

CARBONIFEROUS AIR-BREATHING VERTEBRATES OF THE UNITED STATES NATIONAL MUSEUM.

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The writer has been engaged for some months investigating the structure of the earliest air-breathing vertebrates. Through the kindness of the Secretary of the Smithsonian Institution, Dr. Charles D. Walcott, he was given the privilege of studying the collection of the U. S. National Museum, which contains remains of these forms. This collection is a small one but of great interest, and is unique in containing the only examples known of scaled amphibians from North America, as well as the only known specimen of a Carboniferous reptile from the Allegheny series.

The specimen of the reptile is so important in the light of the present discussions concerning the origin of the Reptilia that it is considered worthy of an extended description, although it has been previously described by Cope, Williston, and the writer. None of these authors has, however, dealt with the anatomy of the animal as a whole, and, although Williston published an excellent photograph (here reproduced) which corrected some of the errors of Cope's original drawing, yet even a photograph is lacking in details. The relations of the pelvic region and the structure of the vertebral column are especially indistinct, so that an outline drawing of the skeleton has been introduced in Plate 5.

ISODECTES PUNCTULATUS Cope.

Plates 4 and 5.

Tuditanus punctulatus COPE, Amer. Naturalist, 1896, p. 303.—HAY, Cat. Foss. Vert. N. A., 1902, p. 415.

Isodectes punctulatus COPE, Proc. Amer. Phil. Soc., vol. 36, 1897, p. 88, pl. 3, fig. 3; Syllabus of Lectures on the Vertebrata, 1898, p. 61.

Isodectes copei WILLISTON, Journ. Geol., vol. 16, 1908, p. 395.—MOODIE, Trans. Kans. Acad. Sci., 1909. [Refers to *Isodectes copei* Williston in connection with the proposed new classification of the Amphibia]; Amer. Naturalist, vol. 45, p. 122.—HOLLAND, 11th Annual Report of the Carnegie Museum, 1908, p. 32.

The specimen of *Isodectes punctulatus* Cope, which is less than 6 inches in length, consists of the following parts: A nearly complete

vertebral column, including the terminal caudal centrum (45 centra preserved); portions of 27 pairs of ribs; three distal carpalia of the left hand; first digit of the left hand entire, and others represented by scattered phalanges, four digits in all; left foot nearly entire, lacks only terminal phalanx for digit III; right foot complete but elements scattered, both legs otherwise complete; portion of pelvis.

The reptile, to which the remains pertain, must have been an aquatic, or at least a semiaquatic form, if one may judge from the expanded foot, although the limbs show no adaptive modifications for aquatic conditions. The dimensions of the foot, as preserved, however, show a broad surface, which may be given the same interpretation as McGregor has given the foot of *Mesosaurus brasiliensis* McGregor,^a from the Permian of South America.

The long tail in the present species would tend to support the idea of the aquatic habit of the animal, although there is not the slightest evidence of lateral flattening, nor are elongate spines and chevrons present as in *Mesosaurus brasiliensis* McGregor. The stout, elongate femur in the present species is in strong contrast with the crocodile-like femur of *Mesosaurus*. The femur resembles, in its proportions, that of *Saururus costei* Thevenin, from the Carboniferous of France.^b In view of the character of the beds from which *Isodectes* comes and the aquatic nature of the Microsauria which were associated with *Isodectes*, it will not be far wrong to assume an aquatic habit of life for *Isodectes* for at least a part of the time. The clawed phalanges are to be looked on as indicating a partial adaptation to land dwelling.

The form of the body of *Isodectes punctulatus* Cope is remarkably lizard-like and resembles in its proportions some of the larger species of *Iguana* without the great length of tail. The vertebral column in *Isodectes* was solidly built and its limbs were strong, being supported, in the pelvic region at least, by a strong arch.

It is extremely unfortunate that the entire skeleton of the reptile was not preserved, since there is no doubt that it was all embedded in the coal if we may judge from the nature of the fracture extending across the anterior region of that portion of the skeleton which is preserved, but in the violent processes of mining the anterior portion of the body was lost. As a matter of coincidence the same accident may be mentioned as having occurred in the case of *Saururus costei* Thevenin. The vertebral column in *Isodectes* consists of biconcave centra with possibly rudimentary intercentra, although no definite evidence is to be had on this head. The spines of the vertebrae were low and almost rudimentary. The notochord was probably

^a J. H. McGregor, Relatorio Final Comissao de Estudos das Minas de Carvao do Brazil, 1908, p. 303.

^b A. Thevenin. Annales de Paleontologie, vol. 1, 1903, pl. 2.

persistent judging from the fractured portion of the most anterior centrum preserved. There are evidences of 21 presacral vertebræ, and there may have been 7 or 8 more, thus bringing the number of presacrals near 30, agreeing exactly in this instance with the vertebral column of *Mesosaurus* from Brazil and also agreeing with *Sauravus* from France, so far as can be determined. There are two sacral vertebræ in *Isodectes*. Twenty-two caudal vertebræ are preserved. They are very stout near the base of the tail but taper gradually until, at the tip, the size is reduced to near one-half. There are two lengths in the caudal vertebræ, as may be seen by referring to Plates 4 and 5. The sixth vertebra from the tip is nearly one-third as long again as the succeeding one. There is another long vertebra four vertebræ above this one. Just what the meaning of this condition is I can not determine, since it has not been observed, so far as I know, in any other early reptile. In *Mesosaurus* the vertebræ are apparently of uniform length. The neural canal is plainly visible in some of the distal vertebræ of the tail and this sinks quite deeply into some of the vertebræ, so that one is led to conclude that there are represented the two unconnected halves of the vertebræ; or, in other words, we have here a primitive condition of the persistence of the pleurocentra such as is paralleled in the developing vertebræ of the chick of thirteen days' incubation^a and also in the vertebræ of some lizards.

There are evidences of 27 pairs of ribs. They are all intercentral in position, agreeing in this respect with the condition in all the Microsauria so far studied from the Carboniferous of North America, and also with the condition in *Sauravus*. In *Mesosaurus* the ribs have migrated backward from the intercentral position. Twenty-four pairs of presacral ribs are preserved. They are all strongly recurved exactly as in *Sauravus*, and are stoutly built. They are not distally expanded and are progressively shorter backward. The ribs are apparently single-headed as in *Sauravus*, there being no evidence of the bicipital condition, although this may be indicated by the expansion of the heads. The three pairs of caudal ribs preserved are short and more strongly recurved than the presacral ribs. The presence of sacral ribs can not be determined.

