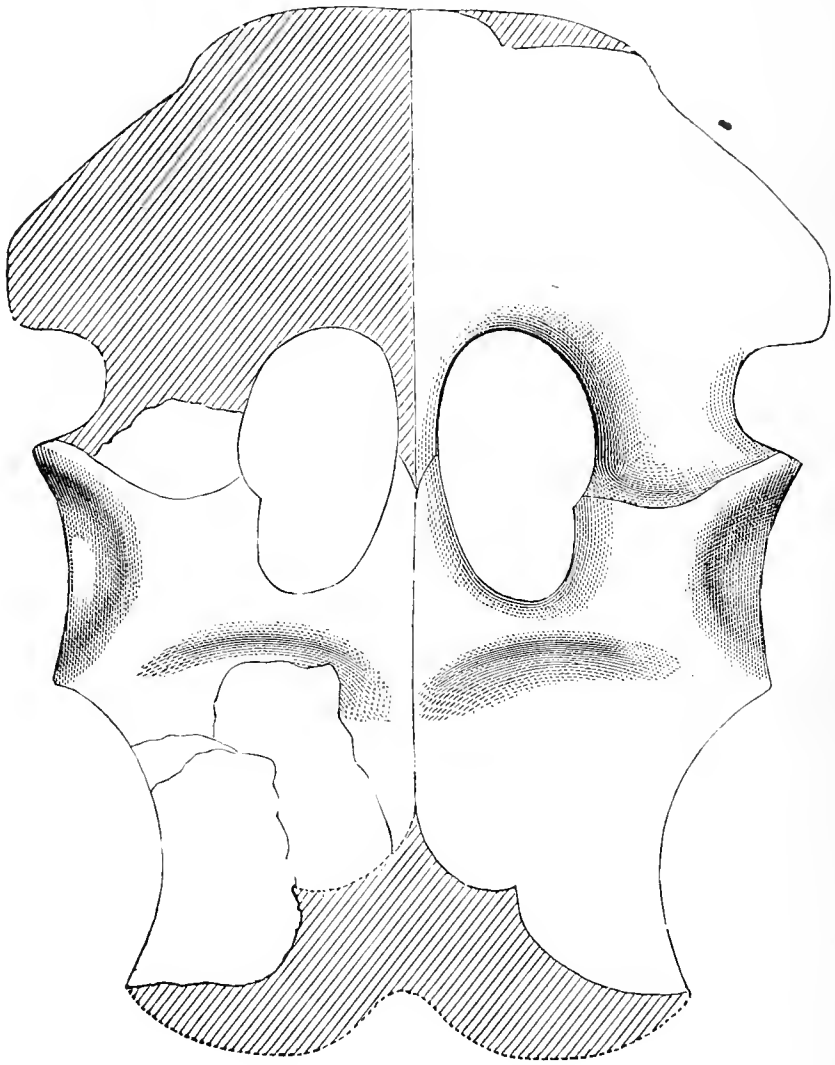
	In.	*Lin.*
Antero-posterior diameter of fourth caudal,	2	4
Transverse do.,	3	10.5
Total elevation,	8	
Vertical diameter centrum,	3	1.5
Anterior-posterior diam. diapophysial pit,	1	9.2
do. do. third cervical,	2	2.
Transverse do. do.,	2	11.

Heads of fourteen *ribs* are preserved, and a great number of shafts. The heads are simple, with elongate oval articular face. They are oblique in the narrow direction, and frequently in their length also; the margins are somewhat everted. The extremities of the diapophyses of the larger dorsal vertebræ are transverse, some flattened,

the others more oval, the more anterior are sub-triangular, and the rib pits on the first dorsals are sub-round or vertically oval. Thus the heads of the ribs also vary. The shafts are all flat, probably more so from pressure. They are frequently curved in the direction of the compression, which suggests a vertical head. They however are probably more or less distorted, and the plane of compression changed. No well defined distal extremity of a rib can be made out, nor have anything like abdominal ribs been preserved.

The *scapular arch* is remarkable for its large clavicles (or procoracoids). As preserved, the latter are quite convex downwards both antero-posteriorly and transversely, while the coracoids are equally concave in both directions.

Fig. 7.



Scapular Arch.

The clavicles have a remarkable external flat projection, which is separated from the glenoid cavity by a deep sinus. The glenoid cavity is bounded by an elevated ridge, which sends a branch along the claviculo-coracoid suture to the precoracoid foramen. This foramen is relatively of small size, and is a longitudinal oval; the two are separated by an isthmus composed equally of processes of clavicle and coracoid. The coracoids are very thin except in a transverse

portion, which extends across behind the precoracoid foramina; a strong elevated rib extends across the posterior face at this point. The outer margin of the coracoid is thickened, rounded and slightly concave.

	In.	*Lin.*
Greatest antero-posterior length scapular arch,	33	6.
" " " clavicle,	14	9.
" " " glenoid cavity,	6	9.
" " " precoracoid foramen,	7	3.
Transverse extent of claviculi,	27	
" " coracoidea,	16	
From acetabulum to foramen,	7	6.

The form of the posterior margin of the coracoidea is unknown, and they are much broken on the inner margin. They may have been considerably longer than in the accompanying cut.

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

	In.	*Lin.*
Greatest antero-posterior length,	25	
" " " pubis,	13	6.
Antero-posterior median length to notch of ischia.	7	
Length coracoids behind notch,	4	6.
Greatest width pubes,	27	6.
" " ischia.	21	

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

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

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

	In.	*Lin.*
Length in middle of curve.	9	9
Diameter at head,	3	3
" distally on curve,	6	
" " straight,	4	

Fig. 8.

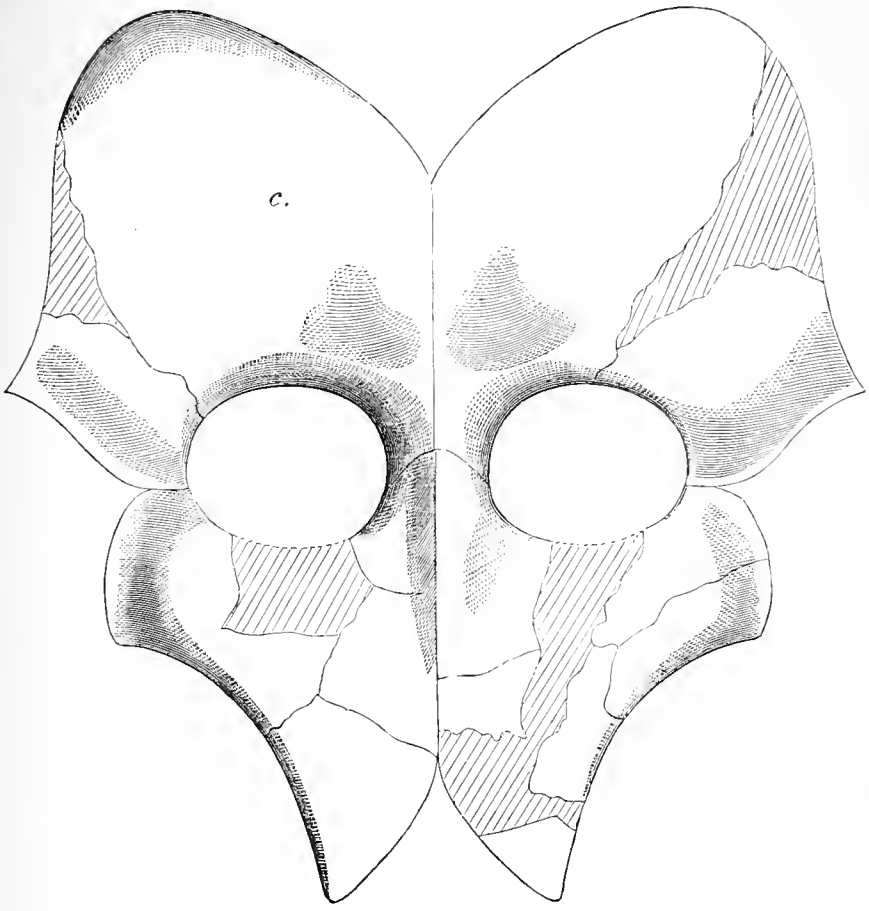


Fig. 9.

Fig. 10.

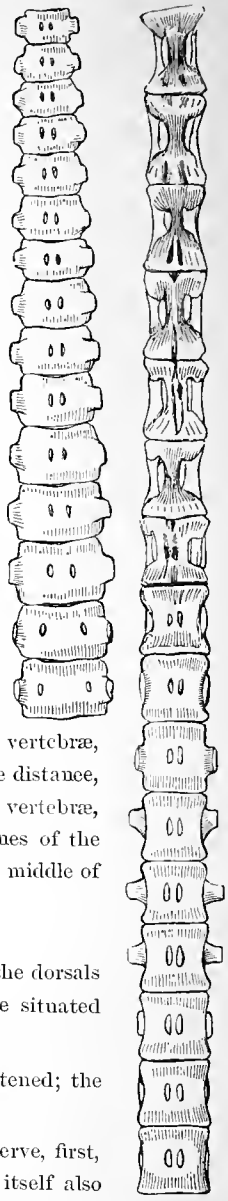
Pelvic Arch.

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

The end of *the muzzle* preserved, includes also the symphysis and parts of the rami of the mandible. The parts have been crushed together, and the ends of the teeth broken off. The alveoli of the two jaws incline at a narrow angle to each other, hence the teeth which alternate, cross each other near the middles of the crowns. The parts preserved appear to belong to the premaxillary bone, though no suture can be found, and the bony walls are so thin as to render their obliteration a probability. There is a keeled ridge along the middle line above, which is not continued to the margin of the bone. The form of the muzzle is narrow, the sides subparallel near the tip, which is elongate rounded. The mandibular symphysis, however, is not very elongate, as the rami are given off at three inches from the tip. The latter appear to have been quite slender from various small sections or pieces sent with the muzzle. The premaxillary border of 4 in. 7 lin. exhibits eight teeth, or their alveoli, of which the median two are close together, and not separated by any mandibulars. The sections of the teeth are round or oval, and their sizes are irregular probably on account of differing age, and degree of protrusion: the diameters at alveolar margin vary from 6 lines to 3. Their form is slender conic, or with the root slender fusiform, and the pulp cavity is small and median.

sometimes cylindric, and sometimes narrowed. The surface from a short distance above the alveolar margins to the tip, is marked with acute thread-like ridges, which are sometimes interrupted, and sometimes furnished with short branchlets. They are more or less undulate, and do not unite, but simply cease as the tip of the tooth is approached. The latter is smooth without lateral cutting edges. The width of the mandible at the commencement of the rami is 3 in. .05 lin.; of the muzzle of the seventh tooth 3 in. 7.5 lin.; at the third tooth 2 in. 4.2 lin.

Fig. 11. Fig. 12.



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

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

The habit of this species, like that of its nearest known allies, was raptorial, as evinced by the numerous canine-like teeth, and the fish remains taken from beneath its vertebræ.

The general form of this reptile, whether it was furnished with large posterior limbs or not, was that of a serpent with a relatively shorter, more robust and more posteriorly placed body than is characteristic of true serpents, and with two pairs of limbs or paddles. It progressed by the strokes of its paddles, assisted by its powerful and oar-like tail. The body was steadied by the elevated keel of the median dorsal line, formed by the broad, high neural spines. The snake-like neck was raised high in the air, or depressed at the will of the animal, now arched swan-like preparatory to a plunge after a fish, now stretched in repose on the water or deflexed in exploring the depths below.

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

The neural canal is everywhere markedly larger in Cimoliasaurus.

As the characters of lesser significance may be added, that in Cimoliasaurus magnus the dorsals with elevated diapophyses are considerably larger in the centra than those in which they are situated lower down. In E. platyurus these vertebræ are of relatively equal length.

The cervical pleurapophyses in C. magnus are anteriorly considerably stouter and less flattened; the same applies to more anterior vertebræ, where they are flatter in both.

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

History.—The determination of the extremities of this species was rendered difficult from the fact that Leidy in his descriptions of Cimoliasaurus, reverses the relations of the vertebræ, viewing the cervicals as caudals and lumbars, and describing the caudals as belonging to another genus. Not suspecting this error, I arranged the skeleton of Elasmosaurus with the same relation of extremities, and the more willingly as the distal cervicals present an extraordinary attenuation, even for this type, and also as the discoverer assured me that the fragments of cranium were found at the extremity which is properly the caudal. Viewed in this light many details of the structure were the re-

verse of those ordinarily observed among reptiles, whence I was induced to consider it as the type of a peculiar group of high rank. This view is, of course, abandoned on a correct interpretation of the extremities. Leidy detected the error in this arrangement, and the correction extends to Cimoliasaurus as well.

ELASMOSAURUS ORIENTALIS, *Cope.*

This species is indicated by two vertebræ. The first resembles both the twelfth from the first dorsal of the cervical series of Cimoliasaurus magnus, or the fifth from behind, of the same of Elasmosaurus. Its large size, lateral longitudinal angle and small neural canal refer it with more probability to the latter genus. It appears to belong to a species possessing some of the peculiarities of the Cimoliasaurus magnus, having the quadrate form of the median cervicals of that animal, and lacking entirely the compression of the centrum and lateral concavity of the E. platyurus. The parapophyses are stronger and slightly more descending than in the fifth cervical of the latter, again resembling the more posterior vertebra of C. magnus Leidy. The bases of the parapophyses are more elongate than in the corresponding vertebra of C. magnus; the process was directed downwards at an angle of 45°, from the plane of the inferior aspect. The inferior plane is slightly concave, with two venous foramina, each in a strong groove on each side of a narrow median rib. The lateral surface is nearly vertical and slightly concave to the strong longitudinal angle. Above the latter the face is oblique concave for a width equal to that below. The articular faces are transverse ovals and slightly concave; their margin not prominent, nor ribbed on the lateral faces.

	Lines.		*Lines.*
Length,	45	Width canal,	7.7
Width,	52	Length basis of parapophysis,	25.
Depth to canal,	36		

If we estimate this vertebra by the position of the lateral ridge to be about the eighth anterior to the last rib-bearing, which I call cervicals in this genus, the transverse diameter of this vertebra in C. magnus is two-thirds that of a dorsal with diapophyses near the middle of the centrum. Should the proportions have been similar in this species, the diameter of that dorsal would measure $6\frac{1}{2}$ inches, indicative of the largest of American saurians. As, however, in the genus Elasmosaurus the disproportion between the sizes of the caudals and the dorsals is less than its ally, the latter have probably presented a diameter more like the same in E. platyurus.

A second vertebra from near the same part of the column of a much larger individual was obtained by Dr. Samuel Lockwood, superintendent of schools of Monmouth County, N. J., from Wm. Conovers' pit in the lower bed, near Marlboro, in that county. The diapophyses are directed downwards at an angle of 45°. The margins of the articular faces are not everted, while the inferior presents an open emargination medially. The two inferior foramina are very large. The measurements are as follows:

	In.	*Lin.*
Width of articular surface,	5	9
Depth do. do.,	4	3
Length centrum,	4	6

The name is not given under any supposition of restricted habitat, which may have been similar to that of the E. platyurus, but in view of the probability of its greater abundance where its remains have been found than elsewhere.

Our knowledge of this species is unfortunately confined to the two vertebræ above described. The first is from the lower cretaceous greensand bed, from near Swedesboro, Gloucester County, New Jersey. It was found in a tailor's shop used as a block to secure a door.

Incertae sedis.

PIRATOSAURUS, *Leidy.*

PIRATOSAURUS PLICATUS, *Leidy.*

Cretaeeous Rept. N. Am., 29, 30, Tab.

Cretaeeous of Red River Settlement, Lat. 49 deg., Northern Minnesota. Deseribed from a tooth.

THECODONTIA.

Owen in part.

In this suborder we have a singularly generalized group, combining characters of lizards, crocodiles and Sauropterygians. The neural arch of the vertebræ united by suture and the slightly biconcave centrum, resemble the last two, so also the abdominal ribs. The limbs are rather crocodilian, the position of the nares, Plesiosaurian. The clavicle is lacertian, while the three vertebræ of the sacrum and the femur are between these and the Dinosauria.

The most important characters distinguishing these animals from the Sauropterygia are the presence of an elongate sacrum and the more ambulatory form of limbs.

Our knowledge of the order is almost confined to Belodon Meyer, and is derived from that author's descriptions of those large and remarkable reptiles derived from the Keuper of Würtemburg, the Belodon kapfii Meyer, B. plieningeri Münst., and B. planirostris Meyer.

The American species of the order are known only from the valuable collections made by Wheatley at Phœnixville, Pa., and by Emmons at Deep River, in Chatham county, in North Carolina. The former are in my hands for examination and description, and will be the subject of an appendix to this work.

BELODON, *Meyer.*

Although this genus does not present the swimming extremities of Plesiosaurus and Nothosaurus, its structure in this respect is not much more different from them, than that of the marine turtles is from the terrestial families of the same order. The structure of the sphenoidal region, the peculiar position of the external nostrils, almost above the orbits, with the rhizodont dentition, are points in which they agree. The position of the exterior nares cannot be regarded as an ordinal character, since we see what remarkable differences of position it exhibits in the existing family Varanidæ. There is is every probability that these animals were aquatic. The posterior position of the nostrils, like that in many other marine animals, enabled them to plunge the long muzzle beneath the surface of the water or mud without interfering with respiration.

The dentition of the posterior parts of the mouth has been shown by Von Meyer to be quite different from that of the anterior regions; the latter are prehensile, that is elongate conic, the former cutting, *i. e.*, flattened, broader and with trenchant edges.

On teeth of the latter kind Emmons established his *Palæosaurus carolinensis* and *P. sulcatus*; and Leidy, *Compsosaurus priscus* and *Eurydorus serridens*. On teeth of the former kind Emmons based his *Clepsysaurus pennsylvanicus* in part; his *Rhytidodon carolinensis* and *R. sulcatus;* Leidy's *Omosaurus perplexus* and Lea's *Centemodon sulcatus* had a similar origin. The names based on the lenticular teeth accompany, as prior to, or synonymes of, the latter series. There is much difficulty in collating them, but I may follow Emmons at present, in seeing in the two styles of smooth and fluted teeth, those representing different species.

In this way I have attached to the fluted toothed *Rhytidodon carolinensis*, Emmons, the *Palæosaurus sulcatus* of the same author. Emmons does not offer any grounds of separation for his *R. sulcatus*, nor Lea his *Centemodon sulcatus;* neither can I find aught in Leidy's *Omosaurus perplexus* by which it can be separated. Leidy represents it to be an "Enaliosaurian," while Emmons says (North American Geology, 67–79–82), that it is the same as his *Clepsysaurus* and *Rhytidodon*, citing Leidy as authority for this close approximation. If this be the case, the form is a shore-loving Belodont, and not nearly related to the marine reptiles included under the old name of Enaliosauria.

To the smooth toothed type belong posterior teeth named by Emmons, *Palæosaurus carolinensis*, and by Leidy, *Compsosaurus priscus* and *Eurydorus serridens*, and anterior teeth referred, erroneously in part, as I believe, to *Clepsysaurus pennsylvanicus*, Lea. The first mentioned name cannot be used, as it has been already applied to a member of this genus. The third was based on a specimen from a very remote locality, and its proper application remains uncertain. The second specific name may be employed in the uncertainty, though its describer included both fluted and smooth teeth in the same species.

Specimens in the Academy Mus., from Montgomery Co., N. Ca., consist of vertebræ, tarsal bones, etc., and parts of cranium with dermal bones of this species. A tooth in place in the extremity of the ramus of the mandible, is as smooth as those from more posterior positions in the jaw, figured by Emmons, N. Am. Geol., p. 69, fig. 42, which in some measure supports Emmons' hypothesis of the uniformity of the characters of the surface sculpture. The cranial fragments indicate a Belodont, and the vertebræ are different from those of Clepsysaurus.

The vertebræ, (No. 5) from the coal of Chatham Co., N. Ca., were accompanied by teeth of the fluted character, though they were not on the same block. As the former indicate a species distinct from that from Montgomery Co., I have regarded them as probably pertaining to Emmons' *Rhytidodon carolinensis*.

The remains, (No. 6) from Phœnixville, include vertebræ, bones of the pelvic arch and posterior limb, with dermal bones, but no teeth. They indicate an animal distinct from either of the preceding.

Emmons describes a species *Clepsysaurus leaii*, from the coal strata of Dan River, from near Leakesville, N. Ca., which appears to be distinct from the *Rhytidodon carolinensis*. It is represented by a cast of a block of sandstone containing 14 vertebræ, etc., which indicate a species different from any of those above mentioned.

Finally, although the *Eurydorus serridens*, Leidy, from its locality (Phœnixville, Pennsylvania), may indicate a fifth species, there is nothing in the type specimen, nor in the description, to determinine any reference. It cannot safely be regarded as the same as the Belodon here described, from the same locality, since the strata in which the two occur, are separated by a vertical thickness of 187 feet of rock.

Having satisfied myself of the existence of four distinct species of Belodonts in our Triassic beds, their generic relations come next in order for consideration.

In his Manual of Geology, Prof. Emmons figures the cranium of a Reptile (fig. 157, page 179), which bears a near resemblance to that of the Belodon plieningeri, Meyer. The cast of this cranium in the Museum of the Academy Nat. Sci., confirms the reference to this genus, and presents no characters by which it can be distinguished from it. The specimens (No. 4) consist in part of the short frontal bones with part of the orbits and cranial cavity, and a portion of the ramus of the mandible, of a saurian near the genus Belodon, perhaps the same. The ilium figured by Emmons (N. Amer. Geology, p. 77, fig. 47,) and the femur, (fig. 48), with portions of mandibular ramus (fig. 42), obviously indicate Belodonts.

Of the Phœnixville saurian, portions of the ilium and ischium are preserved, which indicate that the animal is neither a Dinosaurian nor a Dicynodont, nor yet a Crocodile. The portion of ilium answers to that of Belodon, as figured by Meyer and Emmons.

The Dan River species is referred to the same group without entire certainty. The only teeth occurring in the same strata are, according to Emmons, identical with those of the smooth toothed Belodont from Deep River. The cervical vertebræ are quite similar to those of the Deep River species.

I can as yet find no generic characters by which to distinguish these species from the Belodon of Meyer, neither in the cranial, dental, pelvic nor extremital regions. Meyer describes and figures numerous teeth, both smooth and sulcate, without distinguishing the two forms specifically, though it is certain that three species of the genus came under his observation. He figures ilia of two species, one of which cannot be distinguished generically from that figured by Emmons (l. c. fig. 47).

This genus was referred by Owen to the *Thecodontia*, along with some other little known genera. Some of the latter, especially Bathygnathus and Clepsysaurus, are in our opinion Dinosaurian, while others, as Belodon, represent a family of the present order.

BELODON CAROLINENSIS, *Emmons*, *Cope*.

Proceed. Ac. Nat. Sci., 1866, 249. *Rutiodon (Rhytidodon) carolinensis* Emmons' N. Amer. Geology, p. 82. Geol. Surv. North Carolina. *Palæosaurus sulcatus*, Emmons loc. cit. (posterior maxillary teeth), Fig. Emmons Manual of Geology, p. 179. *Centemodon sulcatus*, Lea. Proceed Ac. Nat. Sci., Phila, 1856, 78. Cope, 1868. 221. *?Omosaurus perplexus*, Leidy, Proceed. Ac. N. Sci., Phil., 1856, 256.

This reptile I find on examination of the type specimen to belong here. Teeth of the same are in Wheatley's collection at Phœnixville. I do not consider that any ground of specific distinction between this animal and the *C. sulcatus* has been pointed out, but leave the discussion of the relations of these Triassic forms for a future essay.

Lea has called my attention to the fact that through some error in reading the scale, the measurements of the type tooth published are double the correct ones. The specimen consist of the distal half of a slightly curved conic tooth, and does not display any pulp cavity; the allusion to this in the original description having reference to fracture. The tooth cannot be called sulcate, but is rather weakly ridged or fluted. The original description may therefore be amended to read thus:

Tooth slightly curved, with low trenchant edges, rounded on the exposed face, openly fluted on the lower (median) portion near the fracture, covered with very minute distinct striæ from the point to the base, which striæ cross to the flutings in oblique lines. Length, eight-twentieths of an inch; greatest breadth, two-twentieths; pulp cavity minute or none.

The enamel of the teeth of B. carolinensis is rarely preserved; when this is the case its striæ, fluting, etc., are as ascribed in C. sulcatus.

Coal Measures of the Keuper Trias. Chatham Co., N. Carolina.

BELODON PRISCUS, *Leidy*.

Palæosaurus carolinensis, Emmons, Geological Survey N. Ca., 1856, p. 80. N. Amer. Geology, 1857, 86, figs. 57–8 60. nec *Rhytidodon carolinensis* supra. *?Compsosaurus priscus*, Leidy, Proc. Acad. Nat. Sci., Phila., 1856, 165. *Clepsysaurus pennsylvanicus*, "Lea." Emmons in parte, Geol. Survey N. Carolina, 1856; North Amer. Geology, 1857, pp. 67–71–3; figs. 37 to 50 nec Leaii.

Represented by numerous specimens from the Triassic of Chatham and Montgomery counties, N. Carolina. Teeth not fluted; caudal vertebræ with articular faces broad as long, and centrum little compressed. Size medium.

BELODON LEAII, *Emmons*.

Clepsisaurus leaii, Emmons. Geol. Survey N. Ca., 1856; N. Amer. Geology. 1857. p. 79, fig. 51, Pl. 8, figs. 1–4.

Emmons states that this species is smaller than the last, and that the centrum is longer than broad. Cervical vertebræ short, compressed, extremities strongly concave. The Trias of Dan River, N. Carolina.

BELODON LEPTURUS, *Cope*.

Spec. nov.

Represented by wholes or parts of fourteen vertebræ; a left femur and fibula; a phalange; imperfect ilium and ischium attached; with numerous ribs and dermal bones, from several blocks of bituminous shale from the bone bed in the tunnel at Phœnixville, Penna.

The fragments indicate the largest species of the genus, one of the vertebræ with spine, measuring eight inches in total elevation. The centra of the dorsals are wider at the articular faces than long; in the other two species the length is greater than or equal to the width. The caudal vertebræ are much compressed, not subcylindric as in B. priscus. The femur restored measures thirteen inches in length. Ischium sending a process forwards bounding the acetabulum below in part, largely excavated by the obturator foramen, which is very externally situated.

