became enlarged. What would have been the result of all this I do not know, for the female was accidentally killed several weeks ago, and the male has lost all the characters acquired under sexual excitement. This species lays its eggs, in Maine, attached to weeds and grass in shallow water, in oval masses two inches or more in diameter, looking much like frog's eggs." Prof. Verrill further states that Mr. S. I. Smith and himself have both observed them, and that Mr. Smith has reared the young from them. Of these he has saved a complete series for the collection at Yale College, and also sent some to the Museum of Comparative Zoölogy, to which Institution Prof. Verrill has also contributed bunches of the eggs. The breeding habits and the eggs of this species he believes have not been described. It loses its external gills, he states, only quite late in its development, but earlier than *Desmognathus* and *Amblystoma*.

The following paper was read by the Secretary: —

ON THE REPTILIAN ORDERS, PYTHONOMORPHA AND STREPTOSAURIA. BY EDWARD D. COPE, A. M., CORRESPONDING SECRETARY OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.

In the course of 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, besides many of lesser significance.

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

2. That serpents exist in the Eocene formations of this country.

3. 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.

4. That the Reptilia of the American Triassic are of the Belodon type.

5. The discovery of the characters of the order Pythonomorpha.

6. The discovery of the characters of the order Streptosauria.

7. The discovery of the characters of numerous members of the Batrachian suborder Microsauria in the United States.

PYTHONOMORPHA.

At present I propose to notice the fifth and sixth results of these investigations.

The genus Mosasaurus, since the discovery of the large specimen in the St. Peter's Mount at Maestricht, has been a subject of discussion by many palæontologists, and always to the writer, with unsatisfactory results. While Faujas held it to be a crocodile, Camper and Cuvier regarded it as a lacertilian, and placed it near the Monitors. In the latter relation it has been allowed to remain by Goldfuss and Owen, who have since written upon it, and so it continues to be regarded by all palæontologists of the present day, who have expressed an opinion on the subject.

I hope, however, to be able to demonstrate, by the light of new material recently discovered, that the Mosasauridæ and Clidastidæ constitute a peculiar order of reptiles, which possess many of the characters of serpents, with some of Lacertilia, and others of the Sauropterygia. The reason why, as I conceive, this genus and its allies have been so little understood, has been a lack of analysis of the structure of portions of the cranium little known, as well as of portions better known; and the lack of certainty as to the structure of the limbs.

With reference to the latter, Cuvier says that very few bones of the extremities of Mosasaurus have been found, and their rarity was such that, for a moment, he was led to doubt whether the animal possessed limbs. He states that he was soon undeceived by recognizing a bone of the pelvis which certainly belonged to Mosasaurus. The bone considered to be a pubis, resembling that of the Monitor, is figured in the Ossemens Fossiles. Cuvier further says, that among some fossils from Seichem, he detected a scapula resembling that of the Monitor, and subsequently received drawings from Maestricht of a clavicle resembling that of a common lizard, and also a coracoid bone. From the specimens and figures, Cuvier supposes the shoulder of the Mosasaurus to have exhibited a close resemblance to that of the lizards. After remarking that he had been unable to procure any long bones of the limbs of Mosasaurus, he expresses his views in regard to certain figures of bones, represented by Faujas-Saint-Fond and Camper, reproduced in the Ossemens Fossiles. In regard to the figure of a portion of an ulna, Cuvier says that if the bone belonged to Mosasaurus, it would indicate the extremities to have been moderately elevated. But, he continues, the bones of the feet, so far as

they are known, appear on the contrary, to have belonged to a sort of contracted fin, as in the Dolphins or Plesiosaurians. Of the different bones of the feet, figured in the Ossemens Fossiles, after Camper, Cuvier likens some of them to the principal carpal bones of the crocodile; another appeared to belong to some huge saurian, some are phalanges, and two are attributed by him to turtles, whose remains are not less common in the deposits containing those of the Mosasaurus. In conclusion, Cuvier adds that "it was not without hesitation that he expressed the conjectures from mere figures, when the immediate comparison of the bones themselves would scarcely suffice, so great is their diversity, and so small the precision of their forms in reptiles."