The left hand is of such a size that we may safely conjecture that the fore limbs were of some strength, but further than this nothing can be said. The carpus as preserved consists of three distal carpalia, being the carpal elements for digits II, III, and IV. There are two small ossicles lying beside the phalanx of digit III, which may be other carpalia. The first digit is preserved entire and the metacarpals of the other digits are also preserved. The phalangeal elements are all alike in the absence of any great amount of endochondrium. There are three elements in the first digit, the metacarpal

^a Lillie, Development of the Chick, 1908, p. 426, fig. 242.

and the two phalanges. The elements of the other three digits are scattered so it is impossible to determine exactly the phalangeal formula for the hand, though it may have been 2-2-3-2.

The pelvis is represented by portions of the ilia which are exposed. The ischia and pubes are not visible. The ilium of the left side is the better preserved. It is seen to be an elongate, flattened plate slightly curved to accommodate the head of the femur. Two sacral vertebrae gave support to the ilia, possibly through the intervention of sacral ribs.

The hind limbs are very strong, with the foot much expanded and the tarsus well developed and bony. The femur is especially strong, and recalls in its proportions some of the higher reptiles. Its head is a little obscured through crushing, but the articular surface for the ilium seems to have been quite large, covering at least an arc of 40° , and thus indicating a wide range of movement for the leg. The two ends of the bone are expanded, but there are no tuberosities for muscular attachment nor should we expect any. The articular surface of the distal end is divided into two clearly marked facets for articulation with the tibia and fibula, recalling in this respect the femur of the plesiosaurs. The tibia has a triangular head, a contracted distal end, and a slender shaft. The fibula is slightly curved with the ends expanded. The distal end is wider than the proximal.

The tarsus, as preserved, in the left foot is composed of eight elements—two proximal and six distal tarsalia, one of which may be a sesamoid or a fractured portion of "t 5." The astragalus (tibiale) and calcaneum (fibulare) are both rounded, but with articular facets for the accommodation of the tibia, fibula, and distal tarsalia. There is no evidence of a *centrale carpi* or intermedium. The carpus is quite regular, and shows more specialized characters than do the later Cotylosauria, in which the *centrale* is still present, in one species of *Labidosaurus* at least.

The digits of the foot are long and slender, with a progressive increase in length from the first to the fourth. The fourth and fifth are nearly equal in length. The metacarpals of all five digits are long and exhibit full ossification, though no evidences of epiphyses are present. The terminal phalanges are pointed. The phalangeal formula of the foot is 2-3-4-5-4, a typical reptilian arrangement. In closing his discussion of this species Cope says: "This specimen is of importance as pertaining to the oldest known reptile, and the only one which has thus far been positively identified from the Coal Measures. I announced this identification in the American Naturalist, 1896, page 303."

The absence of ventral ribs is an assured character in *Isodectes*. I have searched for them under high power of magnification, and have

even flaked off portions of the soft coal on which the animal is embedded, without detecting at any point the slightest trace of an abdominal armature. The absence of scutellæ is complete, since there is no reason why they should not have been preserved, as the skeletal elements are in place and undisturbed by any post-mortem shifting.

The relationships of this peculiar reptile are not known. Its close affinities with the Microsauria is firmly established by many structural resemblances, but to what group of reptiles it may be related is uncertain. There are but few characters preserved on which a relationship could be established. The two sacral vertebrae, the phalangeal formula, and the ossified carpus and tarsus are the only true reptilian characters present in the specimen. Too much stress has been laid on the phalangeal formula as a basis for relationship, and a study of the Microsauria has shown that the presence or absence of ventral armature is of no particular importance, as has been shown to be the case with epiphyses, on which two groups of reptiles have been related. No member of the genus *Tuditatus* possesses abdominal ribs or scutellæ, but in closely related forms, like *Saurerpeton*, *Sauropleuræ*, and *Ctenerpeton*, the abdominal ribs or scutæ are present in great profusion and with well-marked characters, which have been taken as generic landmarks.

The morphology of the ventral armature still remains in mystery. Its origin is not to be explained on the basis of the structures found in any Carboniferous air-breathing vertebrate. The earliest branchiosaurians possess ventral scutes, and the earliest microsaurians possess them. Their origin and function are to be explained with the solution of the problem of the origin of the Amphibia from their piscian ancestor, which has not yet been discovered.

Measurements of Isodectes punctulatus Cope.

	mm.
Length of entire specimen, as preserved.....	132
Width across body, in middle of dorsal region.....	18
Length of digit I of the hand.....	11
Width of ulnare.....	2
Length of metacarpal, second digit.....	4
Length of rib in dorsal region.....	9
Width of same rib.....	.75
Length of dorsal vertebra.....	4
Width of same.....	3
Length of presacral region preserved.....	60
Length of sacral region.....	8
Length of ilium.....	9
Greatest width of the ilium.....	3
Length of femur.....	15
Proximal width of the femur.....	5
Median width of femur.....	2
Distal width of femur.....	4
Length of tibia.....	8

	mm.
Proximal width of tibia.....	3
Median width of tibia.....	1.50
Distal width of tibia.....	2
Length of radius.....	8
Proximal width of radius.....	2.50
Median width of radius.....	1.50
Distal width of radius.....	3
Length of tibiale.....	4
Width of same.....	2
Length of radiale.....	3.50
Width of same.....	2.50
Width of the distal tarsalia.....	1.50-2
Length of metatarsal of the fourth digit.....	5
Length of the first digit of the foot.....	8
Length of second digit.....	14
Length of third digit.....	18(?)
Length of fourth digit.....	19
Length of fifth digit.....	15
Length of the tail, as preserved.....	62
Width of tail at base.....	5
Width of tail at tip, as preserved.....	1.50
Length of distal vertebra of tail.....	3-5

The specimen, a part of the Lacoe collection, is Cat. No. 4457 of the U. S. National Museum. It was collected by Mr. Samuel Huston at Linton, Ohio.

TUDITANUS WALCOTTI, new species.

Plate 6, fig. 1: plate 7, fig. 1.