The bones were enclosed in five slabs of black, bituminous argillaceous rock of the Phœnixville section, and they were taken out from the same immediate proximity by the workmen engaged in the work in the tunnel. One slab contained three dorsal and two caudal vertebræ with chevron bone. The second, one and part of another dorsal ver-

tebræ and the head of the femur; the third a nearly perfect vertebra and diapophysis of another, with dermal bones; the fourth the greater part of the femur, with fibula and dermal bones; fifth, ribs and dermal bones, with pelvis.

Seven *vertebræ* present centra, and are more or less nearly perfect. There are probably no cervicals, but there are three forms of diapophyses which indicate different positions in the vertebral column.

That which I suppose to represent the most anterior, has a short, wide diapophysis with tubercular articular surface, and a short knob with capitular articulation at the base of the anterior aspect of the neurapophysis, with its superior margin on the plane of the diapophysis. In the next, the diapophysis is short, wide, and closely connected at the base with a capitular articular tubercle, for the rib, the extremity of the diapophysis furnishing the tubercular surface. In the first of these the diapophysis is as long as the elevation of the anterior zygapophysis above the centrum, and the capitular knob measures the middle of the latter space with its superior margin, being in the plane of the diapophysis. In three others the elevated position of the capitular articulation is visible. The second form of diapophysis is seen in a nearly perfect vertebra in immediate connection with that first described above, but probably in abnormal relation. The process is narrower, but flat, and without capitular process at base, nor is there any capitular articulation on the centrum. Its position is much lower than in those just described, being opposite to the middle of the centrum. Its extremities are imperfect, probably broken off. I suspect that their condition is indicated by an isolated diapophysis, which is accompanied by tubercular articular face at a distance of 18 lines from its extremity, and probably at some distance from its base, which is, however, lost. The third type of diapophysis is seen in two examples; one, in normal relation to its centrum, etc. This is quite slender and elongate, compressed at base, and cylindric throughout most of the length. On the posterior face of the extremity is a slightly concave articular face; the extremity proper appears also to have borne the tubercular face. That these are the combined tubercular and articular facets is rendered altogether probable by their wider separation on the second example of this form. This is an isolated diapophysis, of slender cylindric form, which, at a distance of an inch from the extremity dilates into a right-angled flat process, whose distal side bears a narrow capitular articular face. The extremity is subcylindric, bearing the tubercular facet.

This arrangement of the vertebræ is confirmed by the arrangement seen in other species, where vertebræ similar to those first described are evidently dorsal. It is probable from the above, that the capitular articulation rises from the centrum very soon in this type, as in the Crocodilia, perhaps very few dorsals retaining it on that portion; and differing from the Dinosaurian type, where this facet is on the margins of the centra and not elevated on a pedicel. This form differs from the Crocodiles in the narrowing and final cylindric form, as well as descent on the centrum of those diapophyses on which the two facets approach and unite.

One objection to the position assigned to the last form of vertebra, is the fact that the only one with perfect centrum presents an oblique truncation on the posterior margin on each side, which looks much like a capitular articular face. There is a precisely similar vertebra in the Museum of the Acad. Natl. Sciences, from Chatham Co., N. Ca., which is ascribed to the B. carolinensis. Their surface is concave in this specimen, but seems too large for the head of a rib. In both, the vertical diameter is one-half the transverse width of the articular face of the centrum. I cannot assign the place or use of this facet with certainty, but the following light is thrown upon the point by another specimen in the Museum Academy, also from Chatham Co., N. Ca., presented by Prof. Emmons.

It consists of five consecutive vertebræ on a block of coal slate, of which the anterior two present the capitular tubercle elevated to the base of the short flat diapophysis, without being confluent with it in the first, but closely united to, and of equal length with the shortened second. On the third, the rib-diapophysis becomes abruptly very much wider, and occupies a position a little lower down on the centrum. The diapophysis is preserved on one side of the block. It is flat, a little narrowed beyond the middle, then dilated, and with an open emargination opening posteriorly and outwards, at the distal extremity. With the extremity it bears a narrow articular surface. These I suspect to represent capitular and tubercular articulations. The fourth and fifth vertebræ bear each, a greatly dilated and thickened diapophysis, which I have little doubt represent the sacral supports of the ilium. Their expanded bases are somewhat lower in position than the diapophyses of the vertebra in advance, and they occupy a broad articular face of their proper vertebra, and a distinct facet of that preceding, leaving an articular face on its posterior margin. I suppose the peculiar vertebræ already alluded to in the B. lepturus and specimen from North Carolina, are, therefore, the last lumbars.

From the above, four points may be derived: 1. That the ribs are continued to the sacrum in this type, a character not before pointed out among its representatives in this country or Europe, and one in which it differs from the Crocodilia from the Cretaceous to the present period inclusive. 2. That the sacral diapophyses articulate with two vertebræ instead of one, a point similarly exceptional with the last point. 3d. That in both these points this type approaches the Dicynodontia and Dinosauria, as it does in some others. 4th. That the B. lepturus belongs to a different species from that from N. Carolina, last described, in having at least three diapophyses with double articulation near the extremity instead of one, and to a different genus from the same, because several of these are cylindric in the former, and broadly flattened in the latter.

Which genus is distinct from Belodon is difficult to ascertain. If we suppose B. carolinensis to represent it, as it certainly does in cranial characters and other respects, the North Carolina specimen will represent another genus, since a sacral vertebra of B. carolinensis presents all the characters of that of B. lepturus.

The centra of the vertebræ are very much compressed, and the articular faces flared out at the margins. The faces are wide vertical ovals and distinctly concave. The posterior face of the supposed last dorsal is flattened, and presents two slightly swollen triangular planes, each from the facet of the margin.

The neural spines of the anterior vertebræ are shorter and wider, of the posterior more elevated and narrower. The rib supporting the anterior zygapophysis is very prominent in all, as is that defining the margin of the neural arch. They include a short vertical concavity between them, giving the vertebræ a marked character.

The caudals are very much compressed, more so than in B. ? priscus, though since they are median in the series, and those of the latter are proximal, there would probably be a greater resemblance between the homologous ones. The articular extremities are vertically oval, and but little flared at the margins. The neural arch with its apophyses is compressed. The diapophyses project just below the base of the arch, and are depressed and stout.

Measurements.	*M.*
Vertebra 1st type,	0.18
Do. height neural spine from canal,	0.10
Do. length diapophysis,	0.026
Do. " centrum,	0.05
Do. diameter centrum middle,	0.021
Do. " " articular face,	0.055
Do. " " vertical, articular face,	0.059
Total elevation type 2d,	0.1951
Do. neural spine from canal,	0.122
Do. width do.,	0.04
Do. length centrum,	0.05
Do. diameter (transverse) centrum middle,	0.023
Do. " " " artic. face,	0.054
Do. " vertical " "	0.06
Do. elevation type 3d,	0.186
Do. neural spine from canal,	0.11
Do. length centrum,	0.049
Do. diam. (transverse) centrum at middle,	0.032
Do. " " " artic. face,	0.061
Do. " vertical " "	0.062
Do. expanse anterior zygapophyses,	0.07
Do. diameter neural canal,	0.02
Length diapophysis,	0.082

The neural canal in the vertebra first described, is narrower and more elevated than in the last dorsal.

A *chevron bone* has nearly cylindric limbs and short common junction of the same. Their proximal extremities are considerably expanded, but not so as to meet on the median line. They are very oblique backwards and inwards. Distal extremity strongly striate.

	M.		M.
Length,	.075	Inner,	.005
Proximal expanse, outer measurement,	.052		

The portion of the *pelvis* preserved consists of the proximal halves of left ilium and ischium, the anterior portion of the latter being broken away. This fragment is not Dinosaurian; the longitudinal expansion forbids the reference of the ilium as the ischiopubis of a Dicynodont, and the ischium is too different to be regarded as the scapula of a Belodont. It presents a broad shallow concavity as acetabulum, which on the inner face is grooved and ridged at the inferior margin, as though united to the ischium by suture. This is well shown in Emmons' figures of the same bone of another species, in North Amer. Geology, Pl. VI. The upper plane of this element is abruptly curved backwards and then broken away. The supposed ischium presents a marked acetabular articular face at its posterior connection with the ilium. Its posterior margin is much thickened, and becomes decurved towards the symphysis, which is lost. It sends a limb anteriorly along the line of union with the ilium, and apparently terminates in a narrow obtuse extremity with rugose margins. Its supposed obturator margin is thickened along this process; the main body of the bone is flattened at a strong angle with the posterior margin, and turned away anteriorly like the ilium of a Dicynodont, and includes an incomplete oval foramen with the acetabular process. The two pelvic elements are crushed nearly into one plane.

	M.		M.
Length of fragment,	0.167	Width ischium at foramen,	.055
" ilium to posterior process,	.0715	Thickness " distally,	.021
" iliac suture of ischium,	.092		

The mode of attachment of the pubis is not indicated in this specimen, but it was evidently quite different from that in the Crocodilia.

The *femur* is that of the left side; it is perfect, except that the portion usually supporting the third trochanter is broken out; say two inches. The head is Crocodilian, *i. e.*, without neck and compressed in one plane. Its extremity is slightly convex inwards, the inner extremity thickened, convex and decurved; the extero-posterior thinned and curved backwards slightly. The margin continued from the latter is therefore thinned, though obtuse edged, and encloses a wide shallow groove with the inner, thickened margin. There are no distinct trochanters. The shaft is quite slender, obliquely spherical triangular in section, with an inner ridge in front, and outer behind. The medullary cavity is very small. At the distal third the shaft is flattened antero-posteriorly. The trochlear groove is wide and shallow, and the condyles project less posteriorly than is usual; they have, however, been under considerable pressure. The inner is wider and shallower, the outer narrower and deeper. Their extremital faces are separated by an open notch.

The *fibula* is a long slender bone, having a slight sigmoid flexure, and ridges twisted round the flattened shaft. The extremities are more flattened, both in the same plane; the proximal is broken away; the distal is obtuse, one end terminating in a point; the surface rugose. Its form is Lacertilian.

	M.		M.
Length femur, restored,	0.34	Diameter condyles, inner, fore and aft,	0.045
Diameter head, antero-posterior,	0.09	Length fibula, broken,	0.24
" " transverse (greatest),	0.044	Diameter perfect extremity,	0.035
" shaft at middle,	0.045	" imperfect "	0.042
" condyles, transverse,	0.083	" shaft,	0.025

What is doubtfully referred as a distal *phalange*, resembles that ascribed to a species of the genus by Meyer, but as I cannot find lateral grooves, and the proximal articulations are concealed by matrix, it may not be such. One lateral margin is obtuse, the other acute; body thinned out to tip, flat in cross section below, concave in longitudinal, as wide distally as proximally.

	M.		M.
Length,	.035	Depth proximally,	.0165
Width distally,	.017		

Surface striate-rugose; lines of the upper surface converging toward a median point from the base.

Several more or less broken, and one complete *rib* are preserved. The two heads are distinct. The perfect rib

is perhaps a posterior dorsal. It is but slightly curved, has a vertically broad oval section proximally, and a depressed trigonal one distally; there is little trace of a medullary cavity.

	M.		*M.*
Length,	0.23	Vertical diameter at distal third,	0.014
Do. from head to tubercle,	0.03	Transverse do.,	0.155.

I find no abdominal ribs, such as are abundant in the North Carolina specimen described on a preceding page.

This species has been distinguished from B. priscus by the form of its caudal vertebræ. The measurements given by Emmons and Leidy, of the other species, differ in the greater elongation of the vertebral centra. The length of the latter is in each case greater than the width of the articular face, instead of less. They are also smaller in all their dimensions. We shall not go very far wrong in estimating the length of this species on the basis of the gavial of the Ganges, as furnished by Cuvier. This would give to the Belodon lepturus a length of about ten feet, and a habit stouter than that of the Crocodiles of the present day.

This species was discovered by Chas. M. Wheatley, proprietor of the lead and zinc mines at Phœnixville, Penna. He obtained the remains from the "Bone bed" of the Trias, where exposed by the Phœnixville Tunnel of the Reading Railroad. This stratum is, according to Wheatley, 6 ft. 6 in. from the top of the series; 52 ft. 6 in. lower down is a stratum rich in plants and Saurian remains, and 95 ft. deeper occur bituminous shales with caprolites and bones.

CROCODILIA.

The constitution of the cranium in this order is very characteristic and peculiar. The basal cranial bones are forced backwards, so that they occupy a more or less vertical position, and the sphenoid is almost concealed in many. The quadratum is immoveably embraced by the exoccipital, proötic and opisthotic. The pubes do not enter into the walls of the acetabulum as in Mammalia and Reptilia, but originate from the inferior pelvic arch. They form no common suture, but extend sub-longitudinally, thus differing from pubes generally. The latter relation of true pubes occurs among Reptiles only in Chelys, Pelomedusa galeata, and Sternothærus, among the Chelonia, and in Pterosauria. An anterior process from the ischium occupies the usual position of the origin of the pubis, as a support for the latter.

There are at least two well marked types in the class, defined as follows:

Vertebræ procoelian, *i. e.* with anterior cup and posterior ball; the sphenoid bone little visible on the base of cranium.

PROCOELI.

Vertebræ concave or nearly plane at both extremities; sphenoid bone with larger and more horizontal exposure on base of cranium.

AMPHICOELI.

The only genus of Amphicœli known in this country is Hyposaurus; the Procoelian genera are the following:

A The teeth composed of several enclosed cones of dentine.

a The cervical vertebræ with very rudimental or split hypapophyses.

A large fossa or foramen issuing between the prefrontal and lachrymal bones of the face; muzzle long, slender, teeth equal.

THORACOSAURUS.

No facial foramen; muzzle long slender.

HOLOPS.

aa The cervical vertebræ with long simple zygapophyses.
Muzzle long narrow, with long symphysis; teeth very unequal.

THECACHAMPSA.

Muzzle broad short, symphysis short.

PLERODON.

AA Teeth crowns a single dentinal cone with enamel sheath.
Cervical hypapophyses rudimental; muzzle broad.

BOTTOSAURUS.*

Cervical hypapophyses elongate, simple.

EXISTING CROCODILIA.

Species of this order have been abundant in North America from the beginning of the Cretaceous period to the end of the Miocene. At present they are confined to its extreme southern regions.

The Cretaceous period was more prolific in them than any later one, for then the Reptilian type in all its representatives reached its fullest development in the numbers, variety and size of its members. Then our sea coasts, estuaries, and fresh waters swarmed with them, an indication of the prolific lesser life on which they preyed or otherwise vented their powers of destruction.

THECACHAMPSA, *Cope.*

Proceedings Academy Natural Sciences, 1867, p. 143.

This genus was characterized from a few teeth from the Miocene of Maryland. Since then additional material has enabled me to construct its characters more fully.

Muzzle elongate, slender, as in Gavialis, the symphysis of the mandible elongate; dental series interrupted by larger canine-like teeth. Dentine of the crown arranged in concentric cones. Enamel thin, with a delicate anterior and posterior cutting ridge near the tip of the crown. Cervical hypapophyses elongate, simple.

The concentric structure of the dentine in this genus is quite the same as in Thoracosaurus. I do not discover in it sections of the teeth of Gavialis, Mecistops and Crocodilus. The cones readily separate and fall out in the fossil specimens. Their existence would indicate a periodical cessation of activity in the secretory vessels on the wall of the pulp cavity of the teeth, with intervening increase of deposit of dentine. In a shed tooth of this genus four such cones may be counted.†

*Probably the thin crown in this genus is composed of several attenuated cones.

†A supposed affinity of this genus to Mosasaurus, which I inserted in the original description, at the suggestion of a friend, I do not now recognize.

This genus presents the same peculiarity of dentition as the Plerodon Meyer (*Diplocynodus* Pomel) of the European Miocenes. The P. plenidens, and P. ratelii are both of the Crocodilian type of cranium, the rami of the mandible with curved extremity and short symphysis, while Thecachampsa is a gavial, with very long symphysis and slender muzzle. I have seen but one cervical vertebra from American tertiaries, and that is of the type of Thoracosaurus; hence this character cannot be *certainly* ascribed to Thecachampsa.

Three species appear to exist in our Miocene beds. The T. sicaria indicates in its slender mandible one character of the genus; it shows the surface to have been ridged and pitted as in other Crocodilia. The T. antiqua Leidy indicates in its dorsal vertebra, a smaller hypapophysis than in the known species of Crocodilus. T. sericodon Cope is only known from its teeth. The teeth of the three species may be thus distinguished. It must be mentioned that I have but one tooth of T. sicaria, three of T. antiqua and six of T. sericodon. In the first the tooth has a lenticular section a short distance below the tip, owing to the great development of the lateral cutting ridges, and the compression of the crown at their bases. In the other two, these ridges are much less developed; in T. antiquus they exist only towards the tip on the inner or concave face of the tooth, while in T. sericodon they extend more than half the length of the crown towards the base, on the inner side.

THECACHAMPSA SICARIA, *Cope.*

Proceed. Ac. Nat. Sci., Phila., 1869, 8.

This species is represented by a lumbar vertebra, an imperfect crown of a tooth, and a portion of the under jaw. They were submitted to me by Philip T. Tyson, State Geologist of Maryland, who procured them from near the mouth of the Patuxent River, along with the remains of Eschrichtius, Physeter, and other Cetacea.

The portion of mandible indicates an animal of a size considerably exceeding both the Gavial of India and the Thoracasaurus of the Cretaceous of this country. It contains all or parts of alveolae of six teeth. Opposite the fourth alveolus from the front, the margin diverges slightly from the median line, indicating the position of the distal extremity of the splenial bone. The slight degree of this obliquity indicates an extensive contact of these elements, and not a symphysis formed merely by union of the dentary elements as in Mecistops and Crocodilus. As no curvature appears at the anterior extremity of the fragment, and the alveolae are similar to those succeeding, it has evidently not been broken from the anterior portion of the symphysis. The nutritious canal of the ramus is thus nowhere exposed, but is enclosed in the long symphysis.

The upper face of the ramus is convex, most so anteriorly. Its lateral and inferior face is more convex than in other Gavials which I have noticed, especially posteriorly. Its surface is coarsely sulcate, and with numerous small foramina. A larger space than elsewhere is seen between the two median alveolæ, which is occupied by a deep concavity for the reception of a large tooth of the maxillary series. This indicates an irregularity in the size of the teeth of that series, as in the Crocodiles, and not an equality as in other Gavials. On placing the fragment in position the teeth are seen to have diverged at an angle of 45°.

The specimen had laid sufficiently long in the Miocene ocean bottom to have been fixed upon by barnacles and oysters, as a place of abode. That it had not remained unburied very long is evident from the small size which these parasites had attained; and that it was buried in Miocene deposits and not worn by a more modern sea, is testified to by the Miocene shells (Turritella, etc.), whose fragments were removed from its cavities with the sandy clay of its place of burial. The teeth have been broken off in this rough contact with the elements, but I procured a large and characteristic portion of the crown of a successional tooth whose apex had attained to the level of the edge of the

alveolus, and whose development had occasioned the absorption of half the fang of the functional tooth. On the basis of this tooth I am enabled to determine the distinctness of this crocodile from the T. antiqua. The crown, instead of being like that species, a cone with a circular section, with a narrow cutting longitudinal ridge rising abruptly from the surface on each side, in this tooth has a lenticular section, with the cutting ridges on the acute opposite angles. The external face is strongly convex, though not so much so as in T. antiqua. The edges are crenate, but not so as to produce a serration of the margin. Enamel finely obsoletely striate.

The vertebra preserved is a posterior lumbar. The entire coössification of the neurapophysis indicates that the animal is adult; their upper portions are lost. The diapophyses have had an oblique basis, rising anteriorly, their middle being opposite the plane of the neural canal, the whole length standing on the anterior two-fifths of the length of the centrum. The cup is subcircular, wider transversely; the centrum is depressed; below broad, with a median longitudinal concavity; sides vertical. As compared with the dorsal vertebræ of T. antiqua, the latter are much more compressed in the centrum; and although the posterior lumbars are always more depressed than the dorsals, yet the present seems too much so to have pertained to the same species. It differs from those of T. antiqua also, in that the floor of the neural canal is entirely plane and smooth; in the latter it is deeply grooved, in consequence of the non-coalescence of the expanded bases of the neurapophyses.

	Ft.	*In.*	*Lin.*
Length fragment of mandible,		8	4.
Diameter of alveolus,			11.
Axial width from margin alveolus to symphysis above,		1	4.
do. do. do. do. below,		2	8.
Greatest width to median line (behind),		3	3.
Long diameter crown, at middle of length,			8.
Width muzzle,		2	8.
Estimated length cranium,		69	5.
do. total length,	33	4	
Length lumbar vertebra (centrum),		3	10.5
Width cup,		2	3.5
Height cup,		2	0.8

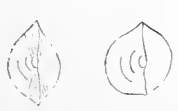
The above estimate of length is based on the proportions of the Gavialis gangeticus as given by Cuvier.

THECACHAMPSA ANTIQUA, *Leidy sp.*

Crocodilus antiquus, Leidy. L. c. 1851, 307. Journ. Ac. N. Sci., II., 135. Tab. *?Thecachampsa contusor*, Cope. Proc. A. N. Sci., 1867, 143.

This species continues as yet to be represented only by the specimens on which it was based, viz., two teeth, two vertebræ, an ungueal phalange, and a rib. These indicate a large species; the vertebræ are even larger than that of the last, and the teeth will not enter its alveolae. It is probably the largest of the known Crocodiles of this country.

Fig. 16.



B *A*

I have noticed only two dentinal cones in the two teeth we possess.

The accompanying outlines are those of sections of the teeth of the present species, and the T. sicaria C. Fig. A represesents the former and fig. B the latter.

The peculiar form of the tooth on which *T. contusor* was based, is due I find to attrition and partial destruction of the enamel.

"Eocene" of Eastern Virginia from the banks of the Potomac.

THECACHAMPSA SERICODON, *Cope.*

Proceed. Acad. Nat. Sci., Philad., 1867, p. 143.

This species was established on fragments of three teeth from the Miocene of Maryland. Four additional and much more perfect teeth, with fragments of jaws, from New Jersey, presented by my friend, Dr. H. C. Wood, Jr., elucidate the characters of both species and genus.

The most perfect tooth is slender and curved, and bears much resemblance to those of Holops obscurus. The section of both root and crown circular, the latter regularly acuminate, and furnished with delicate cutting ridges. Terminal half smooth, basal half with a silky striation. Fang as well as crown strongly curved. Cutting ridge descending as far on the posterior, as the anterior aspect of the crown. In a fractured New Jersey tooth, I count three dentinal cones. In one from Maryland, four. The inner cone is weakly fluted in both, but it scarcely affects the form of the enamel.

The typical tooth of this species, as compared with the T. antiqua, is more slender and curved. In a length of crown and fang slightly exceeding the largest of the latter, the diameters are all about one-half the same. Teeth from other portions of the jaw are but litle stouter.

	In.	*Lin.*
Length of tooth from New Jersey, (on curve,)	3	8.
Diameter at base crown,		6.6

Length of Maryland specimen 16.5 lines. Base of crown, 9 lines.

Mioeene of New Jersey and Maryland.

THECACHAMPSA SQUANKENSIS, *Marsh.*

Sillim. Amer. Journ. Sci. Arts, 1869, p. 391.

The enamel of the crowns of the teeth, is in this species quite rugose. The cutting edges are short, and prominent; the general form cylindric and but little curved.

Miocene of Squankum, Monmouth Co., N. J. Mus. O. C. Marsh.

THECACHAMPSA FASTIGIATA, *Leidy.*

Crocodilus fastigiatus, Leidy. Proc. A. N. S., Phil., 1851, 327.

From Eoeene of Eastern Virginia.

BOTTOSAURUS, *Agassiz.*

The characters of this genus have never been pointed out to the knowledge of the writer. In the general form of the under jaw and teeth it does not seem to differ from Alligator. One character which separates it from that genus appears to be similar to that which distinguishes Thoracosaurus from Gavialis, *i. e.*, the absence of long simple hypapophyses on the cervical vertebræ, and their substitution by low transverse or divided elevations. It also appears that the great external foramen which separates the angular, dentary and articular bones was closed up.

BOTTOSAURUS HARLANI, *Meyer.*

Crocodilus harlani, Meyer Palaeologiea, 1832, 108. *Crocodilus macrorhynchus*, Harlan. Jour. Ae. N. Sci., Phil., 1824, 15 (name pre-oceupied). *Bottosaurus harlani*, Agassiz. Leidy, Cretaceous Rept. N. Am., 12–14, Tab.

The teeth of this species are similar to those of Alligator in the short obtuse crowns. The pulp cavity is remarkably large and extends into the crown, leaving the dentine and enamel at the apex little thicker than the sides.

Besides the remains described by Leidy, portions of a smaller, perhaps younger, individual have been presented to the Academy of Natural Sciences by Dr. Ashhurst, from near Birmingham, N. J. They consist of various fragments of cranium with dermal plates. A tooth is compressed, but has a short conie acute crown, such as has not before been seen in this species.

The interorbital region is strongly pitted medially, and exhibits on each side a deep, short groove. There are no marked crests.

The dermal plates are about the size of Holops obscurus, but have smaller pits, wider intervals, and one margin without pits, but smooth and thinned out.

	Lines.
Width ramus where tooth series turns from inner to outer margin,	14.5
" interorbital space,	14.
" articular facet of mandible,	19.
Length dermal bone,	25.

It is difficult to refer vertebræ to this species with certainty, as they resemble so closely those of Holops. The species is less abundant than those of the latter, and being found with them the vertebræ, are easily confused. It is not impossible, for instance, that those referred to H. tenebrosus belong to this animal, as teeth of the latter were found near the same time and place. There have, however, come under my observation some vertebræ different from those of any of the Holopes, which correspond in size and rarity with the present eroeodile. A description is therefore appended.

First—These are a fourth cervical vertebra, and some long bones, which were presented together to the Burlington County, N. J., Lyceum, and were procured at Gaskill's excavations near Birmingham in the same county.

The vertebra differs much in form from other species here described, and though absolutely larger than those of T. neocaesariensis, the neural arch was not coössified with the body, indicating the immaturity of the individual.