Goldfuss describes and figures several bone fragments from the deposits of the cretaceous period of the Upper Missouri, which he views as the portion of a scapula, a coracoid bone, and an olecranon process of the Mosasaurus. In relation to the habits of the animal, he says, that as it lived in the ocean the toes no doubt were webbed, but the remains which have been discovered, on the contrary, do not lead to the supposition that it possessed fins, like the Icthyosauria. Prof. Owen, after remarking that no part of the organization of Mosasaurus is so little known as that of the locomotive extremities, and substantially quoting the views of Cuvier expressed above, enters into the description of some long bones of the extremities, "showing the lacertilian type of structure," which were obtained in the Green-sand formation of New Jersey. Prof. Owen says, "on the highly probable supposition that these bones belong to Mosasaurus, they indicate the extremities of that gigantic lizard to have been organized according to the type of the existing Lacertilia, and not of the Enaliosauria or Cetacea." Pictet says the humerus of Mosasaurus is thick and short, like that of Icthyosaurus, but gives no evidence for this assertion. He adds, we may conjecture, from the flattening of the bones of the members, that the feet were probably converted into fins like those of the Enaliosaurians.[1] Finally Leidy (Cretaceous Reptiles, 42) states that "remains, apparently of Mosasaurus, which I have had the opportunity of examining, indicate the limbs to have been fins, partaking in their structure of the characters of those of the marine turtle and the Plesiosaurus."

An anonymous writer in the Geological Magazine for 1868, commenting on this view, remarks that "admitting the lacertilian affin-

[1] Leidy, Cretaceous Reptiles, 41.

ities of Mosasaurus," this combination, is "incongruous," and assigns the bones mentioned by Leidy, to the turtles and Plesiosauria respectively.

I, however, believe that Leidy has correctly assigned such limbs to the two species that came under his observation; and I add the evidence derived from another species of Mosasaurus, and from one of Clidastes, as entirely confirmatory of it. On the other hand I am unable to assign hind limbs to any of the species of the order.

The characters of the order are as follows:—

1. The teeth have no fangs.

2. There is merely a squamosal suture between the maxillary and premaxillary.

3. The opisthotic bone projects free from the cranium, and is the suspensorium of the os quadratum.

4. There is no columella.

5. There is no symphysis mandibuli.

6. The parietal is decurved posteriorly and unites with the sphenoid, forming the cranial wall in front of the proötic.

7. The subarticular and sphenial elements of the mandible are connected by articular faces.

8. The vertebræ are very numerous, much exceeding one hundred, and frequently present the zygosphen articulation.

9. The abdominal cavity is long, and is surrounded by many short, curved ribs, which have a free antero-posterior movement on vertical, articulating surfaces, and which commence immediately behind the head.

10. The pterygoids are elongate and bear numerous teeth, and in one type are free, except at the extremities.

11. The brain case is not fully ossified anteriorly.

12. Scapular and coracoid elements are present.

13. The caudal vertebræ are furnished with chevron bones.

14. The squamosal bone is present.

15. The angular bone is distinct.

16. The os quadratum is movably articulated to the opisthotic.

17. The os quadratum embraces and encloses the meatus auditorius externus.

18. The opisthotic is supported by a pedestal projecting from the cranial walls, composed of the prolonged proötic in front, and the exoccipital behind, which embraces the suspensorium for much of its length.

19. The anterior limbs are fins, with all the elements in a single plane, the radius incapable of rotation. The humerus broad and flat.

20. There are probably no hind limbs.

Of the above characters the first ten are those of serpents; the five characters following are lacertilian, while the seventeenth and eighteenth are peculiar, and not found in any existing order of reptiles. The eighteenth is characteristic of the Sauropterygia.

The characters of the teeth are much like those of serpents, and resemble much less those of any saurians, since they are without true dentinal fangs; for the ossification of the pulp, which produces a fang-like support to the crown, is only a subordinate character, like that of ossification or non-ossification of cartilages within many existing families. The pterygoids which are in contact immediately in Mosasaurus, are largely free in Clidastes, where they bear teeth as abundantly as do any serpents. Among the Lacertilia the dentition is either truly rhizodont (the Acrodonta) or pleurodont. The teeth of the Varanidæ are especially different from those of the present order, and, present only a modification of the pleurodont character. The outer parapet of the jaw is low, and the shanks proportionately short; they are, in addition, more expanded than in most other pleurodont families.