A small species of *Microsauria* is preserved as a smooth impression on a block of soft coal from Linton, Ohio. Nearly the entire form of the body is discernible. The specimen is especially interesting and valuable as exhibiting for the first time among the Linton forms the shape of the body of the small microsaurians of the *Tuditanus* type. It differs so markedly in the form of the skull from others of the genus that it is regarded as new, and the name *Tuditanus walcotti* is proposed for it as an expression of the writer's indebtedness to the secretary of the Smithsonian Institution for the use of the material among which the present form was included.

The specimen includes, besides the body impression, the complete skull, a right clavicle with portions of the left, a left humerus, 12 cervical and dorsal vertebrae, 10 pairs of ribs somewhat disturbed as to position, and a portion of the mandible. There are no portions of ventral scutellae nor are there any traces of body scales in the smooth impression of the carbonized skin. One would expect at least to find impressions of the ventral scutae in this specimen if they were present. Cope remarked on the apparent absence of scutellae from members of the genus *Tuditanus* as they were known to him, and no contrary

evidence has since been brought to light. Until such evidence is forthcoming the absence of scutes will be taken as one of the generic characters of the genus *Tuditonus*. Under a magnification of 50 diameters the carbonized skin shows folds and wrinkles like muscle fibers in some places; in others no traces of the muscular structure can be detected. The wrinkles may be impressions of the internal musculature of the body wall of the abdomen. It is especially well preserved in the pelvic and pygal regions. Sections of the coal were made, but nothing definite could be determined as to the character of the impressions, as they were too poorly preserved and the coal too soft to bear much handling.

The specimen is preserved on the belly with the dorsum of the skull uppermost. It has been practically impossible to determine the arrangement of any of the cranial elements except the frontals, parietals, and the supraoccipitals which have the relations indicated in Plate 7, fig. 1. A median suture is clearly evident, with the pineal foramen well back in this suture. The bones of the skull are marked with faint, radiating lines. It is in the form of the skull and the position of the orbits that the specific characters are found. These are the backward position of the eyes and in the oval, pointed shape of the skull. The species is closely related to *Tuditonus minimus* Moodie from the Cannelton slates of Pennsylvania, and serves further to connect the forms from the Ohio and Pennsylvania localities. It differs from the last-named species in the position and form of the orbits, these structures being more oval in the present form and placed farther back. The shape of the skull differs also in the almost entire absence of the posterior table. The median points of the orbits occupy the line which bisects the skull. The interorbital width is less than the length of the orbit. The mandible is heavy and appears to have borne sharp pleurodont teeth.

The vertebral column is little more than a mold of the form of the vertebræ, so that little can be said of its character. The individual vertebræ are short and hour-glass shaped. The ribs are borne intercentrally, as in all the microsaurians which have been studied from the Linton deposits. The ribs are rather long and somewhat heavy, slightly curved and expanded at the proximal end as though an incipient bicipital condition were present.

The right clavicle, which is preserved as an impression, is entire. Its impression shows this element to have been ornamented on its ventral surface with radiating grooves and ridges which started at the lower angle of the bone. The element is distinctly triangular, which is characteristic of the genus *Tuditonus*, so far as known. The fragment of the left clavicle adds nothing to our knowledge of the element.

The left humerus recalls in a striking way that of *Tuditonus longipes* Cope, and it was once entertained as a possibility that the present form might be a member of that species, since the skull is lacking in *T. longipes*. Sufficient specific differences were found, however, in the ribs, which, in *T. longipes*, are very long, slightly curved, and delicate, but which, in the present form, are comparatively heavy. Other characters sufficiently diagnostic are found in the form assumed by the vertebrae in the two forms.

Measurements of the type of Tuditonus walcotti.

	mm.
Length of specimen -----	70
Length of skull -----	20
Width of skull, posterior -----	14
Width of skull, anterior to orbits -----	10
Length of orbit -----	4
Width of orbit -----	2
Interorbital width -----	3
Length of clavicle -----	9
Greatest width of clavicle -----	4
Length of vertebral column, as preserved -----	50
Length of a vertebra -----	1.75
Width of a vertebra -----	.50
Width of body impression -----	15
Length of humerus -----	6
Median width of humerus -----	.50
Width at end of humerus -----	2
Length of rib -----	8
Width of rib -----	.25

This specimen was collected by Mr. R. D. Lacoë, of Pittston, Pennsylvania, from Linton, Ohio.

A second individual (Plate 6, fig. 2; Plate 7, fig. 2) of this species (*Tuditonus walcotti*) is indicated by a rather poorly preserved specimen on a slab of soft coal from the Linton mines. The following portions of the animal have been detected and will be discussed: Partial impression of the skull, with a fragment of a minute jaw, in which are minute teeth; right clavicle; part of the impression of the body; nearly entire left hind limb; impressions of about a dozen vertebrae, very indistinct.

The impression of the skull is distinct only in a favorable light, and even then the boundaries of the cranium are a little uncertain. For this reason no representation of the form will be attempted. The sculpturing on the parietals is, however, distinct enough to show relationship with the previously described specimen, and the form of the body impression, the absence of abdominal scutes, the shape of the clavicle and its sculpture, and the proportions of the hind limb all agree with the characters which have been assigned to the genus *Tuditonus*. The fragment of the jaw is interesting as giving the first information as to the character of the mandible in the genus *Tudi-*

tanus. It is very slender and of uniform width so far as preserved. The teeth are short, blunt cones, apparently pleurodont.

The clavicle is of the typical *Tuditanus* form, with the sculpturing lines radiating out from the angle. The impression of the body adds nothing to that already described for the type-specimen. The nearly entire hind limb is of great interest as adding another example of the phalangeal formula. The foot is almost perfectly preserved, and the formula was probably 2-2-3-3-2. The endochondrium of the limb bones is not highly developed. About a dozen vertebrae are represented by molds in the soft coal, but nothing of their structure can be determined.

The sharp, reptile-like claws in which the toes end recall those of *Isodectes* and of *Tuditanus minimus* Moodie. It is another link in the chain of the suggested relationship between the microsaurians and the early reptiles.

Measurements of the second specimen of Tuditanus walcotti Moodie. (Cat. No. 4481, U.S.N.M.)