The body is but slightly concave between the planes of the parapophyses, which are not at all directed downwards; the latter are very short, and their articular faces are directed posteriorly and outwards anteriorly, the posterior portions being connected by a high crescentoid ridge, whose anterior margin approaches within three lines of the rim of the articular cup; behind, a weak median keel connects it with the body plane, which is succeeded by a prominent tuberosity close to the posterior shoulder. The anterior parapophysial articular surface extends without constriction to the rim of the cup. The floor of the posterior half of the neural canal is broken away, revealing a wedge-shaped chamber, which extends posteriorly and outwardly nearly to the shoulder.

	In.	*Lin.*
Total length,	2	10.
Length to shoulder,	2	3.
Width of cup,	1	8.
Vertical diameter of cup,	1	6.75
" " to edge of parapophysis,	2	
Width between parapophyses near cup,	1	10.
" " " at posterior angle,	2	1.
Length from post. angle parap. to shoulder,	1	1.25
Length from post. angle parap. to cup,	1	2.5

The radii of the median area of articulation are numerous, (34), fine and equal; the transverse rugae of the anterior area are also fine, thirteen in number.

Portions of femur, tibia, humerus, and ribs were in the same lot with the above described vertebra; they resemble the cervical vertebra in color and in the bright green of the matrix which adheres to them externally, as though they had been wet; their size relates so as to render their appertainance to the same animal probable. They indicate an animal of large size.

The shank of the femur is cylindrical at its middle; the prominence of the anterior flexure is situated well below the head, while the head itself is not as broad as in some species (*e. g.* Crocodilus Liporcatus). An obtuse ridge runs from behind forwards and downwards across the outside face of the shaft, transferring the position of the steepest face from the back to the front aspect. On the inner face the trochanter is small, and the surface is swollen near the upper edge at the flexure.

Compared with the shank of the femur of Hyposaurus rodgersi, the present is less depressed and lacks a longitudinal concavity, with obtuse elevated margins, near the superior flexure, which is characteristic of that species. For a considerable proximal portion of the femur, the medullary cavity is quite small; at the middle it is much larger, and the walls quite thin: measurements are,

	In.	*Lin.*
Length of portion of femur,	11	
Largest diameter below head,	2	11.25
Convex extent of head,	4	6.
Circumference of shaft,	4	9.
Diameter of tibia two inches below head,	1	10.
Length of condyles of humerus,	2	9.
Diameter of inner condyle,	1	10.
" region between condyles,	1	6.
" shaft 2.5 inches above condyles,	1	4.
Greatest diameter of head of rib,	2	

Second—A fifth cervical, two lumbars and fragments of long bones from Birmingham, N. J. The cervical is considerably larger than the last, and has the arches coössified ; its total length is 34½ lines, and is appropriate to the adult condition of this animal. The lumbars indicate further the difference between this species and the Hol. obscurus. The cups and shoulder are more expanded latterly than in any species here enumerated, even near the sacrum, and the centrum more depressed, and with concave sides. A very obtuse rib extends along the inferior face.

	In.
Total length,	3.85
Length to shoulder,	2.3
Width of cup,	1.76
" shoulder,	1.76

Both of these specimens represent the *Crocodilus basitruncatus* of Owen, and should their reference to the Bottosaurus by Leidy prove erroneous, will indicate a species under that specific name.

From the Cretaceous greensand of New Jersey.

HOLOPS, *Cope.*

This genus, which appears to differ from Thoracosaurus only in the absence of lachrymal fossæ, has probably been represented by several species during the Cretaceous period in New Jersey. Vertebræ of two species have been described by Leidy as pertaining to the genus Crocodilus. All of them differ from the species of the existing six genera of Crocodilidæ in the absence of elongate hypapophyses on the cervical vertebræ, and their replacement by bified or simple often transverse tuberosities. As observed by Leidy, the T. macrorhynchus from the cretaceous of France presents a similar character.

The student should also notice that in this genus the axis is the longest vertebra, and the third cervical the most constricted. The third cervical vertebra, as well as the axis, is also in Alligator mississippiensis and Crocodilus biporcatus slightly more constricted than the succeeding vertebra. The cups widen above to the fourth dorsal; from this point to the sixth the centra narrow rapidly, presenting more difference than in the same distance elsewhere. The eighth begins to widen again, though still narrowed.

The lumbars grow widest as respect the centrum, to the sacrum. The two sacral vertebræ are the broadest and most depressed and their cups and balls are flattened.

The parapophyses rise from the atlas till they stand truncated above by neurapophysial suture on the fifth dorsal. On the sixth dorsal they stand just above the suture, and on the seventh on a level with anterior zygapophysis (H. brevispinis). Among modern Crocodiles, Caimans and Gavials, Cuvier found hypapophyses on the anterior five or six dorsal vertebræ; on the Holopes and Thoracosaurus these processes are visible on the eighth, and probably on the ninth in H. brevispinis Cope.

The teeth in this genus are much curved. They have long conic crowns with minute lateral cutting edges and minute striæ of the enamel, but no proper ridges as in Hyposaurus. The teeth in T. neocaesariensis are blunter than in the others. In the H. glyptodon, the teeth are coarsely fluted, and the surface everywhere, finely and sharply striate.

As the vertebræ of the species of this genus are very numerous, and the crania are usually much mutilated before coming to the hands of students, I give a synopsis of their characters, including those of Thoracosaurus and Bottosaurus.

I. Cervicals with deeply bifid hypapophyses, and transversely oval cup.

Dorsals with transverse oval cups.

T. NEOCAESARIENSIS.

II. Cervicals with short united transverse hypophyses, slightly bifid posteriorly; anterior extremities more or less quadrate.

Smallest species, vertebræ 16 lines long (without ball); cups of all transverse oval.

H. BREVISPINIS.

Large; dorsals about third and fifth, with subcordate outline and thin margins; *i. e.*, widened above, narrowed below, wider than deep; centra 20-25 lines; cervicals with subquadrate cup.

H. CORDATUS.

Large, centra 20-25 lines long; dorsals about seventh, etc., much compressed; cups deeper than wide, third and fourth regularly round or oval, not cordate, with thick lips; cups of cervicals round or transverse oval.

H. OBSCURUS.

III. Posterior cervicals with hypapophyses scarcely traceable, and well separated.

Large species; dorsals near seventh, with transverse oval cup, with thick margins; cups of cervicals subquadrate, bodies little keeled below; centra 20-25 lines long.

H. TENEBROSUS.

IV. Cervicals with a thick obtuse transverse ridge connecting parapophyses in place of hypapophyses.

Large; cup quadrate. BOTTOSAURUS HARLANI.

HOLOPS BREVISPINIS, *Cope*.

Thoracosaurus brevispinis Cope. Proceed. Acad. Nat. Sci., Phila., 1867, p. 39. Geological Survey N. Jersey, Appendix C.

The specimens on which this species are established are, a cervical vertebra in the Museum of the Academy of Natural Sciences, procured by Timothy A. Conrad at St. George's, Delaware, and one cervical, six dorsal, four lumbar, one sacral and four caudal vertebræ from the Greensand of Burlington County, N. J., which have been liberally placed at my disposal by the Burlington County Lyceum of Natural and Civil History. The last series is from the same individual apparently, and is more complete than that of any other cretaceous Crocodile hitherto brought to light. Also on a seventh dorsal, two lumbars and a humerus from the marl excavations of Samuel Engle, near Medford, Burlington County, New Jersey.

The last are from an adult, while the more perfectly preserved is not fully grown, since the neural arches of many of the dorsal vertebræ have separated at their sutures, yet its approach to maturity is indicated by the persistence of this arch of the third cervical, of some dorsals, lumbars and caudals. The species is the smallest of the genus, and will furnish reliable date for the estimation of the dimensions of other extinct crocodilia. The vertebræ are relatively more slender than those of the Alligators, and the general proportions are more probably those of the T. neocaesariensis and of the Gavials. This will give a basis of estimation for the head and tail.

	Inches.
Length of cervical series,	7.75
" dorsal "	15.
" lumbar "	6.25
" sacral "	2.33
Total body,	31.33
Caudal series (part estimated),	35.
Head (estimated),	13.
Total,	6 ft. $7\frac{1}{3}$ inches.

Cervical vertebræ.—Characteristic of the two of these before us, is the deep concavity of the inferior aspect of the centrum with only a trace of a keel, and the steep elevation of the same surface to the rim of the articular cup. The latter does not form a well defined ridge, but rather a plane, connecting the anterior extremities of the parapophyses, which, in the sixth, supports two short accuminate hypapophyses. In both cervicals the parapophyses look outwards at right angles to the centrum, but as in existing species, possess shorter articular surfaces on the third, whose body is also rather more elongate behind them. In the sixth, which will be typical of the posterior four of the series, from the crest of the posterior shoulder to the posterior outline of the parapophysis, is one-half the distance from the latter point to the margin of the anterior cup, and somewhat less than the articular face of the parapophysis. The posterior shoulder is elevated in both, and the articular globe is contracted and projecting.

The vertical diameter of the neural canal of the third is four-fifths the same as the anterior cup. The latter is small, its vertical diameter being only double the depth of the osseous elevation between the parapophyses. The neural spine is little elevated, compressed, its anterior margin subacute, and obliquely turned backwards to a posterior apex.

Measurements.	*In.*	*Lin.*
Third cervical, total length,	1	5.
Crest of shoulder to outer angle parapophysis,		6.5
Last point to plane of cup rim,		6.5
From middle ball to apex neural spine,	1	7.
Least width of base of centrum,		6.25
Sixth cervical (larger individual), length,	1	7.5
Vertical diameter between rims of cup,		10.5

The expanded bases of the neurapophyses leave only the cariniform epapophysis between them.

Dorsal vertebræ.—The first, third and fourth with the parapophysis on the centrum have lost only their neural arches. The parapophyses have convex articular surfaces, which have a very posterior direction and are followed by a deep depression in the side of the centrum; in the first they are a little behind the middle of the side of the body. The hypapophyses of all are distinguished by their lack of compression and their obtuseness. They are directed vertically downwards, the anterior face posteriorly. That of the first is bifid as broad as long, the others simple, longer than broad on the third. They are preceded by a depression behind the rim of the cup, and succeeded by a second, simple, small hypapophysis near the shoulder, which is finely many-grooved; it exists as a trace on the third, which of all the dorsals, may alone be said to present a very obtuse carina below. The surface in the first three is striate next the rim of the cup; on the shoulder on the first two. The sixth dorsal is more compressed and smoother: its cup is more produced upwards and outwards, while that of the first is more nearly round, and the others are intermediate.

The articular cups of dorsals near the seventh and eighth are nearly round, slightly deeper than broad. The horizontal width of the diapophyses is considerable, and the transverse extent of the articular (inferior) surface of the posterior zygapophysis is equal one-half the length of the centrum between shoulder and cup.

The seventh dorsal of the adult is perhaps twice as large as the above, without being half as large as the same in the H. obscurus. Though the centrum is as much compressed as that of the sixth, the cup is still broader than deep vertically. The centrum has a lateral longitudinal obtuse ridge. The hypapophysis is remarkably large for the position in the vertebral column. It is trigonal in profile with truncate planes before and behind, the anterior concave. The costal articular face is half way to the extremity of the diapophysis on its anterior margin. It is transverse, not vertical as in the sixth in H. tenebrosus.

Sacral.—The first exhibits a longitudinal concavity on the posterior half of the centrum below.

Caudals.—The body of an anterior caudal is not compressed, those of three others, but slightly so; the cup of the first is round; those of the others deeper than broad. Three have stout diapophyses; of these the two posterior have a concave inferior face separated by a strong angle from the sides, while there is an additional lateral angulation on the anterior part of the side of the more anterior. In the two anterior, the neural spine is twice constricted from base probably to near apex, leaving an anterior laminiform portion, and a median much stouter. In the caudals the suture of the neural arch is much obliterated.

Measurements of Vertebræ.

Of Adult.	*In.*	*Lin.*
Seventh dorsal; total length,	1	8.
depth articular cup,		10.5
width,		12.
longitudinal width neural arch (greatest),	1	8.
" " diapophysis,		11.

Of Young.	*In.*	*Lin.*
Sixth dorsal; total length,	1	5.
length to shoulder,	1	1.5
depth neural canal to end hypapophysis,	1	1.5
" articular cup,		9.35
width " "		11.

Measurements of Vertebræ.

Of Young.	*In.*	*Lin.*
Eighth? dorsal; total length,	1	5.
length to shoulder,	1	1.
longitudinal line between zygapophyses,	1	5.5
horizontal base of neural spine,		11.
depth of neural canal,		4.5
" " articular cup,		9.5
width of " "		9.5
neural suture to nearest diapophysis,		3.
Third? lumbar; total length,	1	5.
length to shoulder,	1	1.
longitud. line between zygapophyses,	1	6.
horizontal base of neural spine,	1	
depth neural canal,		4.75
" articular cup,		9.
width " "		11.
First sacral; length,	1	2.75
anterior width centrum,	1	.75
posterior " "		10.
depth neural canal,		4.75
" articulation of diapophysis,		11.
length " "		9.
width neural arch between diapophyses,	1	2.5
Anterior caudal; length,	1	5.
" to shoulder,	1	1.5
depth neural canal,		4.5
" articular cup,		8.
width " "		8.75
width inferior plane,		4.
Distal caudal; length,	1	5.5
" to shoulder,	1	3.25
depth cup,*		6.
width "		5.
length base diapophysis,		3.75

None of the vertebræ exhibit a constriction of the neural canal by a ridge on each of its sides, as is seen in the H. tenebrosus.

This specimen is named from the short longitudinal and vertical extent of its hypapophyses.

A right *humerus* accompanying three vertebræ of the adult, has the same color and mineralization, and was found with them; it probably belongs to the same animal. Compared with a humerus of H. obscurus of medium size, it is three-fifths the length and has more strongly marked articular faces. The head is more transverse, less rounded, and more strongly divided into the scapular and coracoid faces. The width of the head is one-fourth the length, and reaches the summit of the deltoid crest. This crest is lower down in H. obscurus, the above width only reaching its proximal base. The anterior face above the crest is concave in H. brevispinis, nearly flat in H. obscurus. There is a moderate internal tuberosity distally, and the condyles are moderately prominent. Coronoid fossa well marked.

* Measurements of the articular cup are always made from middle to middle of the rim.

	In.	*Lin.*
Length,	6	8.
" to middle of deltoid crest,	1	8.5
Width of head,	1	7.
" shank at middle,		8.5
" condyles,		17.5

A mass of indnarted marl, with vivianite and oxide of iron from Monmouth County, N. J., submitted to me by Prof. G. H. Cook, contains the posterior part of the cranium of this species, with cervical, dorsal, lumbar and caudal vertebræ, dermal plates and coracoids. The individual was immature, as shown by the non-anchylosis of the centrum of the atlas, the neural arches, etc.

The cervical has the small hypapophysis composed of two small separated tubercles slightly prominent. The dorsal, with a prominent hypapophysis which is trincate in front and at the end, has the round cnp characteristic of this species and the H. tenebrosus. The dermal plates are large, elongate-quadrate, considerably exceeding the frontal region in width. Their fossae are in some deep, wider than the interspaces, in others smaller, the plate with a broad smooth bevelled border.

The craninm exhibits the specific and generic characters very well. The muzzle is broken off at the anterior extremity of the pre-frontal bone, showing that there is no foramen as in Thoracosaurus. The acute posterior extremities of the nasals remain. At the anterior border of the orbits the lachrymal is wider than the pre-frontal, and the pre-frontal wider than the frontal.

The pre-frontal suture does not extend further back than opposite the middle point of the diameter of the orbit, No part of the orbital margins are everted, except for a shorter distance on the malar bone. The temporal or crotaphite fossae are of about the same area as the orbits. The width separating them is very little less than one-half the distance between the orbits. The anterior wall of the foramen is not quite vertical as in H. tenebrosus, nor very oblique as in another species. The sculpture is less marked than in the latter, and thongh it would become perhaps more profound with age, it is quite different in pattern from these. There are small pits near the orbital margins, and shallow grooves which incline backwards towards the median line, which is almost smooth. There are no grooves or pits on the interparietal region. In H. obscurus there are large deep pits all over the frontal, which is concave, and broad smooth margins and a median line of pits on the parietal bone. In the the third species (fignred by Leidy Cret. Rept., II., 8,) the pits are more numerons and the interparietal wider, and with marginal grooves. The anterior face of the crotaphite fossa is very oblique, or thickened inwards below, while it is vertical in the H. obscnrus.

	Postfrontal suture, width.	*Frontal width.*	*Parietal width.*
H. brevispinis,	.52	1.23	.6
H. obscurus,	.8	2.	.55
H. ? sp.,	.7	1.95	.68

The surfaces of the malar, postfronto-parietal and post-temporal arches are marked with distant shallow pits. The superior concealed insertion surfaces of the snpraoccipital are largely exposed, and rugose.

The basioccipital, sphenoid and pterygoids are more or less exposed. The first is vertical, with latero-inferior processes directed npwards. The sphenoid has a very narrow exposnre, bnt this is horizontal. The posterior-inner processes of the pterygoid lie closely appressed to the sphenoid and basioccipital laterally. This arrangement is much as in the living Gavialis gangeticus. The posterior nares are more anterior, however, and the septum not completed. Their plane is perhaps a little above that of the orifice of the eustachian tubes. The lower extremity of the basioccipital, has a well-marked posterior keel.

Measurements.

	In.
Length (median above,) to apex prefrontal,	5.5
" (axial) to front of orbit,	4.15
" " " crotaphite foramen,	2.2
Width betweeu extremities quadrata,	6.2
" " postfrontal angles,	2.
" muzzle at point frontal,	3.32
Length dermal scutum,	2.3
" cervical vertebra (to ball),	1.7
Width crotaphite foramen,	1.7

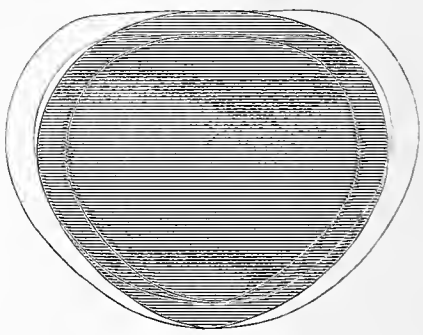
This species furnishes the geueric characters. I have not been able to ascertain the non-existence of the prefrontal foramen in the following species, but as they bear more resemblance in the cranial sculpture and in size to this species, than to Thoracosaurus neocaesariensis, I refer them at present to Holops.

HOLOPS CORDATUS, *Cope.*

Of this species I have only two cervical, two dorsal, and three lumbar vertebræ of one individual, all in a good state of preservation. They present characters similar to those of H. obscurus in the cervical vertebræ, and intermediate betweeu those of that species and the H. tenebrosus in the dorsals. While the fifth dorsal in the former is deeper than wide in its artieular eup and slightly quadrate, the present species preseuts a broadly cordate cup to the fifth, narrowed below, yet considerably wider than deep; the H. tenebrosus preseuts a regularly round or transversely oval eup in the same position, much as in H. brevispinis. The accompanying cut exhibits the difference between this species and the H. tenebrosus. The cordate form is distinct ou the fourth dorsal, where in H. obscurus the eup is regularly oval. The cervieals are not different from those of H. obscurus, except that the eup is rather more prolonged below, or subquadrate.

The cervical vertebræ referred to this species may be known by the outlines of the auterior extremity outside the cup, of which the latter partakes, which is between quadrate and cordate; by the distinct inferior concavity between the parapophyses, and by the gradual but complete lateral eversion of the latter. In the types the posterior shoulder is remarkably prominent. The inferior carina is little marked on the fourth, while the hypapophyses are small and united. In a fifth, judging from the more posterior position of the parapophysis, it is formed of two partly confluent subacute elevations.

Fig. 18.



The dorsal vertebræ, from their nimeralization, condition, and time and place of discovery, probably belong to the same animal as the cervicals above described. The breadth of the cup of the fifth is a little greater than the length to the posterior shoulder, it differs from Leidy's figure of the sixth of tenebrosus, T. III., f. 13, in its large hypapophysis, which stands on nearly the entire centrum, and is very prominent, and concave in front; the sides of the centrum are concave from cup to shoulder. In the third dorsal but a narrow space exists behind and before the hypapophysis, and the vertical diameter of the cup is less than the transverse, and exhibits the same cordate outliue. As usual some (the anterior) lumbars are deeper than wide, and in others the bodies are subquadrate in section, and the transverse diameter of the cup greater. Measurements are as follows:

	In.	*Lin.*
Third cervical : length to shoulder,	2	0.75
" " " " opposite posterior angle parapophysis,	1	4.5
" " width between latter points,	1	10.5
" " least width behind parapophyses,	1	2.
" vertical diameter cup,	1	5.25
" transverse diameter cup, above,	1	5.25
" " " " below,		11.
Fourth cervical : length to shoulder,	2	
" " " end parapophysis,	1	2.25
Third dorsal : length to shoulder,		23.
" " " opposite posterior angle parapophysis,		10.5
" " " of basis of hypapophysis,		14.25
" " width between ends of parapophyses,		33.75
" " " of neural arch just behind diapophyses,		26.
" " " of anterior cup,		22.5
" " " of neural arch,		5.25
" vertical diameter neural arch,		7.5
" " " cup,		19.
Fifth dorsal : length to shoulder,		21.
" " " basis hypapophysis,		14.
" " width of centrum at middle,		12.25
" " " cup,		21.25
" " vertical diameter at middle,		18.
Lumbar : length to shoulder,		25.5
" vertical diameter cup,		20.
" transverse,		19.

Portions of the frontal and parietal bones of a gavial are figured by Leidy (III., fig. 8). They are shown under the head of H. brevispinis not to be referable to the cranium of that species, or of H. tenebrosus ; whether they can be referred to H. obseurus, H. eordatus, or H. glyptodon is as yet uneertain.

This species is no doubt a gavial-like animal, very near the T. obseurus. It is sufficiently different in vertebral strueture ; probably other differenees will be found where other bones are known.

HOLOPS GLYPTODON, *Cope*.

Thoracosaurus glyptodon Cope. Geol. Survey of New Jersey, Appendix C.

This speeies is indieated by a few teeth only, but they are of so marked a eharaeter as to render their reeognition and arrangement proper.

The best preserved speeimen indieates a slender, subeylindrical strongly eurved erown, with the aeute ridge whieh divides the planes extending to its base. There are probably nine obtuse ridges on the inner or eoneave faee, eaeh about as wide as eaeh interval. Both ridges and grooves are covered with sharp fine longitudinal striae, whieh are eontinually iuterrupted and irregular.

The pulp cavity, as on others of the genus, is rat her small. Length of erown, 12 lines ; diameter at base, 4.5 l. The apex is slightly eompressed and smooth. In an older speeimeu the minute striæ are less distinet, leaving the fluting.

From Barnesboro, Glouester Co., N. J. Not found with or near any of the preeeding speeimens, but with dermal plates not distinguishable from those of H. obseurus.

HOLOPS OBSCURUS, *Leidy.*

Thoracosaurus obscurus, Cope, Geol. Surv. N. J., App. C. *Crocodilus obscurus*, Leidy, Smithson. Contrib., 1865, p. 115. Tab. II, fig. 4. *Undetermined crocodile*; teeth tab. I, f. 7, 8, 9.

This species was established by Prof. Leidy on vertebræ from Barnesboro, Gloucester Co. and Arneytown, Burlington Co., New Jersey. I have procured numerous vertebræ from the former locality, which were associated with a cranium, which was nearly destroyed before reaching my hands. Enough, however, has been preserved to indicate with certainty that it is a gavial, and probably of the same genus as that to which Cook's Monmouth County skull belonged. Numerous dermal plates were procured at the same time, which however are not more certainly to be ascribed to the T. obscurus than to the T. tenebrosus, of which several portions were discovered in the same excavations.

The vertebræ from Barnesboro in my possession have apparently pertained to two individuals; two cervicals, a second and fifth dorsal, with six other dorsals and lumbars and a caudal, of the one, and a first and fifth dorsal with eleven other dorsals and lumbar vertebræ, of the other individual.

In addition to these, I have examined two cervicals found with muzzle and long bones at Barnesboro; a fine series of vertebræ and other bones in the Museum of the Academy from near Birmingham; three fine series in possession of Prof. G. H. Cook,† the Mount Holly Lyceum Natural History, and Prof. O. C. Marsh of Yale College, all from Birmingham; portions of two individuals in my own collection from the same place, and a set of eight vertebræ from Mullica Hill in my possession. Numerous other specimens of this species have fallen under my examination. Hence it is obvious that this is the most abundant gavial of the New Jersey Cretaceous.

A series of *cervicals* from Birmingham is instructive, showing the differences in the characters of the respective vertebræ, The axis, which as usual is coössified with part of the body of the atlas thereby much increasing its length, has parapophyses represented by two crests directed downwards and separated by a deep longitudinal cavity; they are united in front. An obtuse ridge on the side of the centrum separates two longitudinal concavities. The third cervical is also deeply concave below, since the parapophyses descend much below the plane of the centrum, and are united by an arched connection in front, which is not separated from the rim of the cup. As usual the parapophyses continue to rise, till on the sixth they are a little above the plane of the centrum. They also become more posterior, till on the sixth their centre is opposite the middle of the centrum without ball: on the seventh this point is behind the middle. The first dorsal is readily distinguished by the small size and posterior direction of the articular face of this parapophysis; its middle is a little below opposite the middle of the cup. On the third dorsal the same point is just above opposite the middle of the cup.

On the fourth cervical a trace of median inferior keel exists; it is quite strong, but thin and concave on the fifth, while on the sixth it is thicker, and does not separate deep concavities, but only slightly concave planes. It is still more elevated on the seventh, and increases beyond. On the third there is no distinct hypapophysis. On the fourth, a transverse elevation on the anterior arch connecting the parapophyses marks it; on the next it appears in the same place as two small longitudinal tubercles with groove between. On the sixth they are similar but stronger. On the seventh it is much more elevated, the groove between its halves being now a transverse plane. On the first dorsal it is a simple, large process, extending over half the centrum with a small knob behind it: on the third it has a longer base, but on the second the longest, extending the whole length of the centrum. On the fifth it is thick, with rounded edge below, and with a truncate triangular face in front. It is apparent on the eighth, as an obtuse elevation in front.

From the fourth posteriorly the characters are drawn from other series, which show many of these vertebræ.

