VII

PENNSYLVANIAN VERTEBRATE FAUNA

By

ROY LEE MOODIE

THE PENNSYLVANIAN VERTEBRATE FAUNA OF KENTUCKY

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INTRODUCTION

The vertebrates which one may expect to find in the Pennsylvanian of Kentucky are the various types of fishes, enclosed in nodules embedded in shale, as well as in limestone and in coal; amphibians of many types, found heretofore in nodules and in cannel coal; and probably reptiles. A single incomplete skeleton found in Ohio, described below, seems to be a true reptile. Footprints and fragmentary skeletal elements found in Pennsylvania[1] in Kansas[2] in Oklahoma[3], in Texas[4] in Illinois[5], and other regions, in rocks of late Pennsylvanian or early Permian age, and often spoken of as Permo-Carboniferous, indicate types of vertebrates, some of which may be reptiles.

No skeletal remains or other evidences of Pennsylvanian vertebrates have so far been found in Kentucky, but there is no reason why they cannot confidently be expected to occur. A single printed reference points to such vertebrate remains[6].

As shown by the map, Kentucky lies immediately adjacent to regions where Pennsylvanian vertebrates have been found. That important discoveries may still be made is indicated by Carman's recent find[7]. Ohio where important discoveries of

[1]Case, E. C. Description of vertebrate fossils from the vicinity of Pittsburgh, Pa: Annals of the Carnegie Museum, IV, Nos. III-IV, pp. 234-241. pl. LIX, 1908.

[2]Williston, S. W. Some vertebrates from the Kansas Permian: Kansas Univ. Quart., ser. A, VI, No.1, pp. 53. fig., 1897.

[3]Case, E. C., On some vertebrate fossils from the Permian beds of Oklahoma. 2nd Biennial Rpt. Dept. Geol. and Nat. Hist. Territory Oklahoma 1901-1902, pp. 62-68. 1902.

Jillson, W. R.. Preliminary Note on the occurrence of vertebrate footprints in the Pennsylvanian of Oklahoma. Amer. Jour. Sci.. XLIV, pp. 56-58, 1 fig., 1917.

[4]Case, E. C., The Permo-Carboniferous beds of North America and their vertebrate fauna: Pub. No. 207, Carnegie Inst., Washington, 1-176. pls. 1-24, 1915.

[5]Case, E. C., The vertebrates from the Permian bone bed of Vermilion County, Illinois. Jour. Geol. VIII, 693-729. 5 pls., 1900.

[6]Newberry, J. S., On some fossil reptiles and fishes from the Carboniferous strata of Ohio, Kentucky and Illinois: Abs: Proc. Amer. Assoc. Adv. Sci., 15th meet. 1867, pp. 144-146, 1868.

[7]Carman, J. Ernest, 1927. Fossil Footprints of Pennsylvanian Vertebrates from Ohio. Full descriptions and figures will be published in the bulletin of the Geological Society of America.

Pennsylvanian vertebrates were made seventy-five years ago, have been summarized by Cope[8], and Newberry[9].

The Pennsylvanian vertebrates so far known from regions immediately adjacent to Kentucky represent diverse faunas[10].

Marine fishes are represented by the sharks. The *Crossopterygian* fishes indicate a salt and brackish water fauna; while the lung fishes indicate a fresh water and swamp fauna. An interesting phase of the Pennsylvanian vertebrates is the minute size of some of the animals found in the nodules at Mazon Creek, near Morris, Illinois. Interesting palaeoniscid skulls showing well preserved brains, internal ears, blood vessels, nerves, etc., contained within oval nodules have been found in Kansas, and in the Caney shales of Oklahoma. The amphibians represent a shore, fresh water, and swamp as well as a brackish water fauna. None of the vertebrate species are completely known although some of the fossils found at Mazon Creek are amazingly perfect, showing soft parts as well as skeletons.