	<i>mm.</i>
Length of entire body impression.....	75
Width across belly, maximum.....	16
Length of skull.....	? 17
Posterior width of skull.....	? 14
Length of fragment of jaw.....	4
Width of fragment of jaw.....	1.5
Length of tooth in jaw.....	.25
Length of clavicle.....	8
Width of clavicle, maximum.....	4
Length of hind limb.....	22
Length of femur.....	8
Length of tibia (?).....	6
Length of metatarsal.....	2
Length of first digit.....	6

Genus ODONTERPETON, new genus.

The generic characters may be found in the triangular shape of the skull, the large size of the teeth, the shape of the vertebrae, the small size of the orbits and their anterior position as shown in the type.

The name of the genus is derived from the remarkable size of the teeth compared with the size of the skull, and it was through them that the specimen was first recognized as a skull.

Genotype.—*Odonterpeton triangularis*.

ODONTERPETON TRIANGULARIS, new species.

Plate 6, fig. 3.

By this name may be known the smallest of all microsaurians hitherto described. *Orthocosta microscopica* Fritsch, from the Carboniferous of Bohemia, is a rival of the present form as to size, but the form described by Fritsch belongs among the Aistopoda, while the present form shows clear affinities with the Microsauria.

As may be seen by referring to the list of measurements, the skull of the present form measures only $6\frac{1}{2}$ mm. in length. The form may possibly be larval, though I do not think so, if I may judge from the well-developed condition of the skull bones and the complete ossification of the vertebræ. The sides of the skull are equal and the base is a straight table, so that the skull forms almost an exact equilateral triangle. The orbits are very small and are placed well forward. The interorbital space is four times that of the diameter of the orbit, a very unusual character and in itself is almost worthy of ranking as a generic character. The median suture of the skull is zigzag, and incloses the minute parietal foramen near the posterior end of the skull. The relations of the elements of the skull, with the exception of those of the frontals and parietals, can not be determined with accuracy, although there are here and there indications of sutures. The characters exhibited by the cranial elements, so far as they can be determined, are those of the family Tuditanida, and the form may, for the present, be regarded as a member of that group. The teeth are very long, slender, and sharp, and are placed close together. There is no indication of fluting on the teeth. They are slightly curved inward.

There are thirteen vertebræ present. The centra are hour-glass shaped, and are apparently phyllospondylous, with the notochord largely persistent. The vertebral centra are unusually long and slender, with the ends rounded. The humerus of the right side is preserved. It is a long, slender bone with expanded extremities. There is no evidence of abdominal armature nor of ribs.

The discovery of this form in the Linton deposits is of considerable interest as indicating a wide range in size and character of the fauna of the time. The forms now known from Linton range from the *Odonterpeton* to the form designated *Macrerpeton hualeyi* Cope, with a skull possibly 8 inches in length and whose body may have attained some feet in length. The large rib described below undoubtedly indicates a large form of the ancient Amphibia from Linton, as do the vertebræ described by Marsh in 1863 from Nova Scotia.

Measurements of the type Odonterpeton triangularis Moodie,

	mm.
Length of animal, as preserved.....	18
Length of skull.....	6.5
Posterior width of skull.....	5.5
Length of side of skull.....	6.5
Diameter of orbit.....	.65
Interorbital width.....	2
Length of tooth.....	.25
Length of vertebra.....	1.45
Width of vertebra.....	.35
Length of humerus.....	2.25
Distal width of humerus.....	.35

The specimen is embedded on a small slab of soft coal from Linton, Ohio. It is Cat. No. 4465 of the U. S. National Museum collection.

ERPETOSAURUS MINUTUS, new species.

Plate 8, fig. 1.

The genus *Erpetosaurus* will be more fully characterized elsewhere. Suffice it to say here that it is erected to include certain members of the genus *Tuditonus*. The species *Erpetosaurus minutus* is the smallest of the genus so far known. The specimen on which the species is based is composed of the greater portion of a small skull preserved in the hard shale from Cannelton, Pennsylvania, and was collected by Mr. R. D. Lacey, of Pittston, Pennsylvania. The characters of the specimen had not been previously determined, since the museum label and number had partially obscured the snout of the skull. The skull is very small, but has the form assumed by other members of the genus. At first sight the specimen looks like a broken scute of some large form. Closer inspection, however, revealed the two impressions representing the orbits, and a Zeiss binocular revealed the characters. The enlarged photograph plate 8 (fig. 1, $\times 5$) shows the structure of the skull. The large size and anterior position of the orbits, the character of the sculpturing, the presence of a slight posterior table to the skull, as in *Erpetosaurus (Tuditonus) tabulatus* Cope, are the characters on which a specific diagnosis is possible. The specific characters which distinguish this form from the *E. tabulatus* Cope, are the slight development of the posterior table, the more delicate form of the sculpturing, the more posterior position of the orbits, and the varying shape assumed by the parietals in the two species. Any one of these characters would be valid as a specific character. The pineal eye is indistinct, but is observed to lie in the broken tract in the median line of the skull in the middle of the portion posterior to the orbits. The interorbital width is equal to the width of each orbit. The orbits themselves are slightly oval and not round as in the case of *E. tabulatus* Cope.

The skull elements are sculptured with sharp radiating grooves and ridges, and on the supraoccipitals and epiotics the grooves take the form of pits in a row, which undoubtedly represent the occipital cross-commissure of the lateral line system first observed by Andrews in the skull of *Ceraterpeton galvani* Huxley. The supraorbital canal is represented by a slight elongate depression observable over each orbit and extending, in one case, for some 5 mm. The presence of the circular arrangement of the lateral line canals in the jugal region is suggested by the depression on the left of the photograph on the posterior edge of the squamosal.

The portion of the skull anterior to the orbits is wanting, curiously enough, just as it is in *Erpetosaurus tabulatus* Cope. In the re-

mainder of the skull the supraoccipitals, the epiotics, the parietals, the squamosals, and a portion of the right frontal can be detected, although the boundaries of but three can be accurately defined. The depression bounding the anterior outline of the skull is taken to be the impress of the mandible, in which case this structure would be of some depth, as in the case of the mandible associated with *E. tabulatus* Cope, to be described elsewhere.

The present specimen is of interest in respect to the presence of the lateral line canals, its small size, and its generic identity with forms from Ohio. There is still another form known from the Cannelton slates *Erpetosaurus (Tuditanus) sculptilis* Moodie. It is No. 12315 of the University of Chicago collection.