The cups of the third to fifth cervicals look a little more truncate below, owing to the prominence of the transverse ridge. They are almost perfectly round thence to the second dorsal, where the transverse diameter begins to exceed the vertical a little. First on the fifth dorsal the cup assumes some of the narrowed form of the centrum.

The very numerous lumbars present nothing peculiar. As in other species they are more or less striate grooved at the bases of the cups and balls.

The series first mentioned as from Barnesboro presents typical characters of the cervical hypapophyses.

† The types of T. obscurus preserved in the museum of Rutgers College have been kindly placed in my hands by John Smock, Asst. State Geologist.

It is in the third a short acute transverse crest truncate in front, gradually inclined behind; fourth, a similar crest curved into a crescent quite as in Leidy's plate* above cited under T. obscurus. In the fifth they are two weak elevations, much less marked than in the above in my possession. All the above exhibit a well marked constriction between the parapophyses and the rim of the cup. The dorsals with hypapophyses are distinguished by the less cordate form of the articular cups, they being relatively broader below, and in the second to fifth, narrower above than in the T. cordatus. Their neural arches have on the inner faces a ridge constricting the neural canal slightly. The hypapophysis of the two-fifths in my possession are rather short, broad and obtuse.

The cervicals may also be known by their strong posterior shoulder, and constriction of the body behind the parapophyses, where the width enters the length (exclusive of ball) twice: the relation is 1:1.5 in T. neocaesariensis. The parapophyses are most abruptly turned out, and are directed downwards, thus embracing a median concavity which is divided by a rather narrow carina. Separated from the rim of the cup by a narrow transverse plane, a hypapophysial elevation extends transversely between positions in front of the parapophyses: this is less elevated medially than exteriorly, the latter position being marked by a prominent angle.

The articular cup of the first *dorsal* is a slightly transverse oval. The lumbar vertebræ exhibit little to distinguish them from those of other species. An anterior caudal is more depressed than that from near the same position in T. brevispinis. The cup is broader than high, and the inferior plane broad and concave.

Measurements.	*In.*	*Lin.*
Fifth cervical; total length,	2	9.
length to shoulder,	2	1.5
width of neural canal,		9.
" between ends diapophyses,	2	8.5
" " " parapophyses,	1	9.5
lateral depth of body in front,	1	9.
median " " "	1	8.
depth articular cup.	1	4.
" " "	1	4.75
Seventh dorsal; total length,	2	7.
length to shoulder,	1	10.5
width neural canal,		6.25
depth anteriorly, with hypapophysis.	1	11.5
width of cup,	1	6.75
depth "	1	6·25
Posterior dorsal; length to shoulder,		24.25
vertical diameter cup,		20.75
transverse " "		19.

The *mandible* preserved, indicates an animal of considerable size. Estimated according to the proportions of existing Gavials its length would have been :—

	In.
Head,	28.70
Body,	92.85
Tail,	69.64
Total,	Ft., 15; In., 11.19

	In.	*Lin.*
Length of mandible preserved,	13.	
" symphysis,	11.5	
" splenial in front of fork,	4.6	

*II, fig. 4.

	In.	*Lin.*
Width at anterior point of splenial,	2.	
" near extremity,	1.9	
" an inch behind fork,	1.	4
" between rami at same point,		13
Teeth opposite symphysis,	13.	

The larger teeth are all broken, but one with fang exposed, would probably measure when complete 1 in., 10 lin. The form of some of the smaller is well represented in Leidy's figures above cited; they are acuminate, strongly incurved, of a full lenticular section, with an anterior and posterior raised cutting ridge, in the transverse plane of the crown. The sides present numerous narrow weakly defined facets, and are in a half protruded one, finely striate. The alveoli do not open on the horizontal plane of the inside of the mandible, but the latter is raised above them for the posterior half of the symphyseal portion of the jaw; the latter is more depressed towards the extremity. Teeth from other specimens and localities exhibit marked characters. They are all much curved and slender conic, and subcylindric; the tip smooth, the remainder more or less extensively minutely striate, but not fluted or ridged. The fang is slightly flatteued. In T. neocaesariensis the crowns are relatively shorter, less curved and more obtuse; in both the anteroposterior dividing ridge is well marked. Part of the teeth attributed by Leidy to Hyposaurus belong here; see synonymes.

The *muzzle* of a larger individual from Birmingham, accompanied vertebræ of this species, with a smaller gavial cranium in fragments; and a cervical vertebra similar to that described under Bottosaurus harlani. Its refereuce to this species is not certain, but I give a figure of it.

The lateral maxillo-premaxillary suture is not preserved, so the number of premaxillary teeth cannot be exactly ascertained; there are four to the line of the posterior margin of the large incisive foramen, of which the anterior is quite small. The posterior palatal suture of the same clement is prolonged in a narrow chevron on the median line below, to opposite the eighth alveolus from the front; there are nine alveoli behind this point, to the brokeu extremity. A noteworthy character consists in the presence at the posterior part of the series of deep fossae between the maxillary alveolæ for the reception of the mandibular teeth, showing that the latter did not project externally between the former, as in the existing gavial. The same structure appears in the smaller cranium which accompanied it,* but is not found in the Thor. neocaesariensis.

Fig. 19.

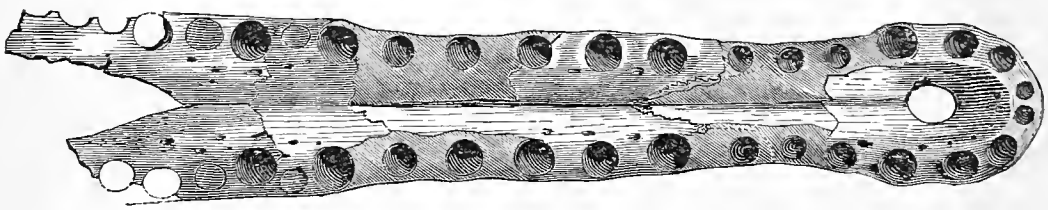
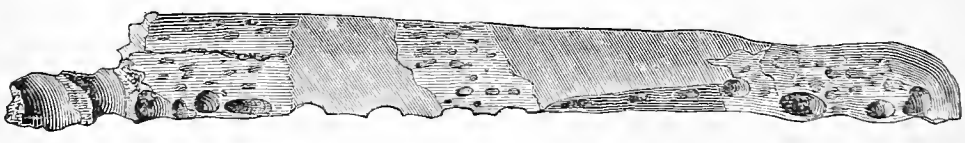


Fig. 20.



* The fronto-parietal region of this one is described under head of H. brevispinis.

Measurements.	*In.*	*Lin.*
Length of muzzle to 16th tooth,	16	0.5
" " " extremity of premaxillary bone,	7	1.
" " " to posterior edge incisive foramen,	2	4.5
" " " to anterior " " "	1	7.5

Humerus.—This, with a femur, belongs to the right side of the series from Birmingham, first described. Its characters are indicated under the head of T. brevispinis. The shaft is rather slender and curved outwards; the head is strongly curved backwards; its articular face is narrow, and remarkably convex. The condyles are broken away, leaving the commencement of the coronoid fossa:

	In.	*Lin.*
Length (restored),	9	5
" to summit deltoid ridge,	2	11
Width head,	2	3
Circumference shaft (least),	2	1

Femur.—This piece is perfect; two distal ends from Barnesboro, besides numerous proximal ends, have also come into my hands. It is more slender than in the caimans and crocodiles of the present day. The inner trochanter is quite prominent, the articular face of the head very convex. The shaft is sigmoidally bent anteroposteriorly, and is bowed extero-internally, with a subordinate abrupt incurvature below the head. The latter is largely caused by a prominent thickening on the inner side. The outer condyle is twice the size of the inner, and they are continued into obtuse crests on the upper face of the bone, of which the outer is much more elevated. Below their sides spread apart.

	In.	*Lin.*
Length,	10	7
" of head (straight),	2	7
" (transverse) of condyles,	2	3
Least circumference of shaft,	3	5

Of *dermal bones*, those of two species, perhaps of more, were procured from the excavations that produced four species of Gavials, with Bottosaurus,* and to which they are to be referred is not very clear. In the one, the pits or fovea are very large and are separated by narrow elevated partitions; in the other they are small and are separated by flat intervals wider than themselves. In the former the fovea extend to the edges of the plate on the bevelled edges; in the latter, the bevelled edges are without fovae. Leidy says of those of this type, "plates coarsely foveated." The first described belong to the median series of the present species, as they usually accompany its bones when they occur alone; and the latter to the external series.

Parallelogrammic dermal bones without pits, and with very high longitudinal crests, standing on more than half the length, frequently accompany remains of this species. They are cervical or nuchal bones, and are of relatively large size, equalling those of the dorsal region. The crests are oblique in the direction of their length. Such bones belong to this species, perhaps to H. cordatus also.

HOLOPS TENEBROSUS, *Leidy.*

Crocodilus tenebrosus, Leidy. Cretaceous Reptiles U. S., 115. Tab. III., figs. 12–15. *Thoracosaurus tenebrosus* Cope. Geological Survey of New Jersey, Appendix C.

This species is as yet little known. Leidy's type is represented by two cervicals, a seventh dorsal, a caudal, and portions of humeri; on account of their close resemblance, and marked specific separation from H. obscurus, I regard as the same an animal of which a cervical and three lumbars are preserved in my collection. The dorsals exhibit a

*Several simple coprolites which accompanied these remains, probably belonged to the same species.

round cup with thick edges. In the cervicals the hypapophyses are represented by rudimental elevations separated by a space, except on the third, where there is the usual anterior cross ridge, followed by a concavity. I refer here a dorsal, kindly lent me by Prof. Marsh, where the cup is more transverse oval than in T. obscurus.

The lumbars from Barnesboro are characterized by a form more slender than those of the T. tenebrosus, more nearly resembling some from the series of T. obscurus. Measurements of:

	In.
Fifth cervical: length to shoulder,	21.
" posterior angle parapophysis,	15.
" anterior " "	6.
width to posterior angle parapophyses,	19.25
" behind the parapophyses,	13.25
" of cup above,	15.
" vertical diameter cup,	15.25
" neural canal,	8.
Lumbar: length to shoulder,	24.
vertical diameter cup,	18.
width of " "	17.
" neural canal,	5.
" basis of neural arch in front,	15.

Specimens of an adult from the pits of the West Jersey Marl Co., near Barnesboro, Gloucester County.

THORACOSAURUS, *Leidy.*

Cretaceous Reptiles, Smithson. Contrib., XIV., 5. Pr. Ac. N. Sci., Phila., 1852, 35.

This genus adds to the characters of Holops, a pair of large prefrontal foramina similar to those characteristic of Teleosaurus, and Plesiosaurus. The other cranial characters, as well as the vertebral, are very different from those of Teleosaurus, which is amphicoelian, and are rather those of the existing Gavialis. The teeth and cervical vertebræ, however, differ from those of the latter genus.

What is not seen in Gavialis or Holops is the character here presented, of a strong septum dividing the posterior nares most completely; the latter open inferiorly and opposite the hinder part of the crotaphite foramina.

A species, the T. macrorhynchus, occurs in the cretaceous of France, as observed by Leidy.

THORACOSAURUS NEOCAESARIENSIS, *Dekay.*

Leidy. Smithsonian Contributions, XIV., 1865, 5. Tab. I.

Gavial Dekay Ann. Lyc. N. York, 1833, 156. Tab. III., fig. 7–10. *Gavialis neocaesariensis* Dekay. Zool. New York, 1842, pt. III., 1844, 82. *Crocodilus s. Gavialis clavirostis* Morton. Proceed. Acad. Nat. Sci., Phila., 1844, 82. Giebel Fauna v. Vorvelt, 1847, 122. *Crocodilus basifissus* Owen. Journ. Geol. Soc., London, 1849, 381, Tab. X., f. 1, 2. Palaeontology, 1860, 277. Pictet Traité de Palaeontolgie I., 1853, 482. *Crocodilus dekayi* Leidy. Journ. Acad. Nat. Sci., II., 135. *Sphenosaurus* Agassiz. Proceed. Ac. N. Sci., Phila., 1849, 160. *Thoracosaurus grandis* Leidy. Proc. A. N. Sci., Phila., 1852, 35.

Cretaceous limestone of Vincentown, Blackwoodtown, and Big Timber Creek; sandstone of Navesink; greensand of Blackwoodtown, Barnesboro, and Monmouth County, New Jersey.

Several individuals of this, the largest of our cretaceous species, have been found, but only fragments preserved. The cranial bones are smoother than those of the species of Holops, and the posterior nares are separated as above mentioned. The cervical vertebræ of this species are distinguished among those of its congeners by the lack of inferior concavity, breadth of basal carina, complete bifurcation of low hypapophyses, and posterior and transverse position of parapophyses.

AMPHICOELIA.

HYPOSAURUS, *Owen.*

Journ. Geol. Soc., London, V., 383.

This genus is as yet the only known representative on this continent of the Amphicoelian Crocodiles. It belongs, says Owen, to the Teleosauridae, from which the great size of the parapophysis distinguishes it. Its remains are quite abundant in the New Jersey cretaceous; stratigraphically its position is the latest of its family. Thoracosaurus being the earliest of the Procoelian Crocodilia, the interesting spectacle is presented of the coexistence in America in large numbers, of two types which, in the old world, are separated by the whole period between the Jurassic and Tertiary.

As might be supposed then, there is some approximation in structure between these two extreme genera of their series. The hypapophyses of the cervical vertebra in Thoracosaurus are of the Teleosauroid type. Both are alike slender-nosed genera, as I have been able to ascertain for the first time for some of them.

As a Teleosaurian reptile the bassioccipital does not present the vertical position usual among the Procoeli, but is horizontal. The sphenoid is also more horizontal in its exposure, and much wider, and with a straight anterior margin, not incised to accommodate the posterior nares. The frontal bone is marked with longitudinal shallow grooves.

The teeth of Hyposaurus are more compressed than in the last genus described, some of them are from the shortening of the crown almost triangular in outline, but most are elongate; the enamel is thrown into a few fine continuous ridges.

The cervicals may be distinguished from those of the other gavials of New Jersey, in addition to the form of the articular faces, by the earlier appearance of a strong keel-like hypapophysis, that is, on the fourth of the series; at first it is most prominent at the anterior end.

HYPOSAURUS ROGERSII, *Owen.*

Loc. Cit. Leidy, Cretaceous Reptile N. Am., p. 18, Tab. III, 4–21.

Vertebræ.—The neural spines of the cervical vertebræ are acuminate, of considerable—finally, of great—height, the anterior standing transversely on the neural arch, the median subtetragonal, the posterior, as usual, longitudinal in section. In an anterior cervical vertebra, length 2 in., the spine is 2 in. 10 l. above the ceiling of the arch, and is acute; it receives a strong lateral wing from each posterior zygapophysis, which does not disappear till near the tip. These enclose a deep groove on each side behind, with a strictly perpendicular posterior median

rounded rib; in front a narrow keel extends from the tip to the neural canal; the lateral alæ are curved backwards. On a more posterior cervical, the lateral alæ are very heavy, short and rounded, and enclose no groove with the slightly projecting posterior vertical rib, while the anterior keel has become a strong compressed wing, dividing two shallow anterior grooves; breadth and length equal in section. In a last cervical, length 2 in. 12 l., the longitudinal section (equal about an inch) is longitudinal cuneiform, owing to the projection of the anterior ala. In an anterior dorsal the section is longitudinal (1 in. 5 l.); the lateral ribs remain at the base only, and the posterior carina is strong and sharp; it is acuminate, and was probably subacute, but is broken at tip; if restored would measure 4 in. 6 l. at least.

Humerus.—This element is relatively much shorter than in Thoracosaurus or modern Crocodilia; it is also stouter and more curved than these, and furnished with very largely developed deltoid crest and condyles. One specimen accompanying femur from the same—the right side, and many other elements from near Birmingham, Burlington County, N. J., have been submitted to me by Prof. Cook.

The condyles are deeply divided, and project far before the coronoid fossa, which is little marked. The shaft is nearly cylindric, strongly arched backwards. The groove bounded by the deltoid crest is very deep. A portion between the head and the crest is lost. The former is truncate above, with a very oblique coracoid face. The medullary cavity is very small.

	In.	*Lin.*
Total length (restored),	10	
Length from condyles to deltoid crest,	6	7.
" across head (straight),	3	2.
" across condyles,	3	0.5
Least circumference of shaft,	4	2.

Femur.—The shaft of the femur is a most characteristic piece from the greensand of the Eastern States. It is rather more than usually flattened intero-externally, and at the point of insertion of the adductor muscle is trilateral in section from the elevation of the ridge of insertion, and the depression of the antro-inferior face into a shallow, longitudinal concavity. The ridge and the surface behind it are rugose. The shaft below and up to the head is longitudinally concave on the inner side, plane on the outer. The articular face of the head has a remarkable antero-posterior extent, and is more obliquely produced upwards and forwards, in relation to the longitudinal axis of the shaft than in the other species. To support it the end of the shaft is turned forwards and strengthened by thickness, having a flat anterior face not seen in other species, and the articular face is bent downwards at right angles to it, and to the course of the longer posterior portion. It is here widest also. This form gives an unusual anteroposterior range of motion, and is appropriate to a powerful swimmer. The insertions for powerful muscles would indicate the same.

The condyles of this femur are lost.

The *teeth* have some resemblance to the Polyptychodons in their strong ridges, but they have distinct anterior and posterior cutting edges, dividing a larger external from a smaller internal surface, the anterior turning in towards the latter, near the base of the crown. The section of the base of the crown is a broad oval, tip more compressed and worn obliquely outwards by use. Internally eight, externally eleven strong, but fine ridges extending over the usual half or two-thirds, alternating with shorter ones; all obsolete at base anteriorly. The color of the two teeth is black at base, ochre at tip; between, lined by both colors.

	Lines.
Total length tooth,	22.5
" crown,	9.
Diameter antero-posterior at base,	4.

These teeth are in the alveolae of a distal portion of the maxillary bone, 4 in. long. Three in. one line includes three alveolae, measuring between margins. The muzzle has been here very slender, as the measurements show, made at the posterior tooth; the anterior teeth issue successively higher up, and above the palatine plane.

	Lines.
Width of palate,	18.5
Height of os maxillare at middle,	14.
Thickness of palatine suture of o. maxillare,	2.5

Cretaceous Green Sand of New Jersey.

HYPOSAURUS FRATERCULUS, *Cope.*

Spec. nov.

This small species seems to be clearly indicated by a portion of the ramus mandibuli containing three and half a fourth alveoli, and two perfect teeth. These parts are less than half the size of those of the smaller individual of H. rogersi, whose maxillary bone and teeth are described in the preceding article. The crowns of the teeth are shorter and more compressed than those in the corresponding part of the jaws in H. rogersi; they are marked with a coarse obtuse fluting to near the tip, with a finely striate enamel as in Holops glyptodon; in those of H. rogersi, the enamel is smooth and ridged by fine keels, which do not extend more than half the length of the crown.

That the animal of which I describe this fragment was not the young of the larger Hyposaurus, is, I think, indicated by the deep grooving and strong ridging of the dense layer of bone of the ramus; by the minute pulp cavity of the crowns of the teeth, and by the well developed successional tooth in the fang of one of the latter, whose apex has nearly reached the alveolar margin. That the individual is not fully grown is probable, but that it is of smaller species than the H. rogersi, there appears to be little room for doubt.

The ramus is scarcely flattened below, as is the case with most gavials, and the depth at the symphysis is equal the width of each ramus. Sculpture in deep longitudinal grooves slightly inosculating. Teeth directed very little outwards: their fangs and crowns are considerably compressed; the antero-posterior cutting edge is stronger than the ridges, and does not diminish to the base of the crown. Viewed from within the form is symmetrical and straight; from behind their crown is greatly incurved. The outline of the crown from within is an isosceles triangle, the width, more than .66 the height. Ribs on the inner face, seven, on the outer, eight. A few teeth in the jaws of H. rogersi are as short and broad as those here described, but they are not found in the middle of the series as in this species, but probably belong in the posterior alveoli, as occurs in some alligators.

	Lines.
Length of fragment,	19.3
Width at middle,	6.
No. of alveolae in an inch: three and half and interspace.	
Length tooth above alveolus,	4.
" crown of tooth,	2.75
Width " " at base,	1.75

From the middle Green sand bed at Birmingham, Burlington, Co., N. J. Presented to the Academy by Judson C. Gaskill.

INCERTAE SEDIS.

The following species probably belongs to the Amphicoeli, but to what genus cannot well be determined, as nothing but the teeth are known.

CROCODILUS HUMILIS, *Leidy.*

Trans. Amer., Phil., 1860, p. 146. Tab.

Bad Lands of the Judith River, Nebraska.

APPENDIX TO THE CROCODILIA.

PEROSUCHUS, *Cope.*

Proc. Acad. N. Sci., Phila., 1868, p. 203.

Characters.—Toes 5—4, with claws two-three. No osseous nasal septum or bony eyelid. Belly protected by series of osseous plates, as well as the back.

All the genera of Crocodiles hitherto known as living, are characterized by the possession of three claws on the fore-foot. The present therefore offers a remarkable exception. The free fingers and half webbed toes, and the bony abdominal buckler, together with the cartilaginous nasal septum, are points of strong resemblance to Jacare (Gray including *Caeman* Gray) but it differs from these creatures in the lack of bony orbit. In specific characters it differs from those of this genus which it most resembles—as J. *nigra*, in the absence of a transverse bony ridge between the orbits. Another feature of importance is the relation of the canine teeth of the lower jaw to the upper. On one side this tooth is received into a notch as in Crocodiles, on the others, it enters a pit of the maxillary bone, within the border of the same as in Alligators! This remarkable combination may be abnormal even in this species, but this cannot he now ascertained, as it rests at the present time on a single specimen only. As its affinities are rather more Alligatorial, I am disposed to anticipate that the dental arrangement of the latter animals will be most common.

Fig. 21.

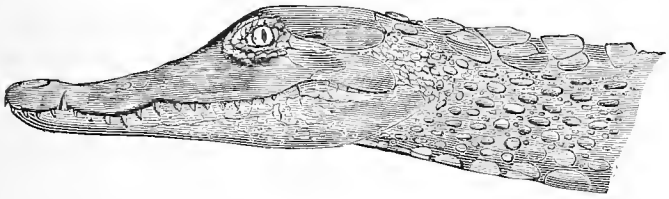


Fig. 23.

Fig. 22.

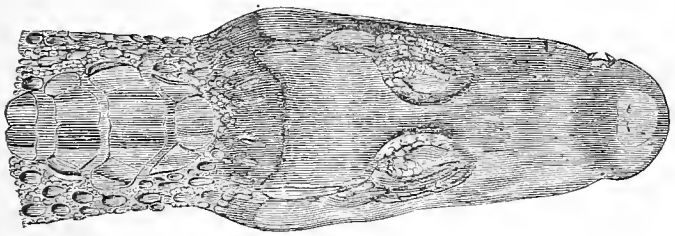
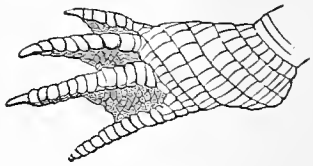


Fig. 24.



PEROSUCHUS FUSCUS, *Cope.*

Char. specificus.—Nuchal plates in a cross row of six; cervicals in four cross-rows, all of four plates except the last of two. Dorsal plates in six—in a few eight in each transverse row. No posterior crest on arm or leg. Tail short with remarkably low crest. Muzzle broad flat, without any ridges; its width at the eighth tooth entering 1.4 in length from end muzzle to anterior margin of orbit.

Description.—The specimen in the Museum of the Academy is young, measuring only 2 feet 5 inches in length. Of this the skull measures to the margin of the supra-occipital 2 in. 10.5 lines; and the tail to the vent 13 in. 7 lin. From groin to heel 3 in. 2.5 lin., and the hind foot 3 in. 7.5 lin. The muzzle is a broad ovate, the sides rather more convergent anteriorly than in the Alligator *mississippiensis*. There is a thickening in front of each orbit, and

between them on the middle line another which together enclose two shallow concavities. Superciliary margins raised, the cranial table quite flat. The margin of the quadratojugal bone projects strongly. The scales of the limbs are all smooth, and those of the dorsal region with very low keels. The sides have four longitudinal rows of ovate scales separated by scarcely defined smaller ones. The abdominal plates are longer than broad, and are in twelve longitudinal rows. Dorsals in seventeen transverse series from interscapular to crural region. The lateral crests of the tail are only obtuse keels; they unite on the thirteenth annulus behind the vent inclusive. Color above dark brown, almost black on the upper surfaces of the head. The tail is paler, of a light olive brown. Lower surfaces everywhere bright yellow, including the entire lower jaw and margin of the upper. Eyelids and a band through ear yellow, the former with a black spot above.

Remarks.—This interesting addition to our knowledge of the Reptilia was made by Schulte Buckow of New York, while on a visit to the interior part of the course of the Magdalena river in New Grenada. This naturalist has also enriched our collections with other interesting vertebrata of that region, both living and dead.

OSTEOLAEMUS, *Cope.*

Proceed. Acad. Nat. Sci., Phila., XII, 550, 1860. *Halcrosia*, Gray Ann. Mag. Nat. Hist., 1862, 273.

As this genus has been variously understood, since its first publication, I take the present opportunity of quoting the original description, and adding such observations as are necessary to a full comprehension of the species embraced by it.

"Osteolæmus, Cope, was characterized as a genus of Crocodiles presenting several points of analogy to the Alligator. The nasal bones were prolonged anteriorly, and uniting with the short spine of the intermaxillary, divided the external nasal orifice, as in the genus Alligator. The eyelids were entirely osseous as in Caiman. There was no transverse bony ridge between the orbits. The dermal plates upon the tail, extremities, and the thorax, were more or less completely ossified; upon the gular region the ossification was most complete, the shields having a coarse natural articulation.

"The digits of the posterior extremity were very slightly webbed.

"Cervical plates distinct from the dorsal.

"Mr. Cope alluded to the remarkable extent to which ossification was carried in this genus. The cranium was much more rugose and pitted than in the adult specimens of much larger species, and the crotaphite foramina were roofed over by bone. The latter peculiarity was sometimes observed in the genera Jacare and Caiman.

"The osseous gular and thoracic buckler was also similar to that exhibited by those genera, and by the extinct "Crocodilus" Hastingsiæ Owen, the existence of which has been shown by Professor Huxley.