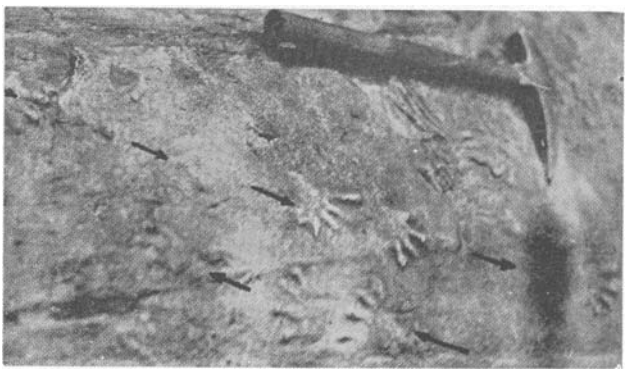

Fig. 30. Fossil footprints found by W. R. Jillson in Pennsylvanian rocks of Oklahoma. These remarkable tracks may be either amphibian, of an unknown type, or reptilian. The absence of claw marks may indicate an amphibian affinity. The size may be judged by the hammer. After *Jillson.*

[8]Cope, E. D., Synopsis of the extinct Batrachia from the Ooal Measures. Geol. Survey Ohio, II. pt. II, 351-410, pIs. XXVII-XLV, 1875.

[9]Newberry, J_ S., Paleozoic fishes of North America. Monograph U S. Geol. Survey, XVI, p. 228. See also: Paleontology of Ohio, Ohio Geo!. Survey, I, 1873, 1889.

[10]The close relationship between the Pennsylvanian rocks of Ohio with those of Kentucky is shown in the geological map published by W. R. Jillson. Agricultural Perspective of Kentucky Geology: Pan-American Geologist, XLIV, 295-308; 387-396, with map, 1925_ Here the eastern Coal-Field is shown to consist of three sections: the Pottsville, the Allegheny, and the Conemaugh; all standard divisions of the geological column.

CONODONTS

Geological Range: Confined to the Paleozoic.

Certain small (about 1 mm. in length) glistening black or brown, tooth-like objects, found abundantly in the Devonian and Mississippian, and known as *conodonts,* still remain an enigma in their nature. Newberry regarded them as the teeth of lampreys; later he regarded them as annelid teeth; Owen regarded them as mollusc teeth; Ulrich and Bassler[11] believe the objects to be the teeth of primitive and extinct fishes, supporting their view by illustrations of teeth and dermal plates of recent fishes. Irrespective of their zoological relations conodonts are regarded as valuable index fossils[12] for the determination of stratigraphy. They have been found in the Mississippian of Kentucky.

Long before the opening of the Pennsylvanian certain chordates had become extinct. These were not true fishes. They are known as the *Cycliae* (genus *Paleospondylus*), the *Ptyctodontidae* and a diverse group called the *Placodermata* (genera *Dinichthys* and *Bothriolepis).* So far as we know these forms left no descendants.

CLASS PISCES

Geological Range, Ordovician to Recent.

The fishes of the Pennsylvanian represent a diverse fauna. The sharks of the several families recognized by Eastman[13], are known chiefly from scattered and often isolated teeth and spines, but not all of them are marine, since a tiny shark, *Acanthodes,* is known from the Mazon Creek shales, which are probably of brackish water origin. Shark teeth have been differentiated according to form into groups, known as *Cladodont, Petalodont* and *Cochliodont;* terms which are convenient but meaningless as indicating the relationships of the fishes which bore them. A few of the more important families of sharks are:

[11]Ulrich. E. O. and Bassler, R. S., A Classification of the Tooth-like Fossils, Conodonts, with Descriptions of American Devonian and Mississippian Species: Proc. U. S. Natl. Mus., 68, 1-63, 11 pls., 1926.

[12]Bryant, William L. The Genesee Conodonts with Descriptions of new Species: Bull. Buffalo Soc. Nat. Sci., XIII, No.2, 1-27, pls, I-XVI, 1921.

[13]Eastman, Charles R. Fossil Fishes in the Collection of the United States National Museum: Proc. U. S. Nat. Mus., Vol. 52, pp, 254-276, plates 1-23, 1917.

ORDER ELLASMOBRANCHII

Geological Range, Silurian to Recent.