Measurements of Erpetosaurus minutus Moodie.

	mm.
Length of skull.....	18
Posterior width of skull.....	17
Width of skull across orbits.....	14
Length of orbit.....	4.5
Width of orbit.....	3.5
Interorbital width.....	3.5

This specimen forms part of the Lacoe collection and is Cat. No. 4545 of the U. S. National Museum.

Pectoral girdle provisionally associated with *Erpetosaurus sculptilis* Moodie.

The present specimen is preserved on a block of slate from Cannelton, Pennsylvania. It is associated with the previously described *Erpetosaurus (Tuditanus) sculptilis* Moodie on account of its size and the character of the sculpture. It may pertain to an unknown species. There are preserved on the block of slate, besides the three element of the pectoral girdle, other remains, but they are, for the most part, too imperfectly preserved for recognition. Some of them are phalanges, and I believe I detect a scapula in the rounded curved plate lying near the right clavicle. The three pectoral elements, the interclavicle and the two clavicles, are preserved intact with the ventral surface uppermost. There are no evidences of pectoral elements other than the scapula.

The specimen is particularly important as furnishing further evidence of the simplicity of the microsaurian pectoral girdle, which has been regarded by Jaekel as being extremely complex, in one species at least, *Diceratosaurus punctolineatus* Cope. The three elements are broken, but either the elements or their impressions are present, so that identification is possible. The elements are sculptured with radiating grooves and ridges as in so many of the Microsauria. The interclavicle is spatulate and bears a general resemblance to the same element of *Metoposaurus fraasi* Lucas from the

Triassic of Arizona. The clavicles are triangular, with rounded angles, and the hypotenuse occupies the interior border.

Measurements of the pectoral girdle.

	mm.
Width across the entire girdle.....	17
Length of interclavicle.....	15
Width of interclavicle.....	10
Length of clavicle.....	11
Width of clavicle, maximum.....	6

The specimen is Cat. No. 4539 of the U. S. National Museum (Lacoe collection).

TUDITANUS MINIMUS Moodie.

Plate 8, fig. 2.

A nearly complete skeleton (Cat. No. 4555 U.S.N.M.) forms the basis of this species, which has already been described and an outline of the skeleton published.^a A photograph of the specimen on which the species is based is published herewith. The form is interesting as showing an advanced type of endochondral formation of the limb bones, and also in the complete preservation of the hand and foot.

EOSERPETON TENUICORNE Cope.

The new genus *Eoserpeton* has been erected for the reception of the species formerly described by Cope as *Ceraterpeton tenuicorne*. The characters of the new genus are found in the skull, which is represented by a nearly perfect specimen belonging to Columbia University. The skull was excellently supplemented by a nearly complete skeleton in the collection of the U. S. National Museum (Cat. Nos. 4472, 4473, U.S.N.M.), which shows characters of the skull which vary somewhat from the type. The horns are more slender in the National Museum specimen, and are more curved, and the form of the skull varies slightly in the two specimens. A restoration of the form has been attempted.^b Since the specimen has already been described by Cope a redescription will be reserved.

SAURERPETON LATITHORAX Cope.

Plate 9.

The new genus *Saurerpeton* has been proposed^c for the reception of the species described by Cope as *Sauropleuria latithorax*. The characters on which the new genus was based were the broad ventral elements of the abdomen and the arrangement and form of the cranial

^a Moodie, Journ. Geol., vol. 17, 1909, p. 56, fig. 10.

^b Idem, p. 77.

^c Idem, p. 80.

elements. An outline of the cranial elements has already been given, and a photograph of the complete specimen is given herewith to correct some of the inaccuracies of Cope's original drawing. It ought to be said, in justice to that brilliant author, that he did not see the proofs of the article in which the form was described. A fuller discussion and redescription of the species will be reserved.

ICHTHYERPETON SQUAMOSUM Moodie.

A remarkable form of amphibian was described^a under this name from material in the collection of the U. S. National Museum (Cat. Nos. 4476, 4459). The species was only tentatively assigned to the genus *Ichthyerpeton* Huxley. Its closer definition must await future discoveries. It is, however, *the only evidence of a completely sculled amphibian known from the Carboniferous of North America*. That the specimens are amphibians and not fishes is evidenced in the well-developed ventral scutellation.

CTENERPETON ALVEOLATUM Cope.

Plate 10.

An examination of the type (Cat. No. 4475, U.S.N.M.) of this peculiar form has not resulted in the discovery of any new characters. A photograph is given in Plate 10 to correct Cope's original drawing, which was inaccurate as to details. The form is interesting as furnishing another illustration of the diversity of types assumed by the ventral scutellation in the Carboniferous amphibians. In the genus *Tuditanus* no evidence has ever been detected of a ventral scutellation, while in the genera *Sauropleura*, *Saurerpeton*, and *Ctenerpeton* the scutellation of the abdomen has assumed a well developed and characteristic form.

PTYONIUS PECTINATUS Cope.

Plate 8, fig. 3.

There are four specimens of this species in the collection (Cat. Nos. 4514, 4458, 4463, 4464, U.S.N.M.). The most perfect one, shown on Plate 8, fig. 3, is interesting as giving an idea of the form of the body, which was long, slender, and snake-like. In this specimen there are no evidences of pectoral plates, although these are present on a specimen of another species of this genus in the collection of the American Museum of Natural History in New York City. The skull of *Ptyonius* is long and attenuated. The morphology of the skull has not yet been determined, but it is hoped that this may be possible from a close study of the material at hand, which includes six skulls and various portions of the body. From the form of the vertebrae

^a Moodie, Journ. Geol., vol. 17, 1909, p. 69.

in *Ptyonius* we may conclude that the body was flattened from side to side and that the caudal region was provided with a membraneous fin, such as is found in the recent *Petromyzon* and its allies.

Ptyonius is a typical member of the Aistopoda, the chief character of which group is the absence of limbs. With this character are, however, associated a concomitant lengthening and attenuation of the facial region, a recession of the orbits, an elongation and an attenuation of the body, a tendency to flattening from side to side in the vertebræ, an increase in the length of the tail, and the production of a peculiar type of abdominal armature, consisting of small rods arranged in a chevron pattern, ranging from just back of the skull in the pectoral region probably to the anus.