"Two specimens were exhibited: one a skin brought from the Ogobai river, Western Africa, by Mr. P. B. Du Chaillu; the other, the skull of a half grown individual, obtained from the Museum of the Pennsylvania University,

"These Mr. Cope regarded as belonging to a species hitherto unknown, and which he proposed calling Osteolaemus tetraspes."

Several descriptions of species of this genus have been published under different names. It is a matter of question whether all do not relate to one species. A young one was described by Murray, whose muzzle was of course much broader in relation to its length than in the adult. An adult was afterwards described by Lilljeborg with the relatively longer muzzle. It differed from that described by Murray in having but four rows of dorsal shields, and but two pairs of cervicals; in the latter there are three pairs of cervicals and six rows of dorsals. My type specimen, brought from the Ogobai by DuChaillu possesses six rows of dorsals, and only four cervicals, thus combining the characters of the two. Gray, however, who has seen Murray's type, says there are but four rows of dorsal plates; in the Ogobai specimen one row has but five, and in three others the two outer are nearly united; so I am disposed to think that no great importance is to be attached to this character. Murray's specimen has the relatively enlarged brain cavity of a young animal elongating the table of the cranium; Lilljeborg's, which is adult, maintains this character more than our specimens do. Gray gives a figure of the cranium of the adult, which coincides with two crania in our Museum, one of the above mentioned specimen, while both agree in the proportions of the muzzle with that described by Lilljeborg. The last, however, differs from all these in having the table of the cranium but little

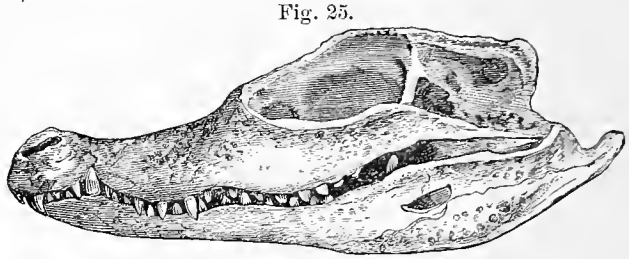
wider than long; in our specimens and Gray's figure it is nearly twice as wide as long. It also appears that the nasal bones do not entirely divide the nasal meatus, which they do in the three specimens under observation. On the whole I am disposed to think that these forms belong to one rather variable species. It is true that Gray says "hind foot fringed," but this I am inclined to think must be true to a very limited extent. There is only a keel in our specimen, and Lilljeborg says there is no fringe in his.

OSTEOLAEMUS TETRASPES, *Cope.*

Proceed. Ac. N. Sci., Phila., 1860, 550.

Crocodilus palpebrosus, var. 2, Cuvier. Oss. Foss. iii., t. 2 f. 6 (part).
Crocodilus trigonatus (part) Cuvier. Oss. Foss. iii., 65.

Fig. 25.

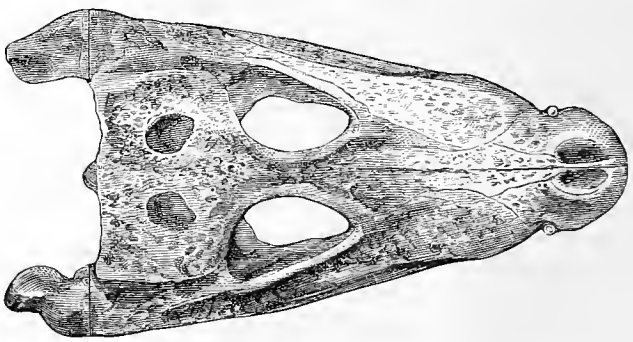


African Black Crocodile, Gray. Rept. British Assoc., 1862, Zool. Section, 107.

Osteolaemus tetraspes, Cope. Proc. Acad. N. S., Phila., xii., 550.

Crocodilus frontatus, A. Murray. Proc. Zool. Soc., 1862, pp. 139, 213, fig. head, t. 29, by Ford. Strauch, Syn. Cro., t. I., head (young).

Fig. 26.



Halerosia frontata, Gray, Ann and Mag. Nat. Hist., 3d series, X., 277.

Halerosia afzelii Lilljeborg. Proceed. Zool. Soc., London., 1867, 715.

Habitat, Gaboon Ogobai (Duchaillu).
Calabar (Murray), Sierra Leon (Afzelius).

This species was originally characterized as follows:

Proportions of the head somewhat similar to those of Crocodilus trigonops, Gray, of India. Breadth of muzzle at ninth tooth equal to the distance between the external nasal orifice and anterior border of the orbit, and to the width of the table of the cranium posteriorly. A short ridge in front of each orbit, directed obliquely inward.

Teeth $\frac{17}{15}$, rather compressed. Four nuchal shields, in a single transverse series; four cervicals in pairs; Dorsal shields in six rows. Posterior extremities without fringe. Total length of the entire specimen, five feet.

In addition to the characters given above may be mentioned the strong concavity of the muzzle in the longitudinal direction, and the prominence of the nares. The margins of the maxillary are very sinuous, being much contracted behind the fourth and eleventh teeth. The derm of the head is thin and corneous, and divided into many segmcuts, which have a fine sculpture of straight lines radiating from the centre in each. The bones of the cranium are very strongly pitted. Seventeen transverse series of plates between nape and posterior line of femora, 12 to union of lateral caudal crests, and 19 from that point to end of tail. Nineteen cross-rows of large plates from ankle joint to groin, on anterior face of limb. Counting similarly on the fore limb, there are 13 series. Only the two lateral dorsal keeled; keels of the outer of the first eight caudal annuli, low.

Color everywhere black; the plates occasionally with irregular olive lines. The young, according to Murray, have olive bands on a yellow-brown ground, including two bands of plates, and separated by two bands. Total length, five feet; muzzle to supraoccipital ridge, 8 in. 9 lin.; do. to posterior margin thighs, 2 ft. 7.6 in.

Gray supposes this to be the "Crokodil noir du niger" of Adanson, and hence cites as its earliest name *Crocodilus niger* Latreille. Dr. Strauch, however, shows that this is probably the *Crocodilus cataphractus* Cuvier, and I have pointed out that it cannot be the species of Latreille.

DINOSAURIA.

The ilium extended horizontally forwards, and supporting a number of vertebræ anterior to the two sacrals of other Reptilia. Acetabulum perforate, and partly enclosed peripherally by the ilium and pubis. Pubes elongate, parallel; ischia longitudinal, in plane of ilium, elongate, with distinct head for pubis. Femur with transverse neck and head, and third trochanter. "Cervical and anterior dorsal vertebræ with par and diapophyses, for articulation with bifurcate ribs." Neural arches of dorsal vertebræ attached by suture; of sacrals, shifted over the intervertebral sutures.

The structures presented by the Dinosauria have presented greater difficulty of explanation than any other type of extinct vertebrates.* This has in part resulted from the attempt so assign them to types already known, and to explain their structures in accordance therewith; a course scarcely consistent with our present knowledge of the peculiarities of the parts themselves. The type is a good illustration of the necessity of interpreting extinct forms by a combination of the "law of successional relation," with "the law of types" or of morphological "correllation," and not by either alone.

The direction assigned to pubes in this order, is suggested by considerations explained below. They have probably diverged forwards and downwards from the vertebral column and their great length indicates a prominent abdomen. The only Dinosaurs where they are preserved in place, the Stenopelix valdensis of Von Meyer, and Compsognathus longipes of Wagner, justify this proposition. The ischium in Stenopelix and Teratosaurus is a broad flattened bone slightly curved in the lateral direction, and of sufficient strength with its fellow, to support the weight of the animal when in a sitting posture. The pubes in Hadrosaurus and Compsognathus are much more slender and proximally dilated; as in the Crocodiles the chief support of each is derived from the articulation with an anterior tuberosity of the ischium. The articulation with the ischium is probably wanting or very slight and ligamentous, and the acetabulum was thus open, a large foramen being included by the three bones which usually compose it.

The head of the femur is transverse to the direction of motion of the condyles, and not oblique as in modern lizards. Hence the motion of this element was in a line parallel with the axis of the body, and the limb could not be directed obliquely from that axis so as to allow the body to rest on the ground between them in the ordinary progression of the animal, as is the case with Iguanas, Crocodiles, etc.

The fore limbs appear to have been weak, even when somewhat elongate, as in Iguanodon. Their articulation with the scapula is a singular part of the structure. In

* For discussions of these relations see Proceed. Ac. Nat. Sci., Phila., 1866, 317, and Proceed. Amer. Philos. Soc., 1869, 16.

Iguanodon and Hadrosaurus there is a very small sphaeroid condyle on the inner side of a broad proximal extremity. If the condyle only articulated with the scapula, the rotation of the humerus would be very limited; if the long narrow proximal articular surface, which is the whole of the flattened proximal extremity of this bone the rotation would be still less. In Laelaps however I find no round condyle, only the long narrow articular face of the proximal extremity, as in the Crocodiles. This would not allow of abduction and adduction, but as in the bird, of only flexure and extension. This is readily seen in the movements of the Crocodile. I suppose the anterior limbs were more useful as supports when these animals placed the head near the ground, than for any other purpose, especially in Laelaps and its allies.

The character of the articulation of the vertebral column by intervertebral discs, the double headed ribs, the elongate sacrum and large medullary cavities of the long bones have been cited by Prof. Owen in evidence of the Mammalian tendencies of the animals of this subclass. Their reptilian features, the single occipital condyle, quadrate and coracoid bones, with the median tarsal ginglymus, are equally shared by the Aves, though most of the usual distinctions between the latter class and the Reptiles hold good here also. Prof. Owen also points out a special bird-like tendency in the alternation instead of superposition of the neural arches of the sacrum on their centra; and other points can can now be added. Thus the reduction of the metatarsals to three in some of the genera, and their close approximation and excess of length over the phalanges, brings to mind these bones in the penguin. With the same reduction follows the confluence of the first series of the tarsal bones, and the great diminution of strength of the fibula and its close application to the tibia; the front limbs are much reduced, and the long bones more pneumatic. In the most extreme form in this direction known, the first series of tarsal bones is entirely confluent with the tibia as in the birds, the three metatarsals are much elongate, the cervical vertebræ increase in number, and the pubes assume a position at right angles to the vertebral axis, which is intermediate between their anterior position in most Reptiles, and their posterior, in Birds.

These features indicate three perhaps suborders, which are defined below.

Quite as important, as indicating the avine affinity and remarkable character of this order, is the evidence derived from the pelvis. And first, the support of this arch, the femur, has been already alluded to. The head and neck of this bone are at right angles to the direction of the condyle. In other reptiles the axes of these are oblique to each other, so that the femur does not move in the direction of the axis of the body, but obliquely to it, thus permitting the body to rest on the earth. In the present case the structure is the same as in the birds and Mammals; the femur could only move in a plane parallel with the axis of the body. The reduced length of the fore limbs of many Dino-

sauria, renders it impossible that they should have reached the ground, in progression, if the posterior were at all extended, and suggests that these reptiles walked erect. That this was the case is demonstrable from the materials at our disposal, I am inclined to believe.

The ilium, instead of having a vertical position as in reptiles, is longitudinal as in birds. That is, the small process which, in Lacertilians and Crocodiles, projects in advance of the acetabulum, is largely extended and developed, while the lower extremity of the posterior, or principal portion, is raised anteriorly, so that the two together constitute an elongate element, embracing not only the two posterior or original sacral vertebræ, but a considerable number anterior to them. The effect of this is to diminish the proportionate number of lumbar or dorsal vertebræ, to increase the length of the consolidated sacral series, and to throw the acetabulum, and consequently the femur farther anteriorly, and also farther upwards, than in the ordinary reptiles. All these features are characteristic of the birds, and have direct reference to an upright position. Thus it is readily perceived that the consolidation of the sacrum, is related to the need of a greater strength of support at a single point; its length, and that of the ilium, to the throwing forwards of that support to beneath the centre of gravity of the animal's body.

The very elevated position of the acetabulum, and consequently of the usual point of support of the pubes, renders it in the highest degree improbable that the latter bones had the usual direction and position seen in the reptiles. That is, an anterior position would not allow of space for the enlarged visceral cavity which these creatures probably possessed. But it is obvious that in most of the Dinosauria, if not in all, the pubes were not supported in the same manner as in most Reptiles. In Hadrosaurus and Iguanodon there appears to have been absolutely no point of union between ilium and pubis, and in Teratosaurus and Megalosaurus that union, if existing, must have been very slight. The ischia of Stenopelix, Hadrosaurus, and Iguanodon furnish the substitute for this, in an anteriorly directed process for the support of the pubis, a feature otherwise characteristic of the Crocodilia only, among reptiles.

I conclude, therefore, that the pubes were not directed forwards and that they were not directed backwards either, in those forms at least, where there is no preacetabular support for that bone. They must therefore have been directed downwards, and this is the position they have in the extreme avine form Compsognathus.

Such ischia as we are acquainted with, are of a remarkably elongate form, simulating those of birds rather those of reptiles, and indicating clearly the existence of a great pelvic visceral cavity.

From these considerations as to the extent of the pelvic elements we derive further, that the visceral cavity was mainly supported by them and that it was transferred so as to be

posterior to its position in ordinary reptilia. This, taken in connection with the anterior position of the support of the body—the femur, rendered the erect progress of the Dinosauria possible.

Another approximation to the birds will probably be found in the sternum and coracoids. These elements are but little known, and that imperfectly; the best example has been furnished by the great Teratosaurus suevicus Mey. Here, according to Plieninger, the elements corresponding to the xiphisternum of Lacertilia is a large thin shield-like bone, of elongate form. The coracoids are narrow, prismatic bones, and abut against the anterior angles of the xiphisternum; being entirely different from the broad flat element of the Lacertilia and other orders, which are usually extensively in contact with each other or with the xiphisternum.

We have, however, among Dinosauria, as among Quadrumanous Mammalia, a series of forms, from those constantly assuming the prone Lacertian position, to those that walked exclusively erect like birds. Perhaps the most Lacertilian form known is the genus Scelidosaurus of Owen: the greater equality in length of the limbs, and the numerous toes, as well as lacertilian dentition assign it to this place. Then we find forms like Iguanodon and Hadrosaurus, the most gigantic of land animals, where a semi-erect attitude was the natural one, as they like the Megatherium and Megalonyx, lived on vegetable food, and were necessitated to raise themselves on their hinder limbs to reach it. Here the bird-like type is approached, in the reduction of the metatarsi to three, and the great antero-posterior extent of the ilium. In the genus Laelaps the position was probably quite erect, and additional resemblances to the ornithic type are adapted to large animals no longer requiring a vegetable diet, but procuring their living food by activity and strength. They are accordingly organized so as to be entirely independent of extraneous support, and furnished with great powers either of running or leaping.

Intermediate between this extreme, and the type of Ignanodon, comes a large carnivorous genus, the Megalosaurus of Buckland, the representative of types like Laelaps, in the old world. In its longer fore limbs it differs from the most bird-like forms. A carnivorous type only known from teeth, is Aublysodon Leidy; it is American.

The other herbivorous species, of less size than Iguanodon, which was furnished with a dorsal series of dermal bones, is the Hylaeosaurus armatus Mantell, found in the Wealden of England; while an allied form which was covered with long massive dermal spines, has recently been discovered in the same formation in the Isle of Wight, and referred to the genus Polyacanthus Owen.

The sizes of the best known species of these genera are as follows:

	Length ft.
Polyacanthus, Owen,	9
Scelidosaurus harrisonii, Owen,	12
Iguanodon anglicus, Meyer,	28
Hylaeosaurus armatus, Mant,	21
Hadrosaurus foulkei, Leidy,	28
Poecilopleurum bucklandii, Deslong,	25*
Megalosaurus bucklandii, Mant,	?30*
Laelaps aquilunguis, Cope,	24
Teratosaurus suevicus, Meyer,	?30
Ornithotarsus immanis, Cope,	?35

Prof. Owen suspects the animals of this order to have had the septum of the ventricles of the heart complete as in the Crocodilia. It is an interesting inquiry whether there were two aorta-roots or only one, and if one, whether the right or left remained. I have little doubt that the Dinosauria further resembled Crocodilia in having the lateral lobes of the cerebellum developed, and the vermis plicate.

The affinity to the modern Sauria, or Lacertilia, which some authors have allowed of, is very slight; the Crocodilia, though somewhat removed, are the nearest living allies. If we consent to a derivative relation between types, we must consider this order to have given origin by divergence and metamorphosis to both the Mammalia and Aves. The structure and embryology of the last two classes forbid the idea that either could have been derived from the other.

Besides the differences in the structure of the tarsus and metatarsus observed in this order, there are marked differences in that of the tibia. Thus most of the order present a very prominent spine and crest, of bird-like character; but Plateosaurus Meyer and Teratosaurus Meyer both Triassic genera, appear to possess this character in a very slight degree, the former scarcely at all. I have, therefore, not included them in the groups following.

ORTHOPODA.

Cope Proc. Acad. Phila., 1866, 317. *Therosauria Haeckel*, 1866.

Proximal tarsal bones distinct from each other and from the tibia, articulating with a tibia and with a terminal face of a well developed fibula. The ilium with a massive narrowed anterior prolongation.

In the few genera of this suborder, of which the teeth have been discovered, a successive divergence from the type of the Goniopoda is visible, in the shortening and increase in

* These estimates I have reason to think exaggerated.

number of the metatarsals. Thus so far as known, according to Owen, Hylaeosaurus Mant. had three closely approximate metatarsals. In Hadrosaurus they are elongate, but their number is unknown. In Iguanodon, Owen represents a fourth, but rudimental metatarsal, the hind foot being still three-toed, while in the more ancient genus Scelidosaurus, the same authority gives four shortened metatarsals, of which the smallest supports a digit; and a fifth rudimental metatarsus, which supports no digit. In Stenopelix there appear to be five digit bearing metatarsals according to Von Meyer.

This order is then probably divisible into the following families:

I. Teeth in several rows forming a vertical pavement; metatarsals ? three.

HADROSAURIDAE.

Embracing the genus Hadrosaurus, Leidy.

II. Teeth in a single row, cutting; three digit bearing metatarsals.

IGUANODONTIDAE.

Genera Iguanodon Buckl. Hylaeosaurus Mant. ? Palaeoscincus, Leidy.

III. Teeth in a single row, cutting; four digit bearing metatarsals.

SCELIDOSAURIDAE.

Genera Scelidosaurus, Owen. Stenopelix Myr. (?teeth). The last named genus is known from a single skeleton, in which according to Von Meyer, the sacral vertebræ are all distinct. It is perhaps an immature individual.

HADROSAURUS, *Leidy.*

Proc. Ac. Nat. Sci. Phila., 1858, 218. Cretaceous Reptiles N. Am., 76. *Trachodon*, Leidy, L. C. 1856. ? *Thespesius*, Leidy l. c.

This genus embraces at least two species which are among the most gigantic terrestrial animals of which we have any knowledge. They represent the Iguanodon of the old continent, whose species is similar in bulk. The two genera, however, differ in many details. The teeth, as above noted, are different. The spines of the dorsal vertebræ, instead of being flat anteriorly, are smaller and slender subcylindric.

Most of the characters of this genus have been given by Leidy in his description of H. foulkii. I add a more complete examination into the characters of the scapular and pelvic arches, which are but lightly treated of in the "Cretaceous Reptiles of N. America."

Scapula.—Here may be introduced a description of certain massive bones of two individuals of a species of Dinosaur. I had formerly admitted the possibility of their pertinence to the pelvis of Hadrosaurus, but the discovery of that element in the H. foulkei, indicates that another place must be sought for them.

Fig. 27.

There was when the bone was complete, a double head, the anterior or superior apparently for articulation with the coracoid; the inferior, to receive the proximal end of the humerus, whose condyle is adapted to it both in size and shape. It is a flat bone curved in the direction of its plane, which is vertical, and narrowed distally, where it is broken off. It is expanded proximally into two heads of which the support of the inferior is in the general plane, while that of the superior is obliquely transverse to that plane: this head, which I believe to be the anterior and attached to the coracoid, is broken off. The inferior articular face is slightly concave; it is rugulose for an articular cartilage, and its plane is exactly transverse to the long axis of the bone. Its form would be vertically oval but for an expansion on what I suppose to be the outer side. The inner side is characterized by an obtuse longitudinal ridge, which extends upwards and backwards from the anterior head and soon disappears. A similar ridge is seen in the ischium of Crocodilia. As this ridge disappears from the inner side, a more obtuse one appears on the outer, and is in line with the subtransverse expansion of the neck of the anterior head; it soon reaches the posterior margin of the bone, which it thickens. Between this point and the posterior head, the margin is thin and acute. A more imperfect specimen of the same element from the same side (the right) of a rather smaller individual exhibits similar characters.

As compared with the scapula of Iguanodon, Hylaeosaurus and Scelidosaurus, a strong resemblance is seen in the marked distinction of the outline of the glenoid cavity, and the existence of a large distal depression of a subtriangular form. The anterior expansion is broken away, but from the indications at the fracture was probably well developed.

The proportions of the larger scapula indicate a gigantic animal fully equal to the known Hadrosauri; the humeral support agrees with that bone in the latter. The dimensions are as follows:—

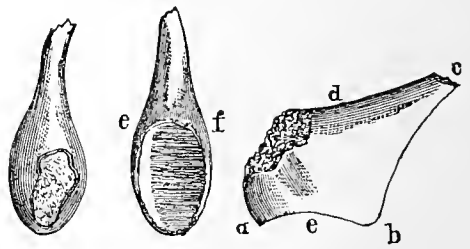
	In.
Length of fragment on posterior margin,	13.9
Depth proximally (greatest),	7.2
" distally,	4

	In.
Depth of glenoid cavity,	3.4
Width " " "	3.16
" " anterior expansion,	4.22
" " fractured end,	1.8

Another fragment of an animal of dimensions similar to the last was found at the same time and at or near the same place, (Freehold,) in Monmouth county, New Jersey, but cannot be associated with the above described scapula, as neither the place nor time of discovery can be ascertained with sufficient accuracy. It appears to be the glenoid cavity of a scapula from which the blade has been broken off, and from which a short subconic procoracoid projects. The accompanying cut and measurements will furnish the requisite information respecting it.

Fig. 28.

	Inches.
Length from *a* to *b*,	5.54
" " *b* to *c*,	7.22
" " *d* to *e*,	4.71
" " *e* to *f*,	3.53



The fragment may belong to Mosasaurus.

Pelvis.—There is much difficulty in determining the true relations of the pelvic elements of these and other Dinosauria, owing to their unusual forms, our imperfect materials, and the discrepancies between authors.

Ilium.—One of our best clues is the skeleton of the Iguanodon discovered at Maidstone, and preserved on a block of rag, which has been described and figured by Professor Owen. The bones mostly preserve a normal though much disturbed relation to each other. An examination of the figure and description strongly suggests—

First, that the hooked superior prolongation of the ilium is the posterior, not the anterior, as described by Owen. This is confirmed by Owen's figure and description of the ilium and sacrum of the same species in Wealden Reptiles, Pl. III. (Iguanodon), where the thick hook-like process with its abrupt descent to the acetabulum, is also posterior.

The structure of Hadrosaurus, in which both caudal and lumbar vertebræ have been discovered, proves that this relation is the true one. The caudals have a greater transverse diameter than the lumbars, which are comparatively quite contracted from side to side. This is the reverse of what is usual among reptilia, where the caudals are usually

the most contracted. The wide caudals continue without contraction to the point where the tail reaches the ground. They then begin to elongate. The anterior vertebræ thus form a massive column, which no doubt supported the weight of these monsters. That the ischia performed this function in part in Lælaps, is evident not only from their more massive structure, but from the more elongate caudal vertebræ, while the still more slender caudals in the known Triassic genera, adds to the evidence derived from the ischia as to their use.

In the ilium of Hadrosaurus the slender hooked process and the expanded tuberosity both exist, and I am disposed to place the former posteriorly, and the latter anteriorly and externally as the most probably correct relation. This, moreover, throws posterior to the acetabulum, the more elongate articular face, where one might look for the ischiadic suture with propriety. This arrangement, however, presents the apparent anomaly of position, that the planes of the inner faces of the ilia are made to converge instead of diverge, thus rendering the interiliac cavity remarkably narrow. There can, however, be no doubt that this is really their position in Iguanodon, judging from Owen's figures (above), III. and IV., and that the sacral diapophyses really rest on the convergent faces of the ilia, whose planes are directed inwards as well as downwards. This adds still further to the peculiar ensemble of characters of these Dinosauria.

This relation has already been described as the true one, by Leidy.