Family CLADODONTIDAE

The genus *Cladodus,* representing this family, occurs in rocks of lower Pennsylvanian age. An incomplete example is figured by Eastman[13], on Plate LXII, fig. 7. The genus *Dicrenodus* is known from the Pennsylvanian strata of Texas, shown in Pl. LXI, fig. 4, of Eastman's paper.

Identification of Carboniferous shark teeth may best be made by reference to the published reports of Illinois[14] and Ohio[15].

Family PETALODONTIDAE

This extinct family of sharks is known from a single genus, *Janassa,* in which other skeletal parts have been found in natural association with the dentition; a rare condition. No fin-spines are known, and it is suggested that the so-called fin-spines of *Stichacanthus* and *Physonemus* are probably dental elements of the same shark.

Family PSAMMODONTIDAE

The genus *Psammodus,* well known from the Mississippian rocks of Illinois, Michigan and Missouri, is based on large, nearly square teeth, arranged in a pavement in the upper and lower jaws. Eastman[13] figures one on Pl. LXI, fig. 8.

Family COCHLIODONTIDAE

This family of pavement-tooth sharks is fairly well known, and is represented by several genera. Branson[16] described and figured a number of forms. Eastman[13] takes exception to many of Branson's views, leaving the subject confused to the uninitiated. The genera *Psephodus, Deltodus* and *Sandalodus* seem well established, and are figured by Eastman, Pl. LXII, figs. 2, 3.

Other types of sharks are indicated in rocks of Carboniferous age by isolated, and often fragmentary spines, known as

[14]St. John, Orestes R. and Worthen, A. R., Descriptions of fossil fishes: Geol. Surv. Illinois, VI, 245-488, pls. 1-22; Vol. VII, 1883, pp. 55-264, pls. 1-26, 1875.

[15]Newberry, J. S., Fishes of the Coal Measures: Ohio Geol. Survey I, pt. II, pp. 283-355, pls. 38-40 Conodonts, II. p. 41, pl. LVII. Fishes of the Carboniferous System: II, pp. 41-64. pls. LVII-LIX, 1873.

[16]Branson, E. B., Notes on some Carboniferous cochliodonts, with descriptions of seven new species: Jour. Geol., XIII, no. I, pp. 20-34, 2 pls., 1905.

Ichthyodorulites, a term meaning simply a fish fragment. Although many of these objects have been given generic names, they are meaningless, since it is clear that a fin-spine known by one generic name may belong to a fish which is known under another name based on teeth; or even the so-called spines may belong in the mouth. This has been clearly shown by the progress of discoveries in the development of our knowledge of the fossils known as *Edestus,* given on page 269 of Eastman's paper[13]. One of these objects is shown on plate LVI, fig. 4, of this report.

A tiny shark, whose restoration is shown on plate LVII, fig. 1, occurs in the Mazon Creek shales[17], where it is associated with twenty-four species of crossopterygian and other types of fishes.

CLASS TELEOSTOMI

ORDER CROSSOPTERYGII

Geological Range, Devonian to Permian

Family COELACANTHIDAE

This family of "fringe-finned ganoids" is known from Nebraska, Ohio and Illinois. In Ohio, at the Linton locality which has yielded so many amphibians, twenty-seven species of fossil fishes were described by Newberry[18], among which three were members of this family. A species from Mazon Creek is shown here in Plate LVI; A. The genus *Coelacanthus* is of world-wide distribution, ranging upward from the Devonian. An eel-shaped fish, known as *Palaeopichthys,* found at Mazon Creek, is possibly a member of this family.

Family PALAEONISCIDAE

An interesting feature of this family of small fishes is that in the Devonian and in the Coal Measures nodules are found containing well-preserved brains and other soft structures[19].

A great number of fossilized feces, known as *coprolites,* and consisting of remains of food of fishes supposedly of a type closely allied to *Paleoniscus* have been described by Price[19].