In other species of the genus *Ptyonius* the pectoral plates are more highly developed than in *P. pectinatus* Cope and especially in *P. nummifer* Cope. This is to my mind almost conclusive evidence that the Aistopoda are a degenerate branch of the Microsauria, to which they are closely related in most respects. The order Aistopoda may be retained for the present, however, until future discoveries teach us differently.

DICERATOSAURUS PUNCTOLINEATUS Cope.

It is with much gratification that a second specimen (Cat. No. 4461, U.S.N.M.) of this peculiar species is to be recorded from the collections in the U. S. National Museum. It supplements in a beautiful manner the type specimen, as well as those described by Jækel from the collections in Europe. In the present specimen the head is lacking. There are nineteen vertebræ preserved, and nine pairs of ribs. The ilium is present as a mold in the soft coal, and the femur and tibia(?) of the hind limb are preserved. The principal new characters which are added to the knowledge of the species by this specimen are the presence of the peculiar ilium and the large leg.

The vertebræ have the same character as the type. The ribs are intercentral and do not differ from the type as to structure or form. They are but slightly curved and are of an almost uniform width, with the head large. The mold of the ilium is hourglass shaped. It was evidently in the shape of a flattened plate with a rounded short shaft. It apparently attaches to the seventeenth vertebræ in the series as preserved. Since there are very probably two or three vertebræ gone from the cervical region, the sacral was probably the nineteenth or twentieth vertebræ of the series. The body of the animal was stout, as is evidenced by the dimensions of the skeleton.

There are no traces of ventral sentellæ. These structures are scantily preserved in the type specimen, and Jækel did not find them at all in the forms studied by him. The dimensions of the entire leg are those of *Pelion lyelli* Wyman, and at first sight it was thought that

the specimen pertained to that species. Closer examination of the vertebræ and ribs, however, revealed typical diceratosaurian characters. The femur is very long and quite stout, with the shaft long and the extremities expanded. The dimensions of the tibia are not definitely ascertained, but it has a structure essentially similar to the femur, with slender shaft and expanded ends.

The relationship of *Diceratosaurus* to *Ceraterpeton galvani* Huxley is a close one. The peculiar form of the scapula, the number of the dorsal vertebræ, the regular arrangement of the pectoral elements, the length of the tail, the form of the vertebræ and ribs in the two forms are indicative of a close relationship. The two genera both find a place in the family *Urocordylidae*, as defined by Lydekker.^a The generic character which separates the two forms in the position of the horn, which in *Ceraterpeton* is epiotic, and in *Diceratosaurus* supratemporal.

Measurements of Diceratosaurus punctolineatus Cope.

	mm.
Length of specimen -----	94
Length of rib -----	9
Width of rib -----	1.5
Length of vertebræ -----	5
Width of vertebræ -----	4.5
Length of femur -----	27
Proximal width of femur -----	6
Median width of femur -----	3
Distal width of femur -----	7
Length of tibia (?) -----	18
Distal width of tibia -----	4
Median width of tibia -----	2
Length of ilium -----	12
Proximal width of ilium -----	7
Median width of ilium -----	3
Distal width of ilium -----	6

Scutes of AMPHIBIAN, SAUROPLEURA SCUTELLATA Newberry.

Associated with certain specimens of the above-mentioned species are sometimes found peculiar scute-like elements (Cat. No. 4513, U.S.N.M.) which have been regarded as pertaining to the Amphibia and possibly to some species of *Sauroploera* itself. The position of the scutes on the body is uncertain. They range in size from 5 or 6 mm. to 30 mm. in length. They are always somewhat fan-shaped, with one end abruptly acute.

^a Lydekker, Cat. Fos. Rept. and Amphibia Brit Mus., pt. 4. p. 196.

The measurements of the present specimens are as follows:

	mm.
Length of larger scute.....	30
Maximum width of scute.....	13
Minimum width of scute.....	4
Length of smaller scute.....	22
Maximum width of scute.....	8
Minimum width of scute.....	6

THYRSIDIUM FASCICULARE Cope.

The specimens designated as Cat. Nos. 4480, 4462, U.S.N.M., correspond very closely with the figures of that species.^a The specimens consist of ribs, vertebræ, and scutellæ of the abdomen. On one of the slabs of No. 4480 there is an impression of a small patch of rounded scales and carbonized skin. These scales occur about two in a length of a millimeter. They are rounded and without markings. Whether the scales covered the entire body, as is the case in *Ichthyerpeton squamosum* Moodie, can not be determined.

MOLGOPHIS BREVICOSTATUS Cope.

The specimen (Cat. No. 4477, U.S.N.M.) resembles very much the one figured by Cope on plate 44, fig. 1 of the above-mentioned work.^a It consists of vertebræ, ribs, and ventral scutellæ, and adds nothing to our knowledge of the form.

GESTOCEPHALUS REMEX Cope.

The species is represented by two specimens (Cat. Nos. 4511, 4460, 4478, U.S.N.M.). They offer characters which vary somewhat from the type, but the remains are too imperfectly preserved to give definite data for specific separation. They consist of vertebræ, ribs, and many ventral scutellæ which are in some cases disassociated, so that one can with ease determine the separate rod-like form of the ventral armature. The vertebræ in the present specimens are larger than in the type and do not have the wide expansions of the chevron and spine.

PLEUROPTYX CLAVATUS Cope.

The specimen designated (Cat. No. 4509, U.S.N.M.) possibly belongs to this species, as defined by Cope, although it yet remains to be proven that the genus *Pleuroptyx* is distinct from *Molgophis*. The specimen corresponds very closely with the one figured by Cope on plate 44, fig. 2, of the Ohio report for 1875. It is of interest to note that Udden^b has recorded remains from the Des Moines limestone of Iowa which have been identified by Eastman as pertaining to this species.

^a Cope. Geol. Surv. Ohio, Pal., vol. 2, 1875, pl. 42, fig. 3.

^b Udden, Iowa Geological Survey, vol. 12, 1902, p. 406.

LARGE RIB.

Plate 8, fig. 4.