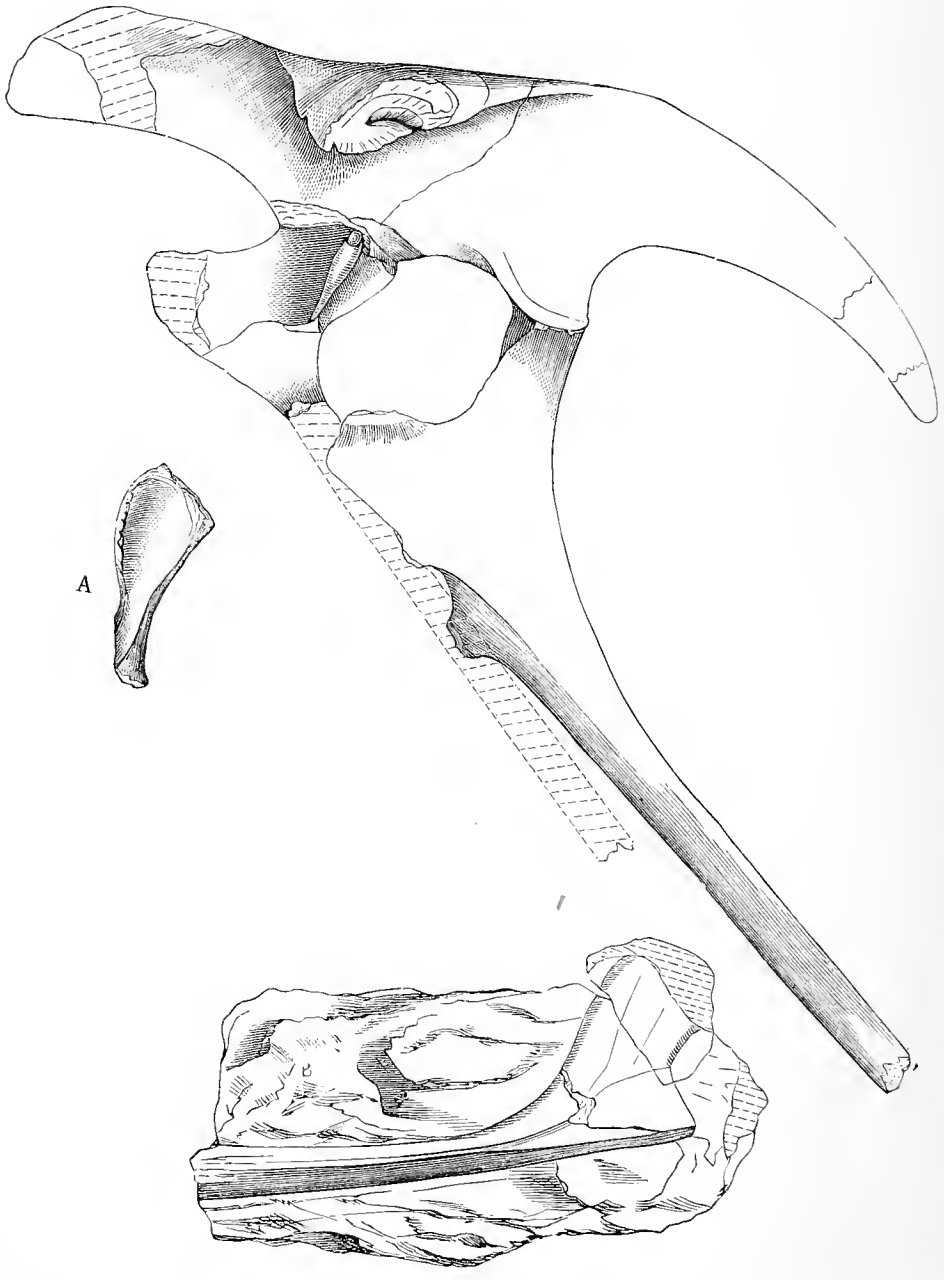
The anterior prolongation of the ilium in Hadrosaurus appears to be less slender and more plate-like than in Iguanodon and Scelidosaurus, where it is remarkably produced. Nevertheless, in the accompanying cut, the restoration (by Dr. Horn) of the anterior portion may be too much dilated, and is probably not long enough.

Pubis. This element of Hadrosaurus has never been described. I believe that I find it in a proximal portion of a large bone, which occupies this relation very appropriately. Its proximal superior subtriangular articular face is naturally associated with the already assumed anterior articulation of the ilium, and when so placed, presents outwards the smooth articular surface of the anterior part of the acetabulum. It also presents forwards a narrowed process, and in line with the same posteriorly, a broad, vertical plate which is soon broken off, but which I suppose to have been continued but a short distance. The posterior process I suppose has been continued as the support of a slender pubis,* conforming in this respect to the type of birds. That there is very little trace of articulation for ischium behind the acetabulum is obvious, so that it is to be supposed that this element was small, vertically dilated proximally, and in contact with the pubis at the superior processes on the supero-external margin of the latter.

* A suspicion which I at one time entertained, that the so-called pubis of the Crocodilia was homologous with the marsupial bones, has been removed, by reading Rathke's posthumous work on the development of the Crocodile.

	Inches.
Length iliac face pubis,	4.25
Width " " "	2.9
Entire depth,	7.5
Width pubic process where broken,	2.
" anterior process where broken,	4.6
" acetabular face,	3.4

Fig. 29.



Ossa ischia. These lateral elements are not very different from those identified by

Owen in Iguanodon with clavicles, and by Leidy in Hadrosaurus with the pubes. The Director in the British Museum has well pointed out the possibility of such a form of clavicle being probable, after a comprehension of the variations presented by the modern Sauria, and the not dissimilar form in Trachysaurus and Cyclodus. Leidy, however, is of opinion that similar bones in Hadrosaurus resemble rather the pubic bones of Iguana, and calls them pubes, with doubt. The writer sees a much greater resemblance between them and the elements called ischia by Wagner in the Compsognathus, and which are homologous with the posteriorly directed bone so called in birds.

It is noticeable that in the great Dinosauria the supposed clavicles do not diminish in length in the same proportion as do the humeri, as one would be led to expect were they clavicles. The relative lengths in three species are as follows :—

		Inches.
Iguanodon anglicus ;	humerus,	35.
	os ischium,	29.
Hadrosaurus foulkii ;	humerus,	22.5
	os ischium,	27.
Laelaps aquilunguis;	humerus,	12.
	os ischium,	20.

Their density and strength in the last named species are not readily reconcilable with the needs of such small fore limbs. Further, in Stenopelix Myr. and Compsognathus, where similar elements exist in the position of pubes and ischia, no clavicles have been preserved to us.

The more or less normal position in which these bones were found in the Maidstone specimen of the Iguanodon, as given in the figure accompanying Prof. Owen's monograph, has been already alluded to ; the ilia were lying parallel with each other, their extremities similarly directed. The ischiadic bones lay across the ilia in their axes, the anterior dilated extremities lying not far from the position of the lost pubes, the posterior directed far behind the iliac crests, parallel to their axes. The similarity of position in both, and the preservation of relation between many of the other bones, renders it probable that their identification with ischia also indicates their natural relation.

The direction of the ischia is a difficult point to determine, but may be best understood by reference to those of Megadactylus and Clepsysaurus. In Hadrosaurus (see Leidy's plate in Cret. Rept. U. S.) this bone consists of a long slender subcylindric shaft with dilated extremity. The dilated portion thin, a part in line with the shaft and truncate, and

separated by a concave margin from a larger portion at right angles to the shaft. The latter bears an oblique surface for fixed articulation at its extremity.

In Megadactylus,* the distal portions of the ischia are united on the median line for a considerable distance, and are styloid in form. This portion is evidently distal, from the lack of articular faces and the divergence and flattening of the other extremities. They also resemble the distal extremities in Compsognathus. In Clepsysaurus, the shaft and dilated extremity are both preserved. The former resembles that of Megadactylus, the latter that of Hadrosaurus in some degree. If the shaft be posterior, the other extremity is anterior, and the larger dilatation extending at an angle to the shaft supports, no doubt, the iliac articulation. The trihedral shaft indicates a median line of junction. In Hadrosaurus no part of the shaft presents a face for contact with that of the other side, while in Lælaps such face is very distinct and elongate. From the above, I suppose that the larger extension of the ischium is superior and bears the iliac articulation, that the concave anterior outline is that bounding the acetabulum, and that the lower dilatation was in contact with but not united to the pubis. This is the more probable, since it agrees nearly with the arrangement in Iguanodon, as pointed out by Huxley.† It cannot be denied, however, that the supposed iliac articulation in the ischium in Hadrosaurus, bears a remarkable similarity to the median suture presented by the union of the two supposed ischia on the middle line below and distally, as in the pubes of Struthio. In that case, they would be pubes. In a posterior direction and median approximation it will agree also with the known pelvic elements of an interesting Saurian described by Von Meyer (Palaeontographica) from the Wealden of Germany, the Stenopelix valdensis. No attempt has been made, so far as I am aware, to refer this animal to its place. It appears to me in its vertebral and pelvic features to be a small Dinosaur allied to Scelidosaurus Owen. The ischia, however, are remarkably prolonged posteriorly, and find a parallel in Compsognathus Wagn.

Believing them to be ischia, the inferior pelvic arches of Hadrosaurus were light and slender, the ischia parallel and light, and entirely incapable of supporting the weight of the animal, as was done by Megadactylus. The tail was no doubt the great support when the head was elevated.

* The large pneumatic foramina in the vertebræ of this genus, together with those seen in the sacrum of Lælaps, explain the character of similar vertebræ described as os quadratum of Iguanodon by Mantell and Owen, and sacrals of Hadrosaurns by Leidy. I regard the latter as indicative of a new genus allied to the Goniopoda.

† Opportunity of reviewing this part of my essay having offered, I must point out the confirmatory evidence I have derived from Prof. Huxley's recent explanation of the structure of Hypsilophodon, with regard to my determination of the pubes in Hadrosaurus. He proves conclusively its *posterior* direction, which view I adopt for Hadrosaurns, contrary to my former supposition.

The figure 29 is the result of the preceding considerations, but it is not to be considered as completely demonstrated. They all go to show the narrow and prominent form of the abdominal region, which was associated with its posterior position, and the great lengths of the femora. Fig. *a* is a front view of the pubis; *b* is an internal view of the ischium of Clepsysaurus.

Dentition.—The teeth of this genus are very much smaller in relation to the size of the animal than in Iguanodon. They bear enamel on one surface only, the external for the inferior series as Leidy points out. Thus but one edge of the worn crowns is enamelled, and acts functionally like that of the anterior faces of the incisors of Rodents. They produce shear-like edges, cutting the vegetable food by a horizontal transverse motion.

HADROSAURUS MIRABILIS, *Leidy.*

Proceed. A. N. Sci., Phil., 1868. 199.
Trachodon mirabilis, Trans. Am. Phil. Soc., XI, 1860, 140. Tab.
Upper Jurassic Bad Lands of Judith River, Nebraska.
Known from teeth, and perhaps vertebræ and phalanges.

HADROSAURUS FOULKII, *Leidy.*

Proc. Acad. Nat. Sci., Phil., 1858, 218, Cret. Rept. U. S. 76, Tab. XII to XVII.
Cretaceous green sand, New Jersey.

There are eight localities in the green sand of Cretaceous age in New Jersey, from which I have seen portions of this species.

HADROSAURUS ?OCCIDENTALIS, *Leidy.*

Thespesius occidentalis. Trans. Amer. Philoso. Soc., XI., 1860, 151, tab.
?Cretaceous Beds of Nebraska, between Moreau and Grand Rivers.

Of this supposed species, Leidy says, "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." In this he refers to Hadrosaurus mirabilis, which Hayden discovered in the Jurassic of Judith River, while the types of *Thespesius* were found by the same geologist, in a bed with other vertebrates, mostly reptiles, which he determined to be of Miocene age.

Now, the extreme improbability of this type occurring in a Miocene bed will occur to many palaeontologists, as has to me. With the view of determining this point if possible, I instituted an examination of the forms brought by Dr. Hayden from this locality, and first of that most characteristic animal, the *Ischyrotherium*, of Leidy. This, as has appeared in the preceding pages, I believe to be a reptile, allied to Plesiosaurus, a conclusion which at once establishes the Mesozic age of the bed. It coincides with the presence of Hadrosaurus, in indicating Cretaceous or upper Jurassic age.

As Leidy has referred the eastern and western herbivorous Dinosauria to one on the same genus, and as there is much doubt as to whether the present animal is not one of them, I refer the latter here as an expression of the probabilities of the case.

PALAEOSCINCUS, *Leidy.*

This herbivorous genus is, as remarked by its describer, an interesting representative of the Hylaeosaurus of the European Wealden.

PALAEOSCINCUS COSTATUS, *Leidy.*

Tr. Am. Phil. Soc., 1860, 145.
Upper Jurassic Bad Lands of Judith River, Nebraska.

ASTRODON, *Johnston.*

Amer. Journ. Dent. Sci., 1859.

ASTRODON JOHNSTONI, *Leidy.*

Cret. Rept. U. S., 102, Tab.
Cretaceous greensand, Maryland, (near Bladensburg.)

To a genus nearly allied to the present, should be referred the animal represented by a large tooth discovered by Thomas Wright in the Island of Wight, described and figured by him in the Annals and Magazine Nat. History, 1852, p. 89. The creature has been of larger size than the *Astrodon Johnstoni*, and apparently of a formidable nature.

GONIOPODA, *Cope.*

Proceed. Ac. N. Sci., Phila., 1866, 317.
Harpagmosauria Haeckel, 1866.

Proximal tarsal bones distinct from tibia; the latter closely embraced by the much enlarged astragalus, on its inferior and anterior faces, forming an immoveable articulation. Astragalus, with an extensive anterior articular condyle below, above in contact with the fibula, which is much reduced, especially distally. Anterior part of the ilium dilated, and plate-like.

This group is named from the abrupt flexure of the ankle in the middle of the tarsus, preventing the foot from being extended in line with the leg.

It represents no doubt an early stage of developement of the Symphypoda, and is remarkably similar in the same points in the structure of the posterior extremity, to the embryo of the chick at about the ninth day. At that time the metatarsals of the bird are distinct, proximally joined by a single tarsal element, which itself is separated by the articulation from a transverse piece composed of the confluent proximal tarsal series. The latter element is not at this time united with the tibia, but it is in contact with the fibula.

The fibula in latter stages withdraws from this connection, and becomes much shortened and reduced.*

The genera which belong to this order are,

Laelaps, Cope;
Poecilopleurum, Deslongchamps;
Megalosaurus, Buckland;
Coelosaurus, Leidy;

and perhaps,

Bathygnathus, Leidy;
Aublysodon, Leidy.

LAELAPS, *Cope.*

Proc. Acad. Nat. Sciences, 1866, p. 275; l. c., p. 316; l. c. 1867, p. 234. American Naturalist, 1867, 27. *Dinodon*, Leidy, Proc. A. N. Sci., 1868. 298, not Ibid., 1856, and Transac. Am. Phil. Soc., 1859.

LAELAPS AQUILUNGUIS, *Cope.*

Loc. Cit. Leidy. l. c. 1868.

This species was described by the author from a number of bones and fragments derived from the top of the "chocolate" stratum of Cook & Smock's upper bed of the Cretaceous Greensand of New Jersey, at a depth of about twenty feet below the surface. They were found by the workmen under direction of J. C. Voorhees, Superintendent of the West Jersey Marl Company's pits, about two miles south of Barnesboro, Gloucester co., N. J. The bones preserved were portions of the under jaw with teeth, portions of the scapular arch, including supposed pubes two humeri, left femur, tibia and fibula, with numerous phalanges, lumbar sacral and caudal vertebræ, and numerous other elements in a fragmentary condition.

The discovery of this animal filled a hiatus in the Cretaceous Fauna, revealing the carnivorous enemy of the great Herbivorous Hadrosaurus, as the Aublysodon was related to the Trachodon of the Nebraska beds, and the Megalosaurus to the Iguanodon of the European Wealden and Oolite.

In size this creature equalled the Megalosaurus bucklandii, and with it and Aublysodon, constituted the most formidable type of rapacious terrestrial vertebrata of which we have any knowledge. In its dentition and huge prehensile claws it resembled Megalosaurus. The species is now rediscribed with additional observations and with figures.

? Zygomatic arch.—A portion 6.5 inches in length is perhaps the malar portion of the arch rather than the squamosal, since near the termination of its inner or concave face it is pierced by a large foramen, similar in position to the suborbital foramen. The bone is slender, chiefly strengthened by a strong external, horizontal ridge, which is probably the homologue of that noticed by Prof. Owen as dividing the face of the maxillary and malar in Scelidosaurus. Alone and below this rib, the bone rapidly thins away. There is little curvature, indicating a long slender zygoma perhaps as in Compsognathus. The foramen has not been closed above.

	Lines.
Vertical depth inside of front of foramen,	18
Horizontal depth zygoma,	15

Maxillary bone.—A portion of the right maxillary displays parts of four alveolæ: three of these have a flattened oval section, while the anterior is round, suggesting the presence of a canine-like tooth. One successional tooth in place extends from the bottom of the alveolus to within .75 inch of the maxillary border; it stands obliquely in place,

*See Gegenbaur, l. c.

the posterior cutting edge being directed outwards. The anterior alveolus is shallower than the second, and this shallower than the third, which gives an oblique slope to the fractured margin of the bone, and suggests the application of another skeletal piece. This I suppose to be the premaxillary, as the bone is externally too flat to permit the median premaxillary suture to occupy that position. The upper portion may be related to the margin of the nares. A series of five foramina extends along the outer face of the bone opposite the middle of the depth of the alveolæ. The alveolæ are directed more anteriorly from behind forwards.

	Lines.
Depth of alveolus,	34
Length crown of successional tooth,	25
Length piece embracing four alveolæ,	61

Mandible.—One portion from the anterior part of the ramus. The latter measure three inches in depth from the outer alveolar border, which is a little more elevated than the internal, and 1.5 in. in thickness at the fractured edge. A longitudinal series of vascular foramina extends along the middle of the external face. The teeth are implanted in deep alveolæ, and had transversely oval compressed fangs; the sections of the crowns of teeth from different portions of the ramus differ. Two from the anterior region are considerably recurved, the concave or posterior edge denticulate to the base of the enamel, the anterior aspect minutely serrate, two fifths the length from the tip. Section at this point lenticular, lower down the anterior face becomes broader and rounded, giving a rounded cuneiform section. Throughout, one face is more convex than the other. A young posterior tooth yet in the alveolus (no. 3) is less recurved, subacute, and of more lenticular section, having both edges denticulate to the base of the enamel. Fangs hollow, the pulp cavity capacious but rapidly diminishing and short; the cast sulphide of iron and marl.

	Inches.
No. 1; total length (fang broken),	2 33
length of enamel,	1.83
width below,	.833
anterior diameter,	.433
No. 2; length of crown (tip restored),	1.875
anterior diameter,	.5
No. 3; length of crown,	2.125
width at base,	.688

Larger teeth are indicated by fragments. The development of the teeth has apparently proceeded as in Megalosaurus. The development of the dental papilla takes place within a niche of the alveolus, between it and the inner mandibular or maxillary wall. Small serate cusps are found in this position beneath but a thin stratum of bone. In one situation a second successional tooth occupies a position between the primary cusp and the functional tooth, and is about intermediate in size between them. These successional teeth then increasing in size, by a horizontal movement, transverse to the cranial axis, place themselves close to the fangs of the functional teeth, into whose places they gradually rise. An absorption of the dental wall probably prepares the older tooth for shedding, at which time the apex of the successional tooth is ready for use.*

Vertebræ.—No cervical or dorsal vertebræ were preserved; we have only as yet sacrals, and numerous caudals. All are much constricted medially, or hour-glass shaped, the centrum cylindrical in section throughout in most of the caudals, the anterior of the latter and the lumbars of deeper vertical than transverse diameter throughout. The articular surfaces are moderately shallow biconcave in all, most strongly in the subproximial caudals. The neural arches attached by permanent suture, and inferior surfaces for articulation of chevron bones. The caudals offer indication of neural spines; their traces are on the majority low, and of considerable longitudinal extent. Articular

* Deslongchamps figures a tooth as doubtfully belonging to Poecilopleurum. It resembles that of a Crocodilian, and probably belongs to a species of that subclass. He states that Megalosaurus-like teeth occur in the strata in which Poecilopleurum was found. There is now much reason to believe that the latter are the true teeth of the genus in question.

surfaces for chevron bones were much narrowed anterior to the middle of series, so that we can infer that the tail was proximally cylindrical. Zygapophyses turned upward, not outward.

The portions of the three sacrals preserved indicate that the centrum is very much compressed, as in other Dinosauria. The proximal caudals, or those with diapophyses, have also compressed centra, though this is less marked than in the sacrals. The diapophyses come off from the neural arch above its union with the centrum in four such vertebræ preserved. In these the arch is not coössified. In the remaining nine there is no trace of diapophysis beyond a ridge visible in the anterior ones, and the arches are coössified. In the four anterior there is on the posterior half of the median line below, a strong groove; in the two median, a foramen penetrates the centrum; in the posterior the groove is less posterior in its position. In the posterior series of ten it is represented by an indistinct plane. These vertebræ are relatively less compressed than the first, but have a more concave inferior outline. The neural spines of these have been apparently curved upwards and backwards, judging from the direction of the lines of ossific growth, as in Poecilopleurum. They originate a little anterior to the middle of the length of the vertebra. Anterior to this point the neural canal is only partially roofed over, there being an opening into it just in front of the base of the neural arch. Anteriorly the roof would appear to be composed by the union of two horizontal laminæ of the anterior zygapophyses. The articular faces for chevron bones are small.

	In.	*Lin.*
Dimensions of an anterior caudal; length centrum,	4.	3
depth do. from suture of neural arch,	4.1	0
width articular face (anterior),	3.	6
" centrum at middle,	2.56	0
Length of median caudal,	4.625	
Breadth centrum,	2.375	
Length base neural spine,	3.25	
Length of a distal caudal (with neural canal),	2.875	
Diameter centrum transverse,	1.125	
" " vertical,	.875	
Proximal caudal (with short diapophysis) length,	4.5	
Depth centrum,	3.125	
Width "	3.	

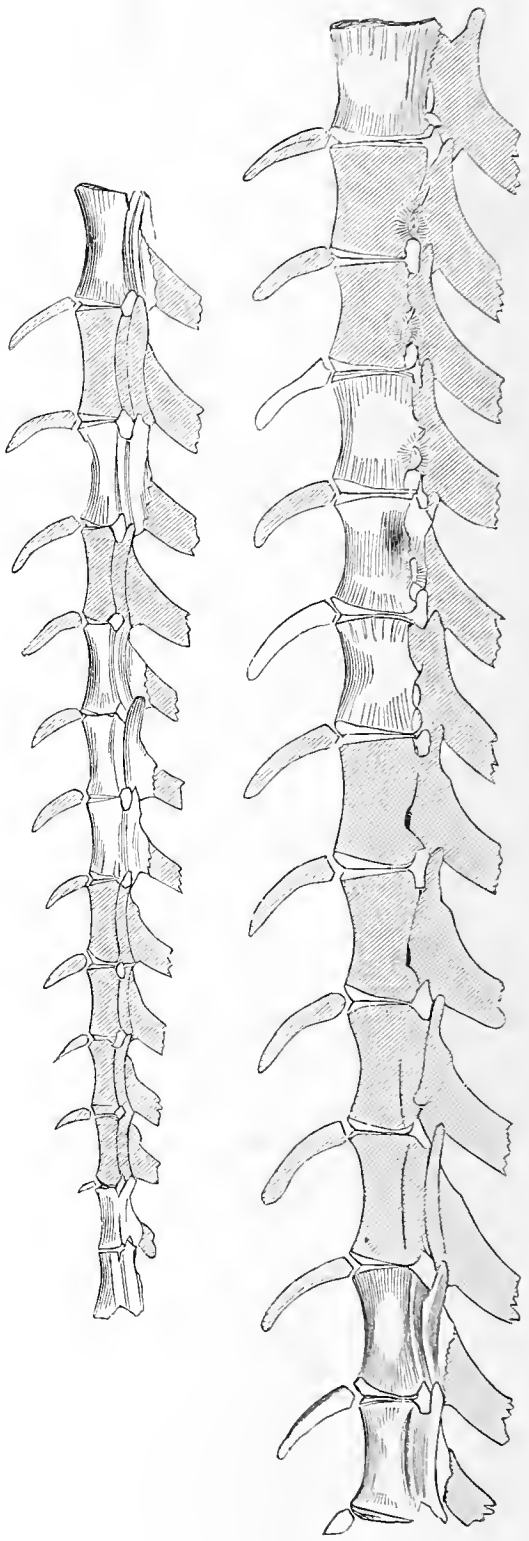
Three separate vertebræ appear to be most probably sacrals, and indicate that this individual was not adult. Their form is much compressed, and the articular-surfaces are rather expanded and concave. The superficial layer of the latter is very thin, and covered with delicate raised striæ, mostly transverse in direction. They present the appearance of incomplete development, and would no doubt at a later period coössify with those of the adjacent vertebræ, forming the long sacrum common to the order. Their exterior dense walls are remarkably thin, and the internal structure of the centra is coarsely spongy or almost cavernous, being far less close and compact than that of the cancellous centra of the caudals. The largest of these has a strong median groove above, probably that of the neural canal: greatest elevation of articular surface 5 in. 2 lin., greatest width of same 4 in. 2 lin. The tissue of this centrum is so coarse as to resemble the borings of Teredo. In another a large foramen marks the mouth of a canal which enters the centrum just behind one of the articular surfaces, and above the thickest portion of the centrum. It descends obliquely towards the middle of the centrum, but its course can be traced only an inch. Foramen .9 inch in diameter.

The number of caudals preserved is fourteen. From interruptions in the series I imagine that ten have been lost, probably a few more; I think the whole number can be estimated at twenty-five. Both distals and proximals are preserved; the former are small and slender, the latter compressed, similar to the sacrals, and with diapophysis, and neural arch not coössified.

This furnishes a remarkable contrast to Hadrosaurus, to which Leidy reckons fifty vertebræ, and a depth of tail of a foot and a half.

* They thus resemble in several ways, the bone referred by Mantell and Owen to the place of the os quadratum, with doubt. There is little probability to my mind, of this reference proving other than erroneous; see the fig. in Pl. XI at the end of the volume.

Fig 30.



In comparing this series with those of Poecilopleurum, so well illustrated by Deslongchamps, it is observable that vertebræ of similar proportions in the two are without diapophyses in the former, while they possess them in the latter. Thus the diapophyses probably cease at a point in Laelaps anterior to the same in Poecilopleurum. It is also noticeable that while they are obliquely directed backwards in the latter, those having them as well developed in the former exhibit them transverse.

Humerus.—Both are preserved, but lack the distal condyle; about half the coronoid fossa of one remains, furnishing an indication of the breadth of that extremity. They are proximally much dilated, having a very strong postero-external ala and a shorter antero-internal dilatation. They are not half the length of the femur; the shaft is flattened antero-internally. Of the proximal articulating surface a portion is lost, but a narrow surface continuous with it externally does not extend further out on the dilatation than opposite to the middle of the shaft. I find no trace of a globular condyle, as is seen in Hadrosaurus. Coronoid fossa large and well marked, not near to penetrating; medullary cavity of shaft relatively smaller than in the bones of the leg.

	In.
Length of humerus (restored),	12.
Greatest proximal breadth,	3.75
Distal breadth across coronoid fossa,	3.
Circumference of shaft,	5.$\frac{3}{8}$

These humeri are relatively shorter than in Hadrosaurus and Iguanodon, and the external alæ do not pass so abruptly into the shaft as in them. They resemble most those of Poecilopleurum. They differ from these in being much dilated distally, especially internally, and in having the coronoid fossa much more pronounced.

Fore-limb.—In the lack of the necessary pieces, one cannot go far wrong in estimating the length after that of Poecilopleurum. In it the lower arm is three-fifths the humerus, which gives for Laelaps a length of 19.2 in. to the wrist. If we accept the Crocodile as the next nearest ally in the fore-limbs, we find the carpus and hand to be .75 of the humerus. The ungueal phalange preserved in Poecilopleurum is shorter than in the Crocodile; if however we add 9 inches to the length already estimated, we have for the whole 2 ft. 4·2 inches.