The characters presented by the temporal region are highly peculiar, and important in determining the affinities of the group. The discovery of its structure furnishes the desired explanation for sundry enigmatical bones which occur not unfrequently in our cretaceous formations. In the following diagnoses the present is compared with the three orders, to which it makes nearest approach.

*Testudinata.* Opisthotic distinct, closely united to exoccipital, squamosal and proötic, and supporting squamosal and quadratum.

*Lacertilia.* Opisthotic distinct, closely attached to parietal arc, and at extremity to exoccipital and proötic; supporting squamosal and quadratum.

*Pythonomorpha.* Opisthotic distinct, not, or scarcely in contact with parietal arc, embraced at one end by proötic and exoccipital, and supporting squamosal and quadratum.

*Ophidia.* Opisthotic distinct, attached only to proötic, and supporting only quadratum.

There can be no doubt that the suspensorium of Mosasaurus is homologous with the element in the tortoises called by Huxley opis-

thotic. It appears also to be homologous to, and analogous with, the suspensorium of the Ophidia; hence I conclude that the latter bone is the opisthotic and not the squamosal, as given by Huxley (Elements Compar. Anatomy); and the more, as it coexists with a true squamosal in these extinct reptiles. Internally it forms a very small, or no part of the walls of the cranium; but it is a solid plug between the embracing laminæ of the proötic and exoccipital. The two latter bones are therefore unusually and peculiarly prolonged outwards, and unite by their edges on both the upper and inferior faces of the suspensorium. The fenestra ovalis is at the base of the infero-posterior face of the latter, and enters an exceedingly small vestibule. The fenestra rotunda is immediately below it, and is funnel-shaped, with a small orifice. In the small development of the auditory apparatus, it is again like the serpents.

The mandibular arch is very much like that of serpents. The lack of symphysis gave each ramus the independent motion which they possess in the Ophidia. The articulation of the splenial is a character not seen in any lacertilian, but is highly characteristic of the boæform serpents of the genera Loxocemus and Eryx, though it does not occur in Boa proper, nor in many other serpents. This has allowed of considerable motion, as the bones of the ramus above it are scarcely united by a squamosal suture, and the dentary terminates abruptly in a furcation of the coronoid, etc. This termination, with the articular faces of the inferior elements, is characteristic of fragments not uncommon in the cretaceous beds, and which have never in this country been referred to their place. The coronoid bone also is developed only as in the few serpents that possess it,—as Eryx, Xenopeltis and Boa; Goldfuss notices its great anterior prolongation and curvature, and overlapping of the extremity of the dentary. Finally the obtuseness and abbreviation of the angle of the jaw is ophidian, rarely lacertilian. The distinctness of the angular bone is, on the other hand, a lacertilian feature.

In the genus Clidastes, the pterygoid bones are distinct, except at their anterior extremity, as in serpents, and bear a long series (17 e. g.) of teeth, resembling thus the serpents.

The vertebral column closely resembles in many features that of the serpents. It is longer, and contains more numerous vertebræ than any lacertilian or saurian type, and has, therefore, a much more slender form than they. The ribs are cylindric, as in serpents, and are present throughout the cervical, long dorsal and lumbar series of

vertebræ, forming a much longer series, and embracing a more ophidian visceral cavity, than is seen in the other reptilian types. An important section of the order possesses the zygosphen articulation and vertebræ closely resembling those of the serpents. The diapophyses present the vertical costal articular face of the Boas. The immensely long tail, used as a powerful swimming organ, is flattened as in the sea snakes, while its chevron bones are a lacertilian rather than ophidian character.

The proötic extends from the basioccipital to the parietal, and overlaps the latter by its superior anterior margin; this does not occur among Lacertilia, except in aberrant forms, but is common to all serpents. There is a strong superior and anterior ala on the sphenoid, which articulates with an alisphenoid.

The ribs are cylindrical throughout much of their length, and resemble those of serpents and lizards in their articulation, by a compressed vertical head, to a vertically compressed diapophysis.

With respect to the characters in which this order is identical with the Lacertilia, the following observations may be made.

The brain case appears to be unossified anteriorly, as in tortoises, crocodiles and lacertilians, and the parietal both descends, as in Testudinata, and the alispenoid ascends, as in Crocodilia.