There is preserved on a block of soft coal a portion of a very large rib, which, with its impress (Cat. Nos. 4489, 4490, U.S.N.M.), represents the possible presence of a labyrinthodont type of animal in the Linton beds. The rib is very strong, slightly grooved, and is curved. There is a tendency to a bicipital condition but the extreme head is lost. The bone is solid and well formed and resembles no fish rib with which the writer is acquainted. It may be tentatively associated with the skull described elsewhere^a as *Macrerpeton huxleyi* Cope.

I am under obligations to Mr. G. Dallas Hanna, of the University of Kansas, for the line drawings of Plates 2 and 4.

EXPLANATIONS OF PLATES.

PLATE 4.

The type specimen of *Isodectes punctulatus* Cope, Cat. No. 4457, U.S.N.M., about natural size. After Williston.

PLATE 5.

Outline drawing of the skeleton of *Isodectes punctulatus* Cope, shown in pl. 4. About natural size.

PLATE 6.

- Fig. 1. Type specimen of *Tuditannus walcolti* Moodie, Cat. No. 4474, U.S.N.M. Natural size.
2. Second specimen of *Tuditannus walcolti* Moodie, Cat. No. 4481, U.S.N.M. Natural size. *T*=tarsus.
3. Type of *Odonterpeton triangularis* Moodie, Cat. No. 4465, U.S.N.M. × 3.

PLATE 7.

- Fig. 1. Outline drawing of the type of *Tuditannus walcolti* Moodie showing the impression of the body and the muscle structure at "M." × 2.5.
- Cl*=clavicle; *F*=frontal; *Fc*=femur; *H*=humerus; *n*=nostril; *O*=orbit; *p*=parietal; *R*=rib; *S*=supra-occipital; *V*=vertebra; *y*=pineal foramen.
2. The left leg of the second specimen of *Tuditannus walcolti* Moodie. × 3.

PLATE 8.

- Fig. 1. Type (Cat. No. 4545, U.S.N.M.) of *Erpetosaurus minutus* Moodie. × 5.
2. Type (Cat. No. 4555, U.S.N.M.) of *Tuditannus minimus* Moodie. × 1.
3. The skeleton (Cat. No. 4458, U.S.N.M.) of *Ptyonius pectinatus* Cope. × 1.
4. Large rib. × 1. (Cat. Nos. 4489, 4490, U.S.N.M.)

PLATE 9.

The skeleton of *Saurerpeton latithorax* Cope. × 1.5. (Cat. No. 4471, U.S.N.M.)

PLATE 10.

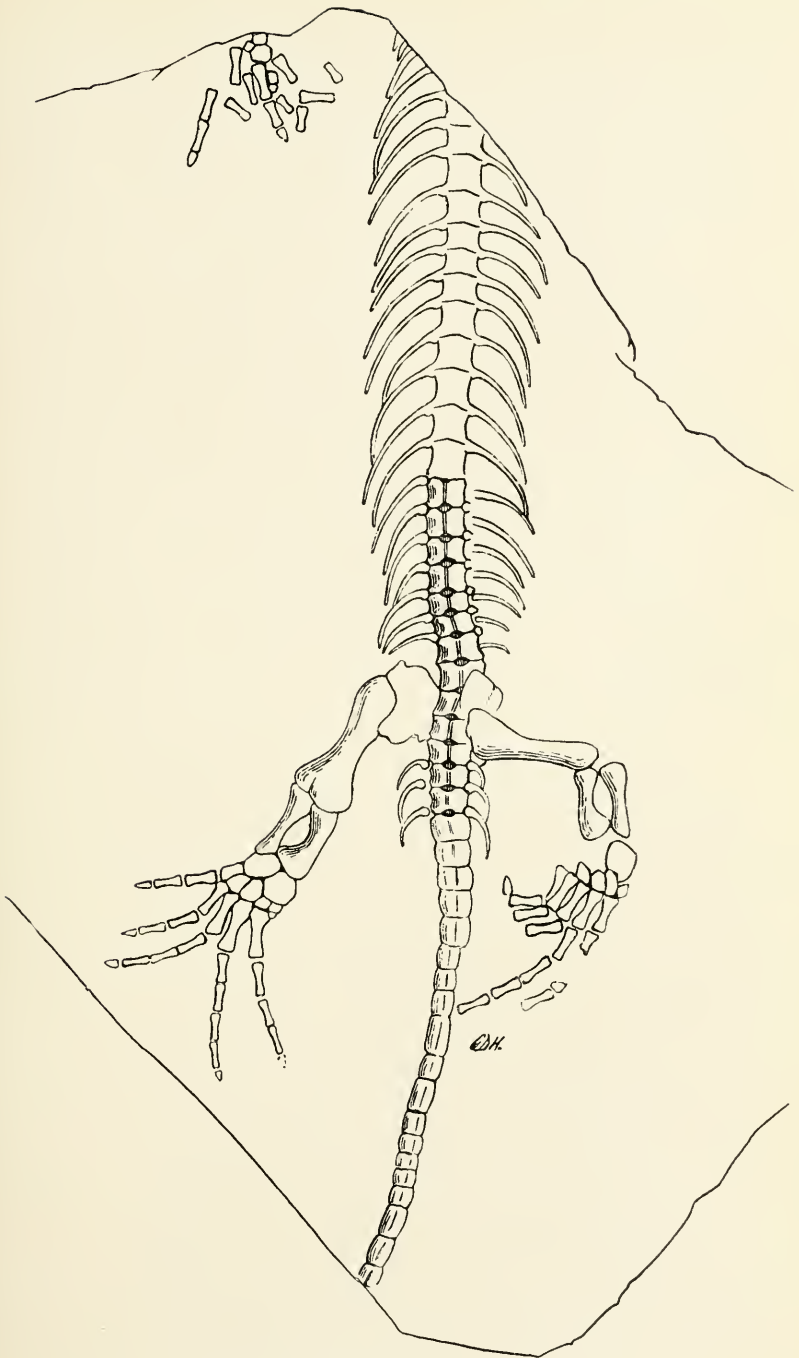
The skeleton of *Ctenerpeton alrcolatum* Cope. × 1. (Cat. No. 4475, U.S.N.M.)

^a Moodie, Journ. Geol., vol. 17, 1909, p. 72.



TYPE-SPECIMEN OF *ISODECTES PUNCTULATUS*.

FOR EXPLANATION OF PLATE SEE PAGE 28.