This is, as will be hereafter shown, a little more than one fourth (1-3.71) the length of the hind limb.

Left Femur.—The head and summit of the great trochanter, and the posterior portions of the condyles, are broken away. The shaft is rather slender, and is strongly arched forwards and slightly outwards. The third trochanter is on the posterior face, is turned inwards, and marks one-third the length of the shaft from the supposed position of the head. Just below it the shaft is cyclo-trigonal, while for a short distance above the condyles it is flattened anteroposteriorly. It is strongly concave between the condyloid ridges at the distal end. At this place the external face is convex, the internal concave as high as a point a little more than a fourth the total length. The concavity is separated from the anterior face by a strong ridge which is partly broken away. The anterior surface is turned posteriorly to the external condyle, while it is concave and turned forwards to the internal condyle.

The posterior portions of the two condyles are broken away, so as to give their remaining portions almost exactly the form of the head of the femur in Hadrosaurus and Iguanodon. The dense layer of the remaining portions is much worn away, but enough remains to show that the external was rather the more prominent. The trochlear and popliteal concavities approach much nearer together than in Megalosaurus, causing a greater attenuation of the basis for the condyles. It cannot be ascertained whether the external condyle bore the small process behind seen in Megalosaurus

The neck is much compressed anteroposteriorly, and extends much interior to the line of the shaft. The posterior face is regularly convex, and then turns into the transversely convex exterior, which is divided above by the groove that separates the external trochanter. The broad posterior face narrows below this trochanter, and presents a strong convexity posteriorly, opposite the upper portion of the third trochanter. The outer trochanter has a flat anterior face, and presents a sharp margin inwards. It is separated from the neck by a deep longitudinal concavity. It is probably much shorter than the head of the femur, about as in Megalosaurus.

	In.
Length of femur restored,	35.5
" actual,	32.
Transverse extent of condyles,	6.45
Posterior breadth of neck,	6.5
Anterior " of great trochanter,	3.25
Diameter neck and " "	4.5
" anterior groove between them (medially),	1.5
Circumference shaft at middle,	11.

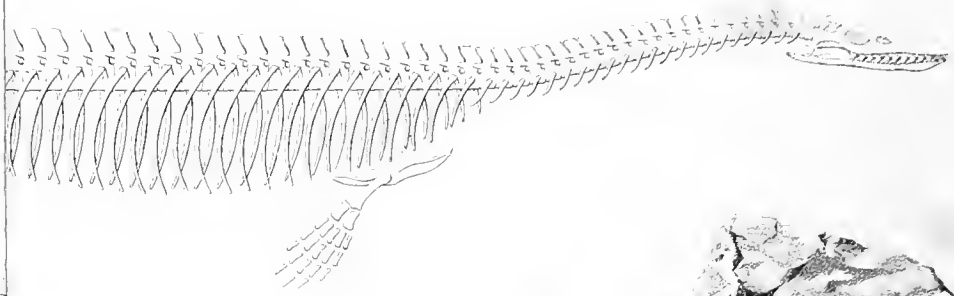
This element, compared with that of Megalosaurus, differs in its considerably more slender form, and in its curvature. The femur of the latter genus is very stout, and has a straight axis. The posterior prolongations of the condyles are broken away, but if the external were as small as in Megalosaurus, it was more external, and the popliteal concavity not so abruptly distinguished from the posterior face of the shaft above. This extremity of the bone more nearly resembles that of the Poecilopleurum bucklandii, described and figured by Deslongchamps.

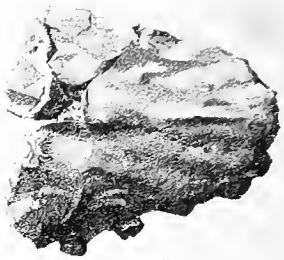
In my original description (Proc. A. N. Sci., 1866) I reversed the position of this bone, I believe incorrectly, which has been observed by Leidy. As it stands broken, the distal extremity is almost identical with that of Hadrosaurus, and the proximal with the trochanter furnishes a very good basis for condyles like those of Megalosaurus; hence the error.

The relative lengths of the femur and humerus of certain genera of this order may be compared as follows:—

	Humerus.	*Femur.*	*Proportion.*
Iguanodon anglicus,	19	33.	.575
Hadrosaurus foulkei,	22.5 in.	41.5	.54.2
Laelaps aquilunguis,	12 in.	35.5	.33.8
Poeciloplenrum bucklandii,	13	38	

Left Tibia.—The tibia is more slender than that belonging to Megalosaurus described by Prof. Owen, and the distal articular surface, instead of being lozenge-shaped, is cuneiform, the inner wide extremity oval rounded. Inner transverse breadth of proximal head one fourth total length. Anterior crest very strong, much incurved, disappearing at between the proximal fifth and fourth of length; internal ridge on proximal half, strong, but not reaching





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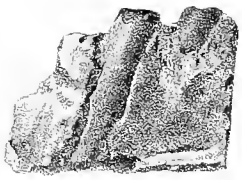

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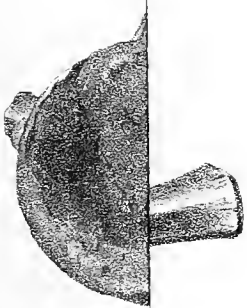

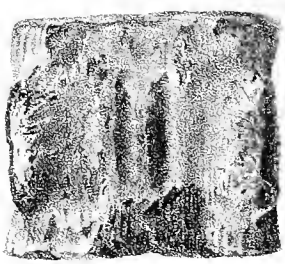

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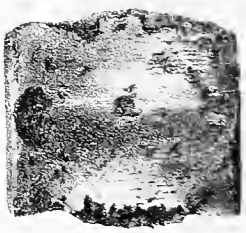
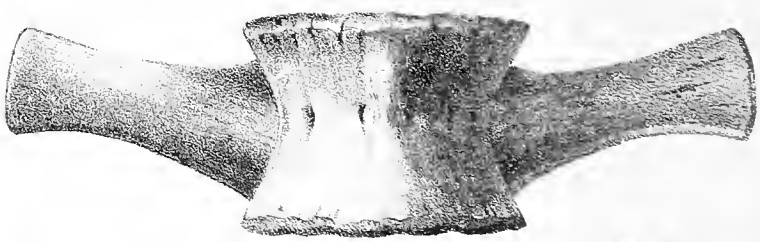


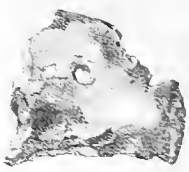
10 a.

3 a.



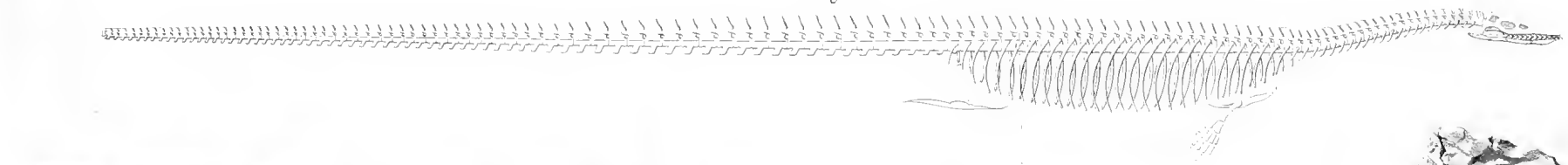
6 a.

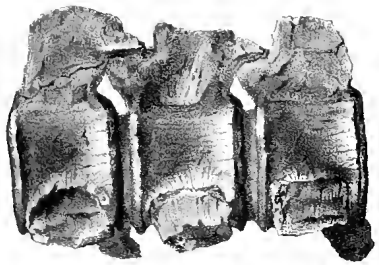
6 b.



7.

Fig 1





2

2a

8 b

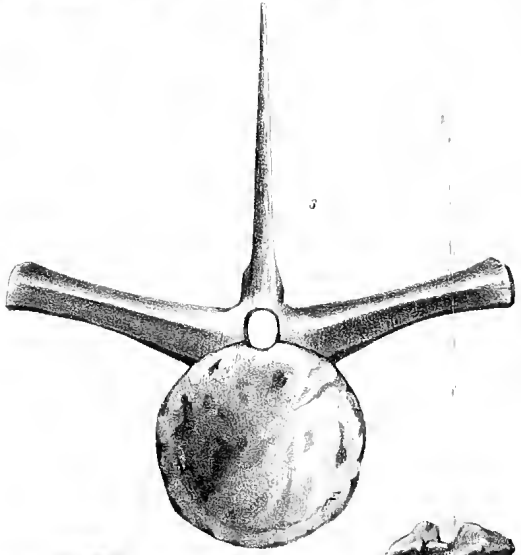
9.

8

8 a

4

4 a



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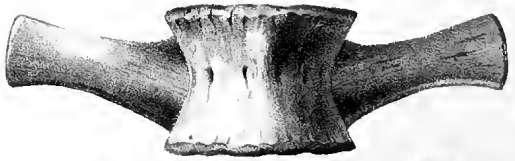
10

10 a



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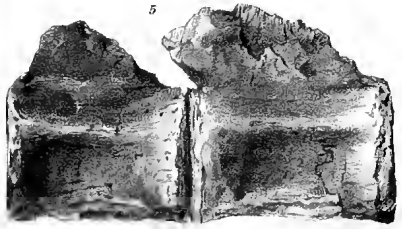

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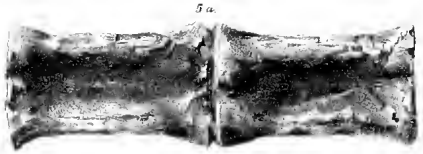
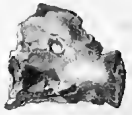


5 a.

8

6 a.

6 b

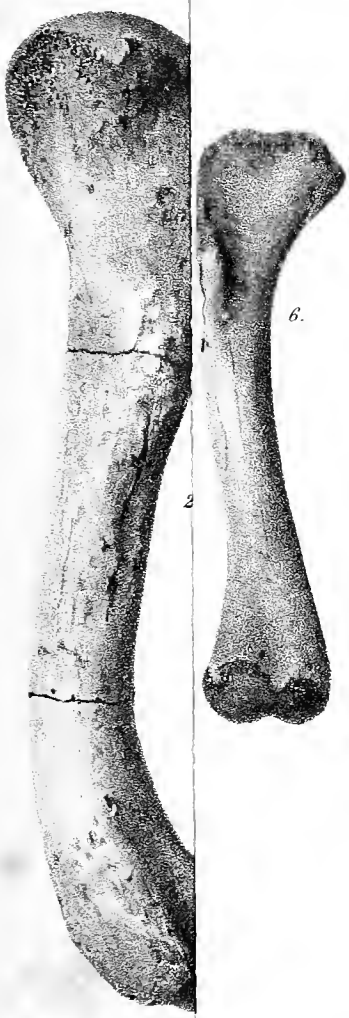


7.

Figs. 1-9. Elasmosaurus platyurus. Fig 10 E. Orientalis.

Elasmosaurus platyurus Cope.

T. Sinclair lith. Philada.



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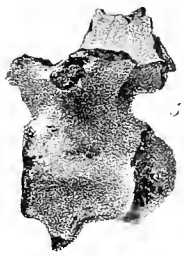

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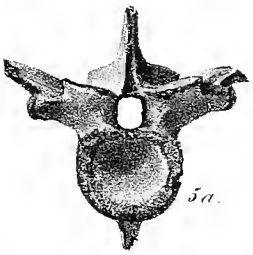
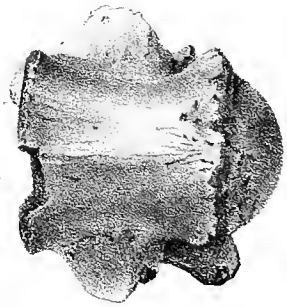
7.



5a.

8.



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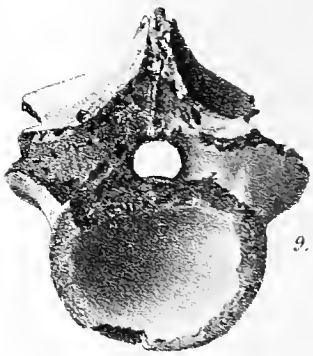

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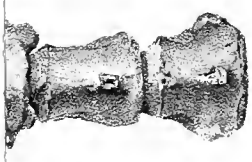
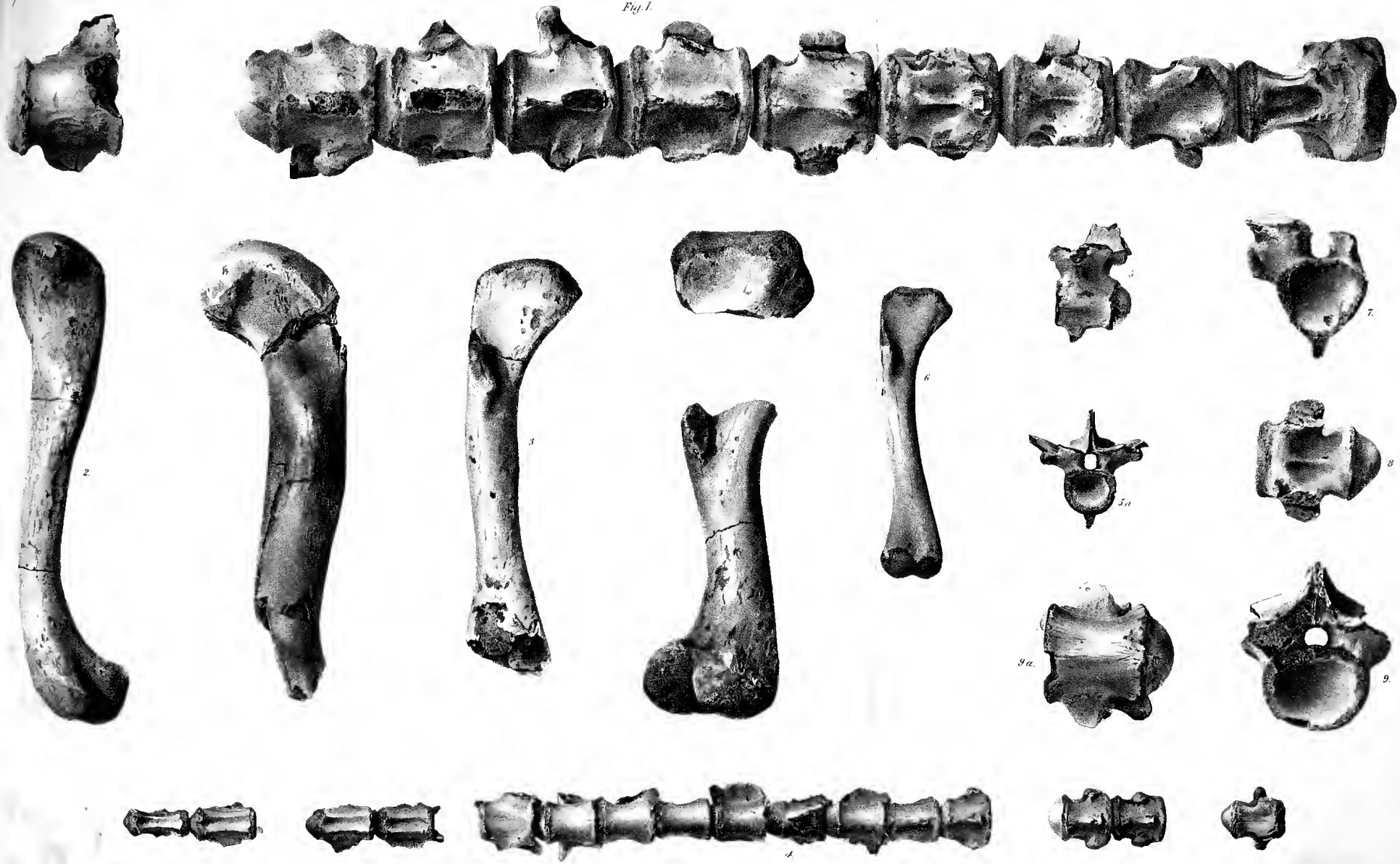


...osaurus-hartani.

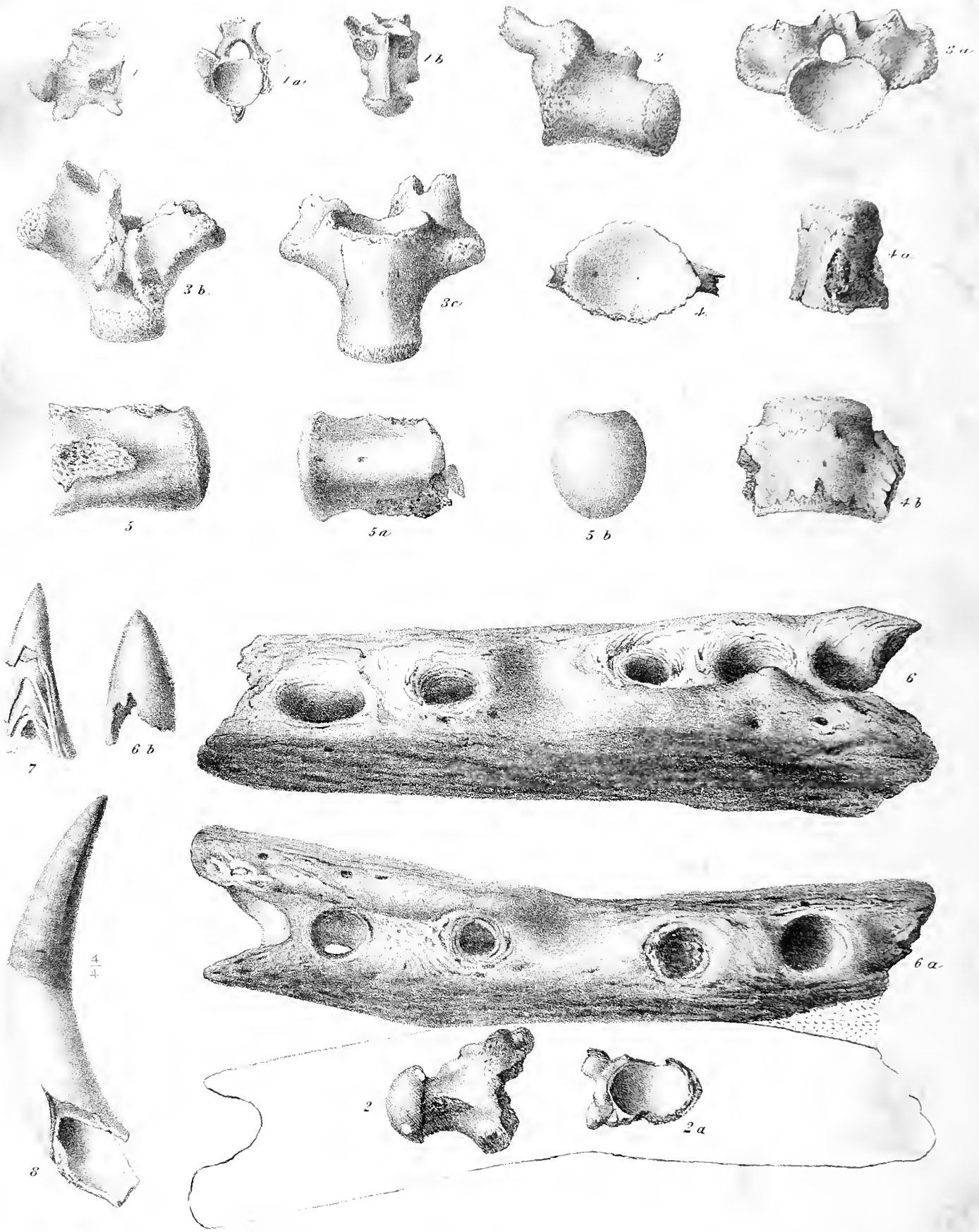
T. Sinclair's Lith. Phila.

Fig. 1.



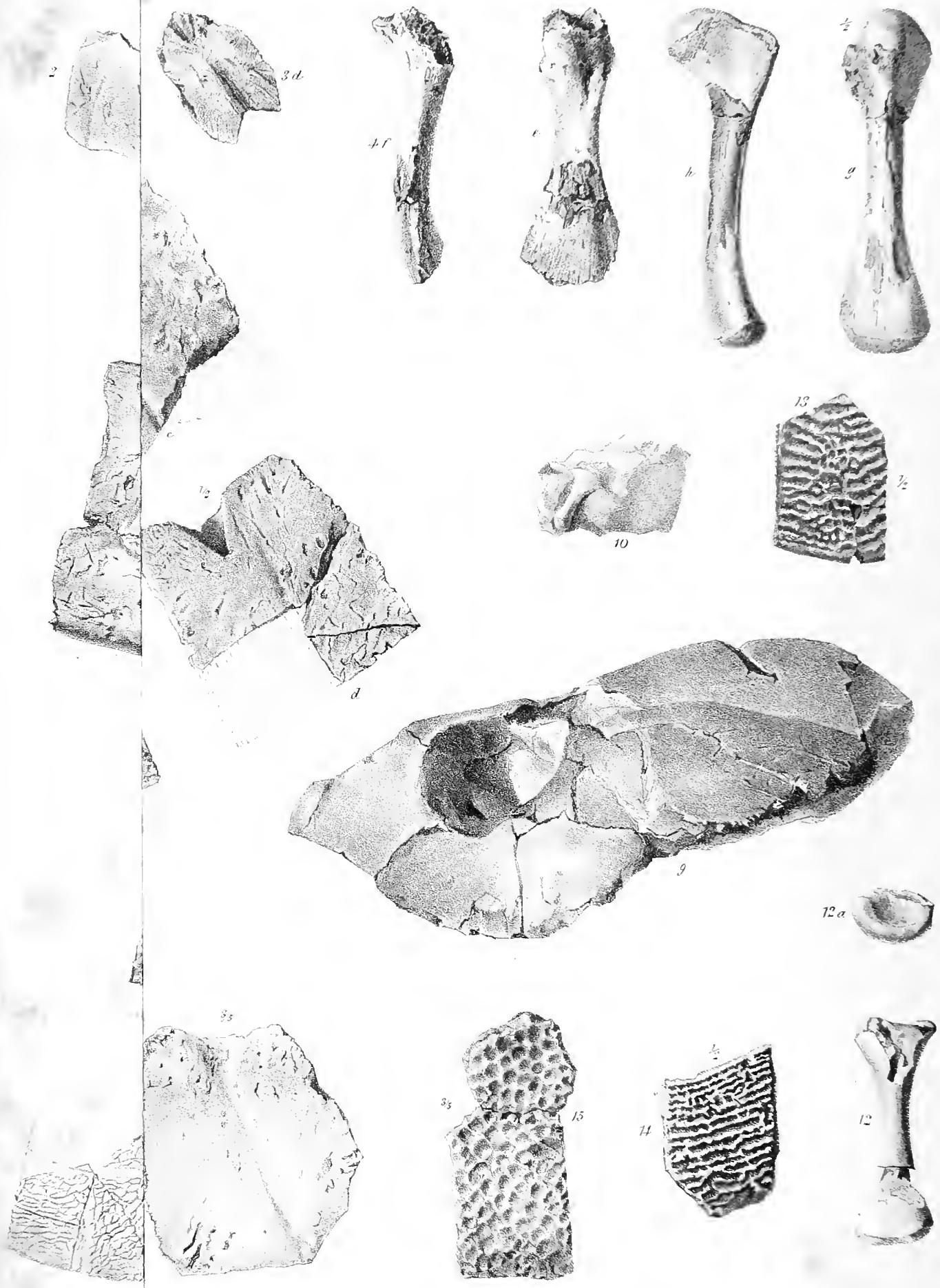
Figs. 1–3 Holops obscurus. A. 6 H. brevispinus. 7 H. cordatus. 8. 9 Bathysaurus harlani

T. Sinclair's Lith. Phila.

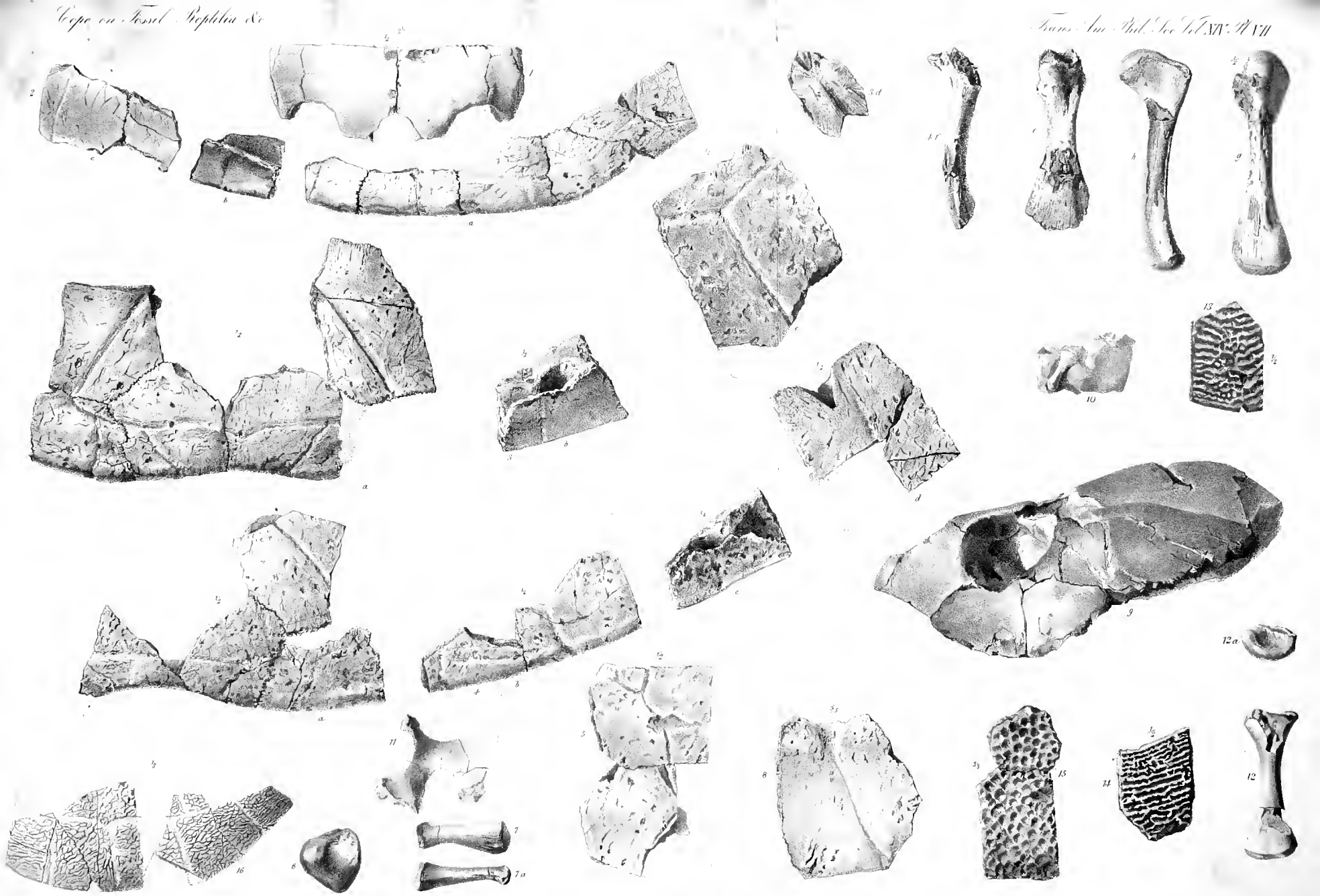


1 Palaeophis – littoralis. 2 P. haliidanus. 3 Clidastes iguanavus. 4 Mosasaurus depressus.
5 Macrosaurus – validus. 6 Thecachampsa – sicaria. 7 T. serridon.