[17]Eastman, C. R., The Carboniferous fauna of Mazon Creek, Illinois: Jour. Geo1., vol. X, pp. 535-541, figs. 1-4, 1902,

[18]Newberry, J. S., 1873. Palentology of Ohio. Ohio, I. Geol. Survey.

[19]Moodie, Roy L., A new fish brain from the Coal Measures of Kansas, with a review of other fossil brains: J. Compo Neurol., XXV, pp. 135-181, with 19 figs., 1915.

[19]Price. Paul H. The Coprolite Limestone Horizon of the Conemaugh Series in and around Morgantown, West Virginia: Annals of the Carnegie Museum, XVII, 211-231. plates X-XXI, 1927.

Similar objects are known from other horizons and Renault, especially, has studied their bacterial content. *Elonichthys* is represented by four species from the Pennsylvanian shales of Mazon Creek. Two of them are figured on Plates LVI and LVII. An example, enlarged, of the paleoniscid fish brain is given in Plate LVI, [fig.] C.

Family PLATYSOMATIDAE

An example of this family is shown on Plate III [?], C. The species is small, as are many of the vertebrate species from the nodules at Mazon Creek.

The above groups of Crossopterygian fishes are important because they are now regarded as having characters ancestral to the Tetrapoda[20]. This is especially true of the Devonian forms.

ORDER DIPNOI

Lung fishes. Geological range, Devonian to Recent.

The lung fishes[21] would be expected in such a swamp and fresh water deposit as existed at or near Yellow Creek in eastern Ohio. Williston[22] found lung fish remains in Kansas embedded in a matrix of exceedingly hard limestone, associated with a fossil sponge, *Gomphospongia*, which might indicate a marine habitat. Scales in the iron-stone nodules from Mazon Creek[23] indicate a wider distribution of the dipnoan fauna. Lung fishes are no longer regarded as ancestral to the air-breathing vertebrates but are an independent group of great antiquity.

CLASS AMPHIBIA

Geological Range, Devonian (represented by a footprint) to Recent.

The primitive tetrapods of the North American Pennsylvanian, most of which are doubtless amphibian, are known

[20]Gregory, W. K., Present status of the problem of the origin of the Tetrapoda with special reference to the skull and paired limbs: N. Y. Acad. Sci. Annals, vol. XXVI, pp. 317-383; plates, 1915.

[21]Hussakof, L., The Lungfish remains of the Coal Measures of Ohio, with special reference to the supposed Amphibian Eurythorax of Cope. Bull. Amer. Mus. Nat. Hlst., XXXV, pp. 127-133 figs., 1916.

[22]Williston, S. W., A new Species of Sagenodus from the Kansas Coal Measures:
Kansas Univ. Quart., vol. VIII, pp. 175, pls. 1889.

[23]Cockerell, T. D. A., Additional Note on reticulated Fish Scales: Science, N. S., vol. XXXIV, p. 865; The Scales of the Dipnoan fishes: Science N. S., vol. XXXIII, Pl'. 831-2, 1911.

chiefly from three faunas, with other scattering evidences. The fauna at Mazon Creek, Illinois, agrees with the fishes in being of small size; the eastern Ohio fauna is a very rich one, both in individuals and in species; and the Joggins fauna at Nova Scotia seems to incline toward the reptilian phase of development. Since the publication of my monograph[24], some years ago, nothing has been added to our knowledge of the morphology of the group. New discoveries have related entirely to footprints, and these are detailed in the section on Ichnology. Since the Canadian fauna is remote to our interests, that of the Pennsylvanian vertebrates which may be found in Kentucky, both in structure of the species and geographical relationships, our remarks in this section will be largely restricted to the faunas from Illinois and eastern Ohio.

The Mazon Creek fauna[25] consists entirely of skeletons and impressions of soft parts of ten species of Amphibia, representing five families. None of the species are based on complete material. The ironstone nodules in which the Mazon Creek fossils occur, are found in the shale which forms the roof of the Morris Coal of Illinois, which is somewhat lower than the Lower Kittanning Coal of Pennsylvania.