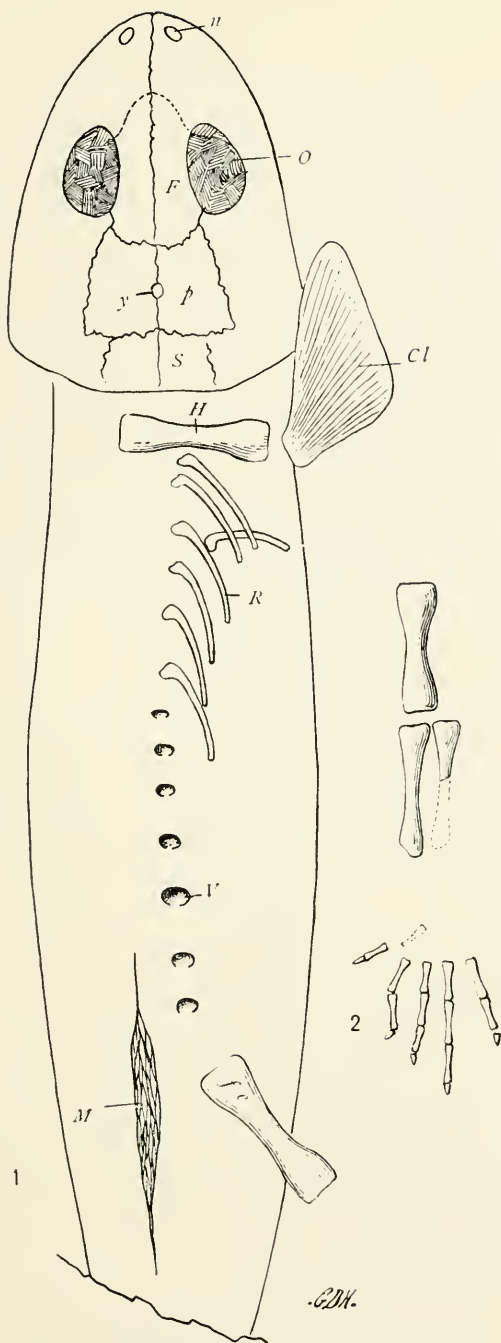
OUTLINE DRAWING OF ISODECTES PUNCTULATUS.

FOR EXPLANATION OF PLATE SEE PAGE 28.



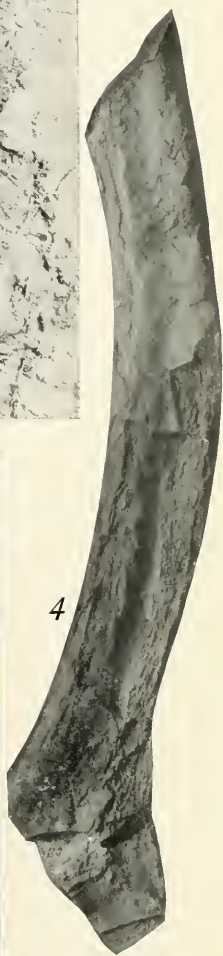
SPECIMENS OF *TUDITANUS WALCOTTI* AND *ODONTERPETON TRIANGULARIS*.

FOR EXPLANATION OF PLATE SEE PAGE 28.



OUTLINE DRAWING OF TUDITANUS WALCOTTI.

FOR EXPLANATION OF PLATE SEE PAGE 28.



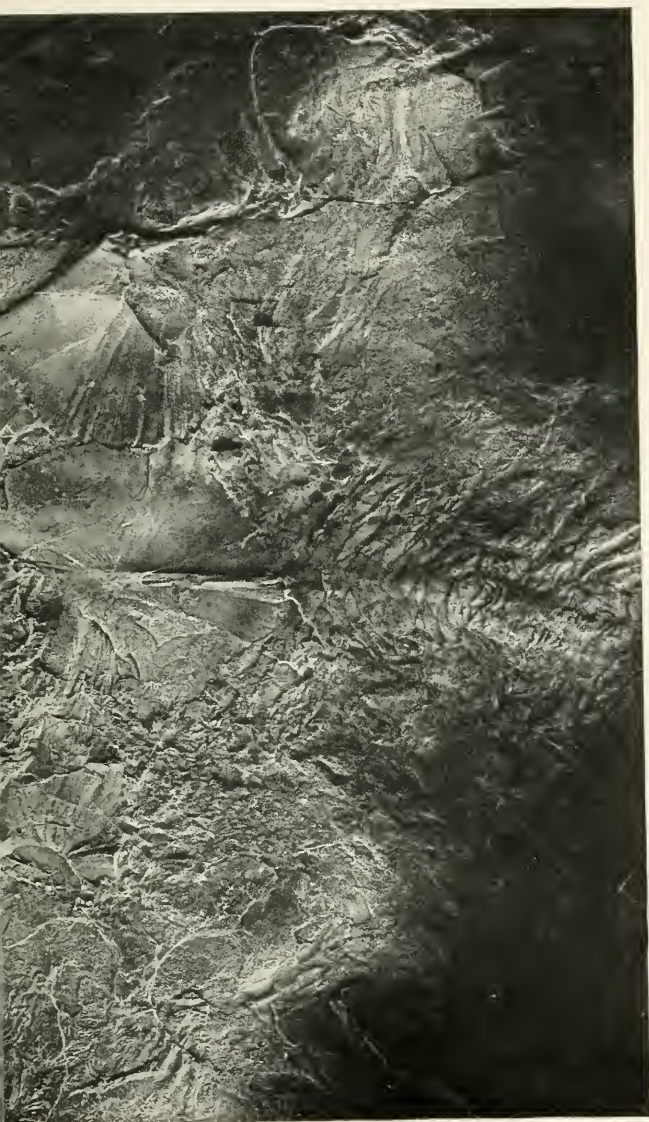
SPECIMENS OF *ERPETOSAURUS MINUTUS*, *TUDITANUS MINIMUS*, AND *PTYONIUS PECTINATUS*.

FOR EXPLANATION OF PLATE SEE PAGE 28.



SKELETON OF SAUROPOD

FOR EXPLANATION



ETON LATITHOROX.

DATE SEE PAGE 28.





SKELETON OF CTENERPETON ALVEOLATUM.

FOR EXPLANATION OF PLATE SEE PAGE 28.