The scapulæ and coracoids are not very different from those of lacertilians, and are not coalescent. The scapula appears to have had an angle or process similar to the procoracoid, while the coracoid is entirely without the emarginations common to Lacertilia. No trace of claviculus, mesosternum or xiphisternum has been found. On the whole, the scapular arch is quite as likely to be similar to that of the Sauropterygia, at that of the Lacertilia.

The attachment of the palatines to the maxillaries is a lacertilian feature.

The os quadratum is like that of the Lacertilia in its form and its support by two suspensoria. It is as mobile as in the serpents, and differs from that of both these orders in enclosing the meatus auditorius behind by a large decurved process. In this these animals resemble the Testudinata, but in this only, for it is not attached to the proötic in front as in them.

In both families of the order there is a zygomatic or squamosal arch, but it is very doubtful whether any malar arch exists. There is no connection by malar or quadrato-jugal posteriorly.

The chevron bones of the caudals, as is well known, are highly

developed; they resemble those of some saurians. These elements do not exist in the Ophidia, where hypapophyses take their place. A structure somewhat resembling the latter seems to exist in Elasmosaurus.

The parietal fontanelle is similar to that seen in Lacertilia and Sauropterygia.

Thus seven characters in which it resembles the Lacertilia are shared by at least one other order of reptiles. In its lacertilian characters it approaches nearest the Varanidæ, which themselves, offer some approximations to the Ophidia. The elongation of the proötic anterior to the internal ear is a character of all the slender-tongued lizards, and the long superior nostrils and lack of malar arch belong only to the Varani.

The singular manner in which the opisthotic is supported is only paralleled, so far as I am aware, by the ophidian family of the Tortricidæ, where it is similarly projected from the grasp of the proötic and exoccipital, as suspensor of the quadratum. In Cylindrophis the parietal and part of the supraoccipital enter the connection also.

The anterior limbs, as has been observed, combine the characters of Testudinata and Sauropterygia. The ulna and radius, and all more distal portions of the limbs, are those of the latter order. The large, ovoid, flat carpals, and flat, medially contracted digits, with fixed articulations, are of that type.

From the preceding evidence, we may now look upon the mosasauroids and their allies as a race of gigantic, marine, serpent-like reptiles, with powers of swimming and running, like the modern Ophidia. Adding a pair of short anterior paddles, they are not badly represented by old Pontoppidan's figure of the sea serpent.

That terrestrial representatives now unknown to us, inhabited the forests and swamps of the Mesozoic continents, and strove for mastery with the huge dinosaurs, that also sought their shades, is probable. That their habit was to devour whole is evident, and though the articulation of the lower jaw will not admit of as much extension as that of the Ophidia, it exceeds other reptiles in this capacity in consequence of the lateral motion of the splenial articulation. The carnivorous dinosaur, on the other hand, tore his prey to pieces, as do mammals of the present day.

Thus in the mosasauroids, we almost realize the fictions of snake-like dragons and sea serpents, in which men have been ever prone to

indulge. On account of the ophidian part of their affinities, I have called this order the Pythonomorpha.

In time they immediately preceded the Eocene Palæophides, and probably will find in them structural allies.

The families embraced are two, the Mosasauridæ and Clidastidæ, which differ as follows:—

The vertebræ with the zygosphen articulation; the pterygoids free on the internal and external margins; no (?) postparietal arch . . . CLIDASTIDÆ.

The vertebræ without the zygosphen articulation; the pterygoids in contact on the median line; (?) a postparietal arch . . . . . MOSASAURIDÆ.

I think it highly probable that the genus Saurospondylus of Seeley, from the lower chalk of England, belongs to this order. If so, it is the type of a peculiar family to be known by the absence of neural spine and low position of the zygapophyses, which have horizontal articular faces. The *S. dissimilis* Seeley, is a much smaller animal than any here enumerated, and is known by a single vertebra.[1]

Goldfuss states that Mosasaurus possesses a malar arch. This is absent in Clidastes, and I am inclined to doubt whether Goldfuss has demonstrated his point; if present, he states that it is very slender.

## CLIDASTIDÆ.

CLIDASTES Cope, Proc. Acad. Nat. Sci. Philad., 1868, p. 233.

In this genus there has been no trace of hind limbs found.

**Clidastes iguanavus** Cope, Proceedings Acad. Nat. Sci, Philad., 1868, 181. Ibid. 1869.

Cretaceous Green-sand of New Jersey.