Euclastes platyops Cope.

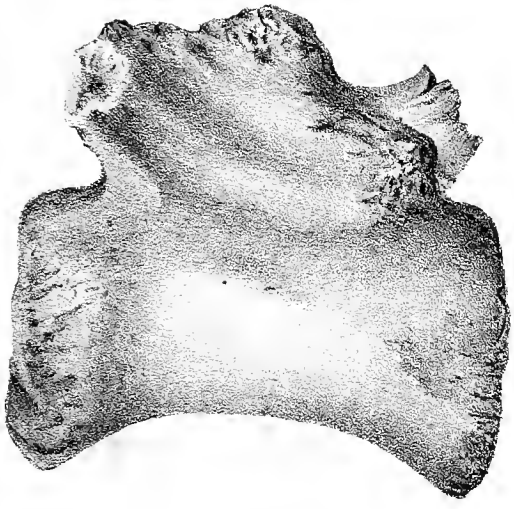


opita. 8 Osteopygis chelydrinus. 9 Euclastes.
phrosphys molops.



1 Pleurosternum pectorale. 2 Catapleura repanda. 3 Osteopygis emarginatus. 4–7 Propleura septa. 8 Osteopygis chelydrinus. 9 Euclastes platyrops. 10–12 Stylemys nebrascensis. 13 Trionyx pennatus. 14 T. lima. 15 T. halophilus. 16 Taphrosphys molops


2 a.

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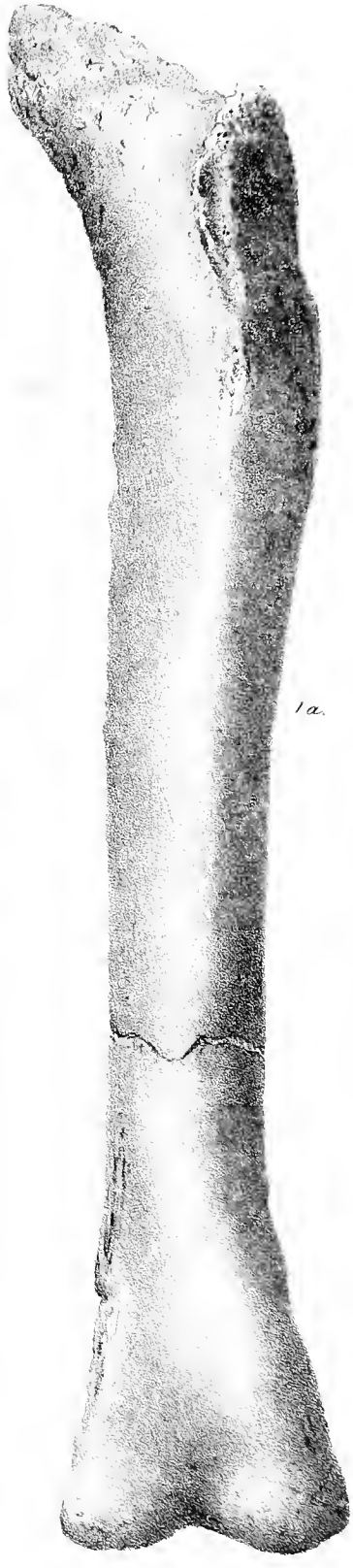
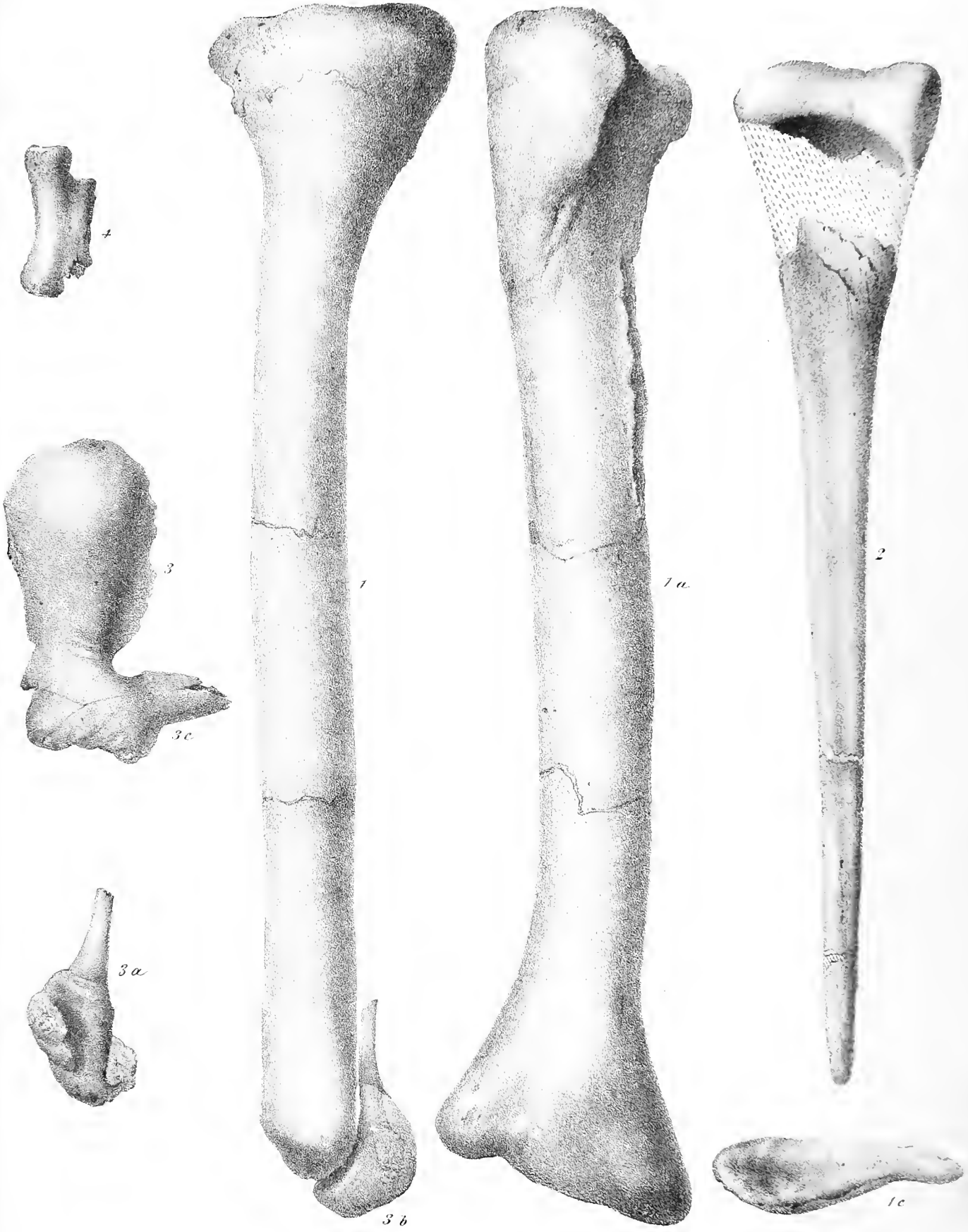
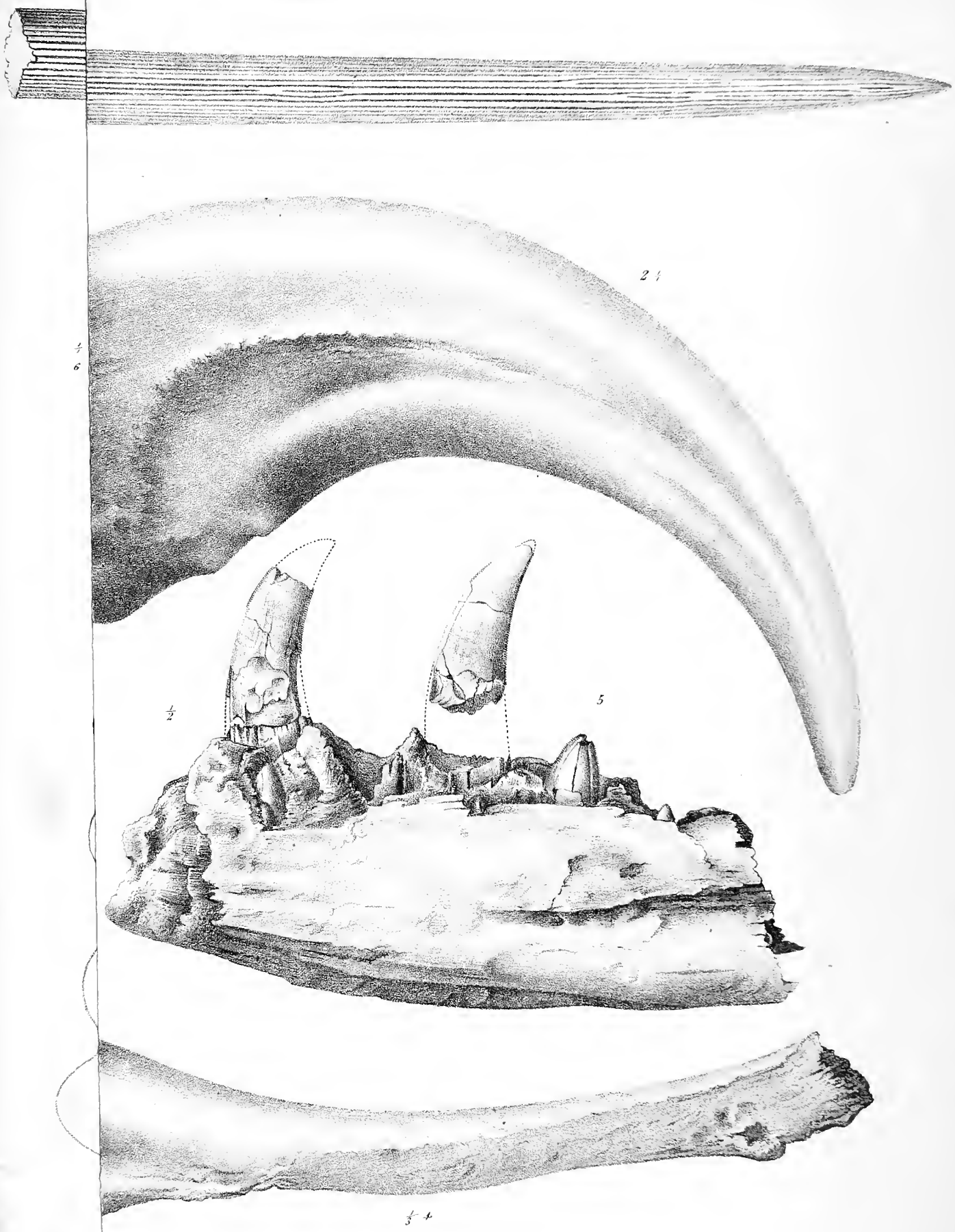

1 a.


1

Laelaps--aquilunguis Cope.



Laelaps aquilunguis



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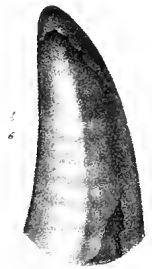
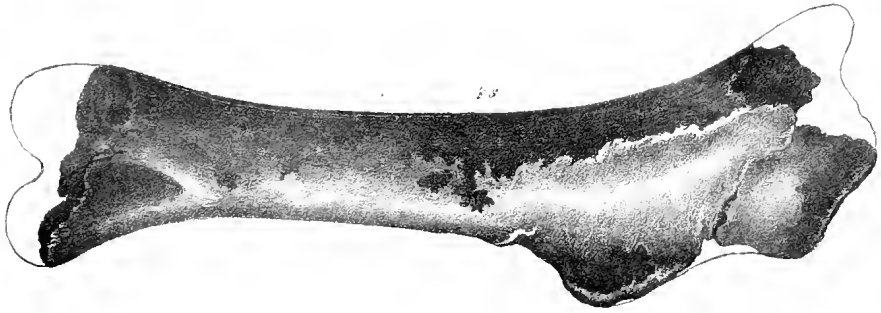
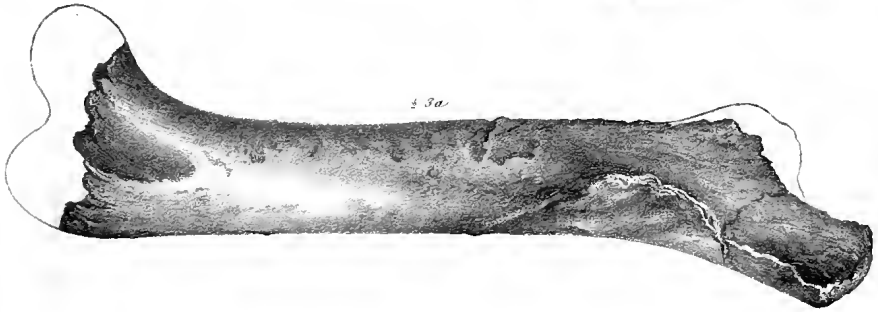
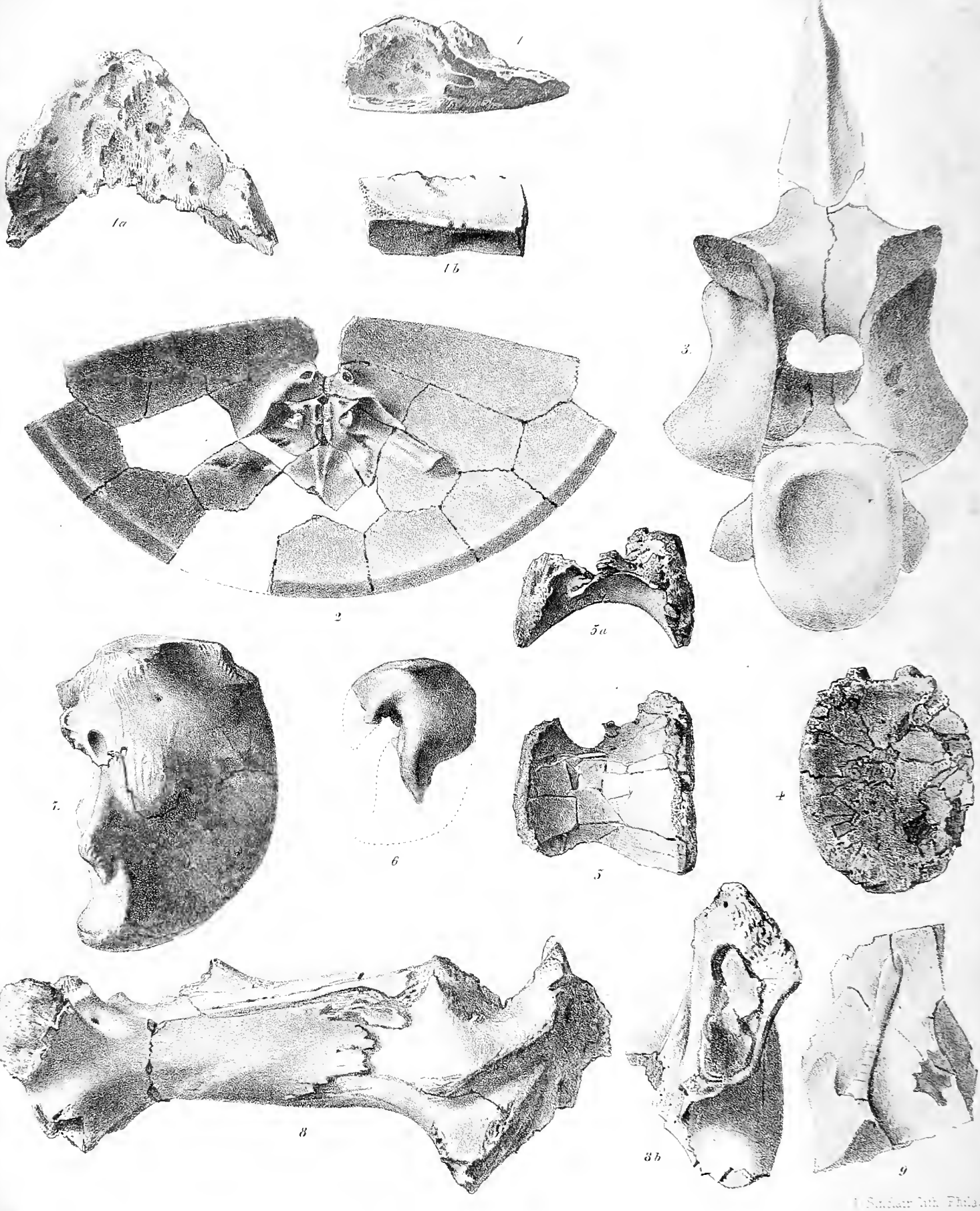


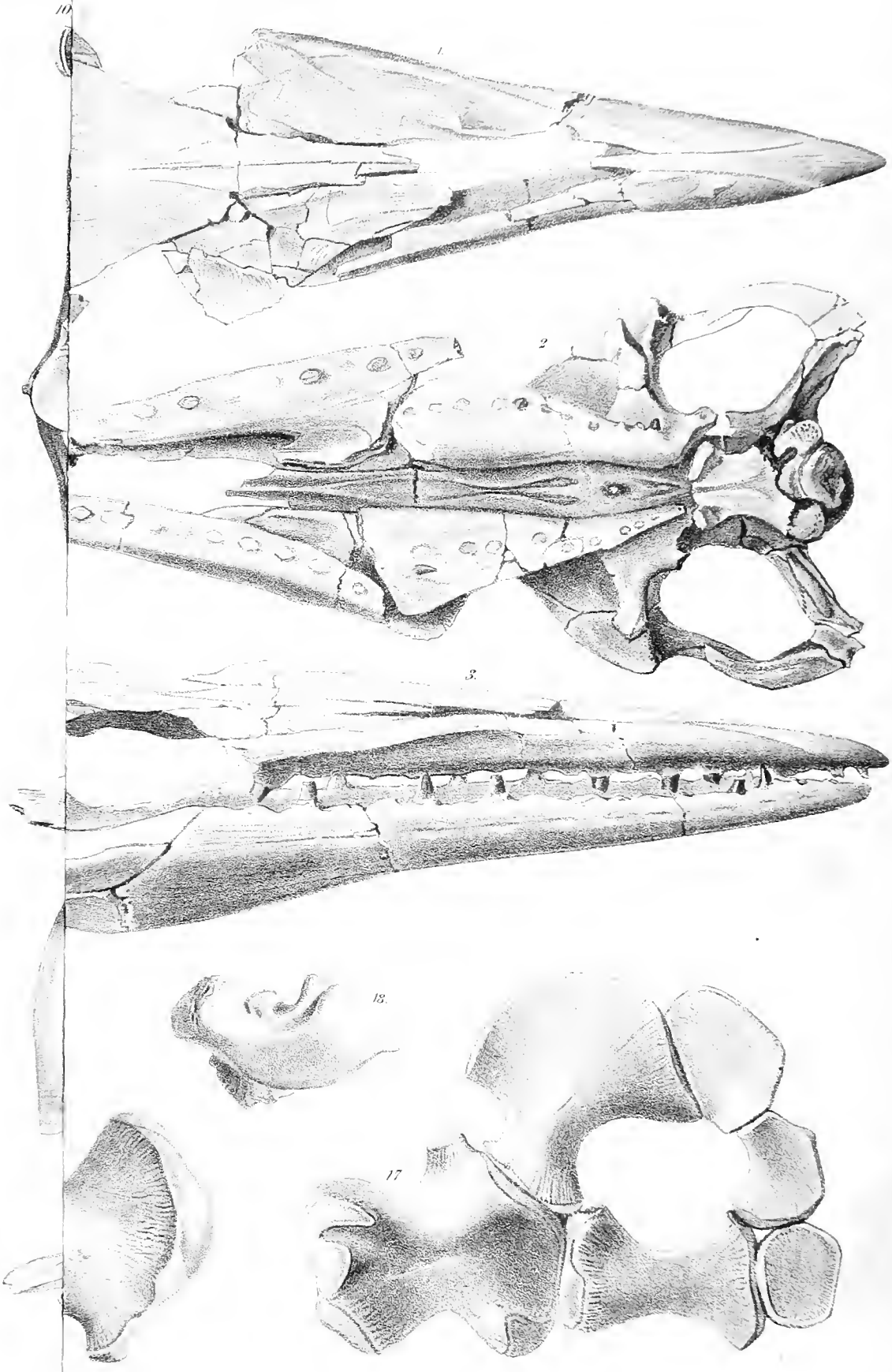




1-6 Laelaps aquilunguis. 7 Coelorhynchus ornatus.

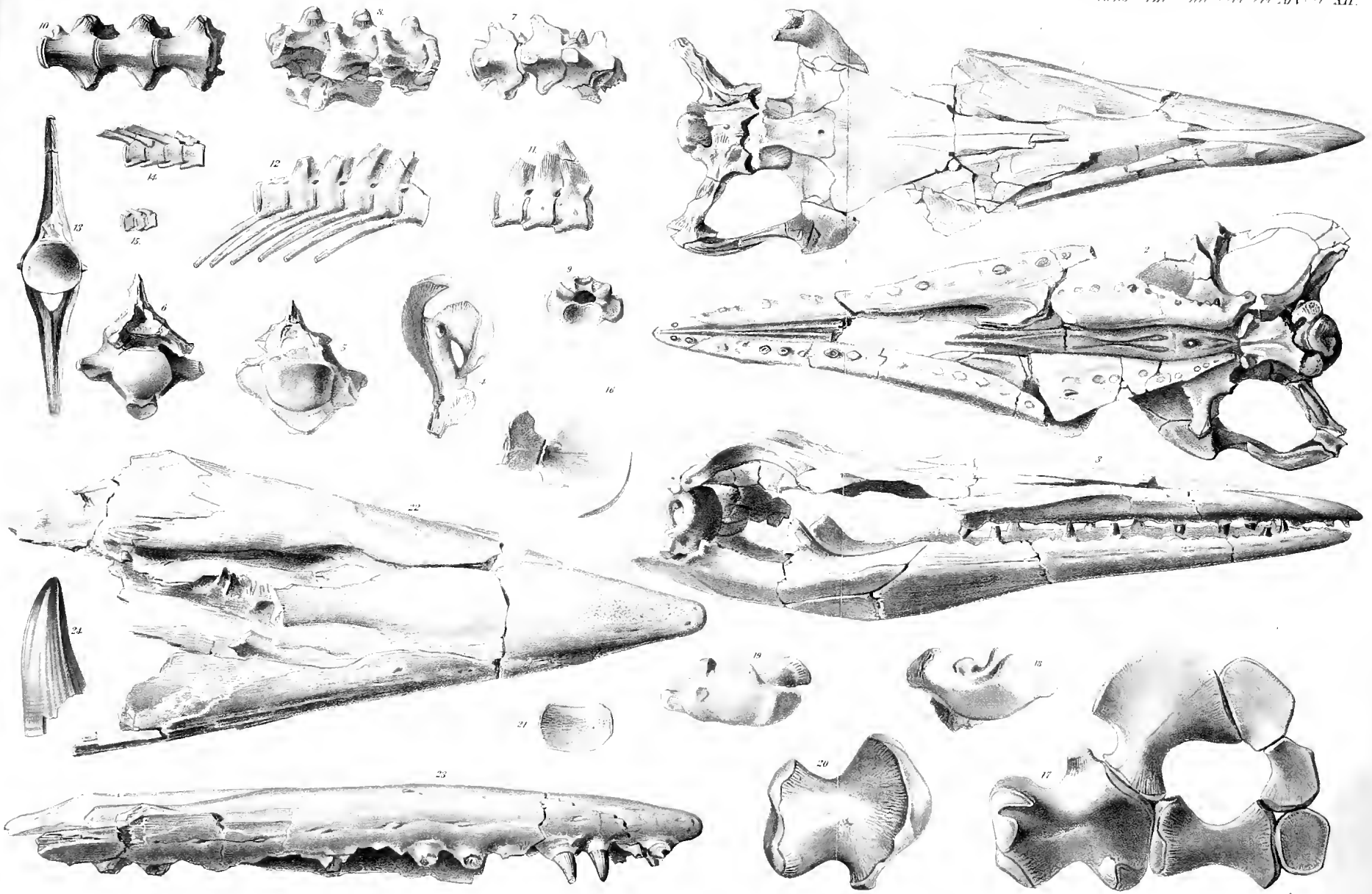


1. *Lytoloma angusta* 2. *Prochonias sulcatus.* 3. *Hyposaurus rodgersi* 4.–5 *Laelaps aquilungais.*
6 *Mosasaurus depressus.* 7. *M maximus* 8 *M mitchellii* 9 *Rhadalopelix longispinis.*



riger.

T. Sinclair lith. Philada.



1–21 Clidastes propython 22–24 Macrosaurus proriger.

T. Sinclair lith. Philada.