**Clidastes propython** Cope.

This species is known from an almost complete skeleton found by Dr. Edw. R. Showalter in the Rotten Limestone, near Uniontown in Alabama.

Its general proportions may be estimated as follows: As a considerable number of vertebræ have been lost, it will be necessary to illustrate in some points from Cuvier's estimate of the length of Mosasaurus Camperi.

[1] See Ann. and Mag. Nat. Hist., Sept., 1855.

| M. CAMPERI. | | | C. PROPYTHON. |
|---|---|---|---|
| | 2 | Atlas and Axis | 2 |
| | 11 | Cervicals with hypapophysis | 6 |
| | 5 | Dorsals with zygapophyses and ribs | 15 |
| | — | At least to be added to this series | 10 |
| 18 | 1 | Total | 33 |
| | 2 | Between the last and those bearing | |
| 64 | | chevron bones (estimated for C. propython). | 96 |
| 51 | 3 | Caudals with chevron bones. | 60 |
| 133 | | Total | 189 |

Where the dorsal series of the *Cl. propython* is interrupted, the vertebræ have increased in the strength of their processes rather than diminished, and I consider an addition of ten to be below rather than above the mark. Of the caudals there are preserved forty-four, all with chevron bones, and none with diapophyses. I have added nine for those without chevron bones, while the interruptions in the series readily justify the addition of seven more. The last series is estimated from that of the *M. Camperi*, adding relatively to the increase observed in the series preserved. The length may be estimated as follows:

| | Inches. |
|---|---|
| Of the cervicals and dorsals (average) . . . . . | $37\frac{1}{8}$ |
| Remaining vertebræ with diapophyses . . . . . | 90 |
| " " without " . . . . . | 30 |
| The cranium . . . . . | $14\frac{1}{2}$ |
| Total; 14 feet, $3\frac{5}{8}$ inches . . . . . | $171\frac{5}{8}$ |

The very ophidian character of the vertebræ, however, leads me to suspect that the length will be hereafter found to be considerably greater. The relative length of the cranium above given, is not greater than in the Iguana, while its dimensions, as compared with the cervical vertebræ, are not relatively greater than in the existing serpents. If the ophidian characters, therefore, were as strongly exhibited in the vertebral series as I suppose, the length would be eighteen feet at the least.

The discoveries with reference to the vertebral column of the *M. missuriensis* prove Cuvier's estimate to have been much too low; while Goldfuss' estimate for the former is probably as much behind nature as Cuvier's is behind *it*.

## MOSASAURIDÆ.

There are probably three generic forms known in this group. We know them to differ so far, only in their vertebræ and mode of implantation of teeth, though no doubt others exist. As to distinguishing them by the crowns of their teeth, I doubt the possibility of this, not only in this family, but even in any of the order, so far as known. They are, in this respect, like the serpents, whose genera cannot be distinguished in peculiarities of the solid teeth only:

The dorsal vertebræ compressed, the body elongate . . . . . MACROSAURUS.

The dorsal vertebræ more or less depressed; the articular faces transversely ovate; pterygoid teeth in alveoli . . . . . MOSASAURUS.

Vertebræ as the last; the pterygoid teeth pleurodont . . . . . PLATECARPUS.

The species which have been described appear to be referable to the above genera, as follows:

### MACROSAURUS Owen.

This genus has undoubted relationships to Clidastes; I have observed in a few of its vertebræ traces of a notch which, in the latter, separates the zygosphen from the zygapophysis. Unfortunately other portions of the genus are unknown.

**Macrosaurus validus** Cope. sp. nov. *Nectoportheus validus* Cope, Proc. Acad. Nat. Sci. Philad., 1868, 181.

Cretaceous Green-sand of New Jersey.

**Macrosaurus lævis** Owen, Quart. Journ. Geol. Society, London, 1849, v, 380.

Cretaceous Green-sand of New Jersey and ? North Carolina.

### MOSASAURUS Conybeare.

There are numerous species of this genus which appear to belong to two groups, the one characterized by the rounded, and the other by the depressed form of the lumbar vertebræ. A species of the latter type has been referred to the genus Amphorosteus by Gibbes. They, however, seem to graduate into each other in such a way as to preclude generic distinction on that ground.

The giants of the order belong here, for the *M. missuriensis*, *M.*

*Mitchillii* and *M. Camperi*, are among the most elongate of animals. They are only exceeded by some of the whales of the present day. Add to this their slender proportions, with no doubt, powers of swimming in the ocean, running, springing and climbing on land, and we have a combination of characters more formidable than those of the cimoliasaurs, elasmosaurs and crocodiles of that age of great reptiles.

Leidy observes that the varieties of form in the teeth indicate unusual variation for a single species, or else a larger number of species than has been hitherto supposed. I adopt the latter view after a comparison of extended material, as I find the most marked peculiarities in the quadrate bones and vertebræ, in addition to those of the teeth.

I. The posterior dorsals elevated, and with subpentagonal section.

Mandibular teeth fourteen on each ramus; premaxillaries six; pterygoids eight, of moderate size . . . . . *M. giganteus.*

Mandibular teeth twelve, spaced. Size smaller . . *M. gracilis.*

Mandibular teeth ? ; premaxillaries four, pterygoids eight, subequal ; the shaft of the humerus slender sub-cylindric; squamosal bone without horizontal expansion on the opisthotic; quadrate bone longer than broad, its proximal extremity an open sigmoid with a very small continuation on the edge of the ala; teeth more or less facetted. . . . . *M. Mitchillii.*

Quadrate bone above a closer sigmoid, with a long, wide continuation on the edge of the ala ; knob inside the meatus very small. . . . . *M. maximus.*

Teeth compressed, without facets, the pterygoid unequal, the median very large; together eight. . . . . *M. impar.*

II. The posterior lumbars with depressed centra, and ovate extremities.

*α.* Large species.

*β.* Anterior lumbars little depressed.

Mandibular teeth fourteen; pterygoids ten; squamosal with broad, triangular expansion above opisthotic. Quadrate bone longer than broad. Dorsals transversely ovate, sides rounded . *M. missuriensis.*

*β β.* Anterior lumbars flattened like the posterior.

Dorsals flattened, with lateral keel on side; caudals vertical and ovate. . . . . *M. Brumbyi.*

*α α.* Small species.

Centra transversely ovate; caudals vertical ovate . . *M. minor.*

**Mosasaurus giganteus** Soemmering. *Lacerta gigantea* Soemmering. *Mosasaurus Hofmannii* Mantell. *M. Camperi* Meyer. *M. belgicus* Hall.

Upper cretaceous; Belgium, Rhine-Prussia and England.

**Mosasaurus gracilis** Owen, British Fossil Reptiles. Upper cretaceous, England.

**Mosasaurus Mitchillii** DeKay. *Geosaurus Mitchillii* DeKay. *Atlantochelys Mortoni* Agassiz. *Mosasaurus Cowperi* and *M. carolinensis* Gibbes.

The upper cretaceous of the Eastern United States.

In addition to the characters already pointed out, this species differs from the *M. missuriensis*, as follows, judging from the figures and descriptions of Goldfuss.

In *M. Mitchillii* the proötic wraps over the opisthotic to its superior face; in *M. missuriensis* the exoccipital wraps over to the superior face of the same bone.

In *missuriensis* the squamosal forms a horizontal three-cornered expansion, and only touches the opisthotic behind.

In *Mitchillii* the squamosal is largely inferior, and has no superior expansion.

In *Mitchillii* the under face of the suspensorium is underwrapped by the proötic, in *missuriensis* by the exoccipital. Glenoid cavity two thirds on squamosal in *M. Mitchillii*; not at all on squamosal in *M. missuriensis*.

**Mosasaurus maximus** Cope. sp. nov.

This new species is indicated by a nearly perfect os quadratum, several dorsal and cervical vertebræ, including axis and atlas, a portion of the mandible with probably numerous teeth. The latter have not yet come into my hands. The remains indicate an animal of the largest size, perhaps seventy-five feet in length.

The quadrate bone, compared with those of two other species from the New Jersey Green-sand, presents marked characters. Six quadrate bones of the *M. Mitchillii* exhibit such constancy in the form as was to have been anticipated, while one of the third species,—perhaps the *M. depressus* Cope, is quite different from both. Its proximal extremity is sub-tripodal, the external angle being much longer than that over the great ala, being in fact a process. In the *M. maximus* and *M. Mitchillii*, it is an obtuse angle, and that over the ala a process, which is very large in the former, and small in the latter. The knob just within the meatus of the ear is very prominent in the *M. depres-*

*sus* and *M. Mitchillii*, while it is rudimental in *M. maximus*; in the latter the outer ridge bounding the meatus is prolonged into a process below, which is merely rudimentary in the two species named. The centra of the dorsal vertebræ are very cylindric, and shortened antero-posteriorly.

The full description of this species is reserved for the monograph now in publication. The remains preserved are larger in their proportions than those of the Mæstricht animal. A portion of an individual from the lower Green-sand bed of Monmouth Co., N. J., has been submitted to me by the director of the geological survey of the State, Prof. Geo. H. Cook. Portions of an individual of similar proportions, which were found in Gloucester Co., are preserved in the Cabinet of the Burlington Co. Lyceum. Vertebræ quite similar have been brought by Dr. F. V. Hayden from Nebraska.

The *M. Mitchillii* may attain the dimensions of this species, though none such have come under my observation. The names which may be applied to this animal are few. The *Atlantochelys Mortoni* Agass., may refer to any large species of the genus, so far as our knowledge goes; it has, however, never been described, and cannot therefore retain this name. The *Mosasaurus DeKayi* Brown, is founded on a tooth like that of *M. Mitchillii*, and cannot be distinguished on such basis alone. The *M. impar* is only known from jaws and teeth, and hence is the only species the name of which is liable to have been duplicated here. It may belong to any of the American species here enumerated, except *M. Mitchillii* and *M. missuriensis*, whose teeth are well known. As it is earlier named than, and may be the same as *M. depressus* Cope, I do not describe the remains of the latter here.

The *Elliptonodon compressus* Emmons, I do not consider to be a Mosasauroid. The *Baseodon reversus* Leidy, is founded on pterygoid teeth of some species. They resemble those of *M. Mitchillii*.

**Mosasaurus missuriensis** Harlan. *Ichthyosaurus* do. Harlan, Trans. Amer. Philos. Soc., IV, 405, Tab. xx, 1834. *Batrachiosaurus* Harlan. *Batrachiotherium* Harlan. *Mosasaurus neovidii* Meyer. *M. Maximiliani* Goldfuss. *M. missuriensis* Leidy.

An unusually perfect specimen of this species was recently exhumed by W. E. Webb, near the town of Topeka in Kansas. My friend, Prof. J. Parker of Lincoln College of that place, informs me that it is seventy-five feet in length, and the gentleman who discovered it, that it measures eighty feet. Its mandibular rami are stated by the latter to measure five feet. Measurements of the ver-

tebræ indicate them to be of a size quite similar to those of large individuals which have been discovered in the Green-sand of New Jersey. They measure as follows, as stated on photographs by my friend, W. E. Webb.

| | Diameter. |
|---|---|
| Cervicals, centra only . . . . . | 2.5 inches. |
| Dorsals, with diapophyses . . . . . | 7 " |
| Lumbars . . . . . | 2 " |

These proportions illustrate again the ophidian form of this genus, and the relatively large size of the head.

The teeth resemble in size those of large specimens of *M. Mitchillii.*

A cranium of this species has been figured by Goldfuss of Bonn.

The following corrections should be made in the nomenclature adopted by him in the explanations of his plate, Nova Acta Nat. Cur., 1845, tab. VI to IX.

TAB. VI.

T. is squamosal, called *temporal.*

T. m. is opisthotic called *temporo-mastoid.*

T. p. is proötic and epiotic.

P. is a thin lamina of parietal, prolonged backwards over supraoccipital.

TAB. IX.

2 ? ? said to be pubis.

3 is quadratum, said to be olecranon.

From the upper cretaceous of Middle North America.

**Mosasaurus Brumbyi** Gibbes. *Amphorosteus Brumbyi* Gibbes. Smithsonian Contrib. to Knowledge, II, 9, Tab. III, 10–16.

This species appears to be common in the rotten limestone of Georgia and Alabama. Further description in MS. will be published hereafter.

**Mosasaurus minor** Gibbes. Loc. cit. 7 Tab. I, 3–5.

This small species appears not to have been so large as the *Clidastes iguanavus* Cope.

The cretaceous of Alabama.

PLATECARPUS Cope. (From πλάτη, an oar.)

This genus is especially characterized by the peculiar insertion of the pterygoid teeth. Its humerus also is more chelonian than that of Mosasaurus, while the os quadratum presents marked differences.

These peculiarities have been pointed out by Leidy, who refers the species to the genus Holcodus of Gibbes. Now this genus Leidy shows was made to include also teeth of Hyposaurus, and it may be that the name should be restricted to that genus, as its meaning is "grooved tooth," a term not applicable to a Mosasauroid. But as it has been accepted for the Mosasauroid included by Gibbes, by the next writer, Leidy, it must be retained for it, according to the just rule usually followed. There is, however, for us no evidence that the present genus possessed such a tooth; and as the teeth of all the genera bear such a close mutual resemblance, I think it must be left for future discovery to determine the application of the genus Holcodus.

Dorsals transversely ovate, rounded; quadrate bone broad as long, meatus larger. Humerus little contracted medially, with flat shaft; pterygoid teeth eight . . . . . *P. tympaniticus.*

**Platecarpus tympaniticus** Cope. *Holcodus acutidens* Leidy, Cretaceous Reptiles N. Am., p. 118, Tab. VII, 4–7; VIII, 1–2–7; XI, 14; vix Gibbes Smithson. Contrib., 1851, II, 7, Tab. I, 3–5 vel Leidy, loc. cit., Tab. X—17.

The individual of this Mosasauroid, from which it is known, was of medium size; it was found in the upper cretaceous of Mississippi, near Columbus, by Dr. William Spillman.

## STREPTOSAURIA.

Under this name I have characterized a group of high rank among the Reptiles, which is allied to the Sauropterygia. The diagnosis will be as follows.

The articular processes of the vertebræ, reversed in their directions; viz., the anterior looking downwards, the posterior upwards; the procoracoids distinct from the scapulæ, but confluent with each other and the mesosternum into a simple breast plate. Mandible with symphysis. Pelvic arch present; limbs present. Neural arches of vertebræ coössified with centra.

The characters of this order are altogether peculiar. They are largely derived from an almost complete specimen of *Elasmosaurus platyurus* Cope in the Museum of the Academy of Natural Sciences of Philadelphia. The vertebral character may be explained on the supposition that the zygosphen and zygantral articulation is present, and the zygapophysial wanting, or that the obliquity of the faces of contact of the zygapophyses is reversed. The genera known are three,

I. The vertebræ plane, moderately elongate.

Tail very long, compressed; fore limb small; no diapophyses on lumbar region . . . . . ELASMOSAURUS.

Tail short, depressed; forelimb strong; diapophyses on lumbar vertebræ . . . . . CIMOLIASAURUS.

II. The vertebræ with very short antero-posterior diameter, slightly biconcave . . . . . CRYMOCETUS.

The species indicated are seven, as follows:

### ELASMOSAURUS Cope.

**Elasmosaurus platyurus** Cope. Proc. Acad. Nat. Sci., Phil., 1868, 92.

Length about forty-five feet; bulk of body near that of an elephant. The upper cretaceous of Kansas.

**Elasmosaurus orientalis** Cope, MS.

Dimensions similar to those of the preceding. The Cretaceous Green-sand of New Jersey.

**Elasmosaurus constrictus.** *Plesiosaurus constrictus* Owen, British Reptiles.

Known only from a caudal vertebra from the British Chalk.

### CIMOLIASAURUS Leidy.

*Cimoliasaurus*, *Discosaurus* and *Brimosaurus* Leidy.

**Cimoliasaurus magnus** Leidy, Cretaceous Reptiles N. Am. *Discosaurus vetustus* Leidy l. c.

Cretaceous Green-sand of the Eastern United States.

**Cimoliasaurus grandis** Leidy. *Brimosaurus grandis* Leidy. Proc. Acad. Nat. Sci., Philad., 1854, 72.

Upper cretaceous of Arkansas.

**Cimoliasaurus latispinus.** *Plesiosaurus latispinus* Owen, British Reptiles.

From the Green-sand of England. Perhaps it is an Elasmosaurus.

### CRYMOCETUS Cope.

**Crymocetus Barnardi.** *Plesiosaurus Barnardi* Owen, British Reptiles. Palæontographical Soc., Cretac. Rept., Tab. XVIII.

From the chalk of England. This species is founded by Owen on supposed cervical vertebræ. They appear to me to be rather lumbars, and to indicate an ally of the preceding genera.