The nature of the amphibian remains discovered in these nodules may be seen in Plate LVIII, B, LIX, A & B; LX, F: LXI, A, C, D. The following discussion will enable one to locate new material representing primitive tetrapods.

FAMILY BRANCHIOSAURIDAE

This family of small, salamander-like animals has long been known from the late Paleozoic rocks of Europe. Its species in North America are confined to the Illinois fauna. The bodies of these primitive salamanders were covered with small scales above and a complicated pattern of myocommatous rods beneath. The short ribs, broad flat head with large orbits; short, weak limbs; and a long, flattened tail, are all characteristic of the members of this family. In agreement with Euro-

[24]Moodie, Roy L., The Coal Measures Amphibia of North America: Publication No. 238, Carnegie Institution of Washington, pp. 1-222, 26 plates, 42 figs, 1916.

[25]Moodie, Roy L., The Pennsylvania Amphibia of the Mazon Creek, Illinois, Shales: Kansas Univ. Sci. Bull., VI, No.2, pp. 323-359, pls. 1-14, 1912 The Mazon Creek, Illinois, Shales and their amphibian fauna: Amer. Journ. Sci. vol. XXXIV, pp. 277-285, 2 figs, 1912.

pean specimens, those found in Illinois show the general contour of the body, the character of the dermal covering, the color markings, the lateral line system, and in three specimens the molds of the entire alimentary canal (Plate LX, F). Two of the known species do not exceed 50 mm. in length.

The genera *Micrerpeton, Eumicrerpeton, Mazonerpeton* are the chief representatives of this family and are fully described in my monagraph[24].

FAMILY COCYTINIDAE

This family is based on material discovered in eastern Ohio, with which is associated an Illinois species *Erierpeton*, indicating a close relationship between the two faunas. This must be accepted with the caution that the two known species of the family are based on very incomplete material.

FAMILY AMPHIBAMIDAE

This group is known from the Illinois locality by two genera, *Amphibamus* and *Cephalerpeton*. They show a tendency toward the reptilian type of tetrapod. A restoration is given in Plate LIX, above, and the skeletons are shown in Plate LXI, A, D. None of the species exceed six inches in total length.

The skull is abruptly truncate posterior, limbs very long; toes provided with claws; ventral armature highly developed.

Two other families are suggested by incomplete remains from the Mazon Creek shales; the *Molgophidae* and the *Cricotidae.* Our knowledge of the entire fauna is badly in need of strengthening by the study of additional material.

The amphibian fauna of eastern Ohio, from the locality long known as Linton, near Yellow Creek, presents many fascinating features. In association with many types of fishes and a possible reptile we have at the Ohio locality a view of Pennsylvanian vertebrate life such as can be found nowhere else.

Fifty-one species have been described from this locality in eastern Ohio; gathered in part from the dump, as well as from the systematic splitting of hundreds of tons of cannel

coal. J. S. Newberry was then (1869) director of the Ohio Geological Survey, and to him we owe our present knowledge of this wonderful vertebrate fauna of the Pennsylvanian. The flora was also of the greatest interest. These organic remains of a past fauna and flora were carefully described in Volumes I and II of the Ohio Geological Survey. These volumes are of the greatest value in interpreting the life of the Coal Measures. Although there is some slight evidence of a relationship between the Mazon Creek fauna and that of eastern Ohio, yet it seems more probable that the three North American amphibian faunas, that of Mazon Creek, of Linton, Ohio, and of the South Joggins, Nova Scotia, were all distinct.

A brief review of the fauna found in the cannel coal will suffice to show the nature of the amphibians therein. No branchiosaurs are known from eastern Ohio. All the species are apparently members of the group Microsauria with reptilian tendencies.

The family *Tuditanidae* may be considered as fairly typical of the Ohio beds, as well as the neighboring Cannelton shales of Pennsylvania. Three genera with thirteen species represent this family. The dorsum of the skull and the pectoral plates have a characteristic sculpture, consisting of pits and radiating grooves. The members of the genus *Erpetosaurus* have a broad flattened head, with clearly indicated lateral line canals.

The family *Urocordylidae* agrees with certain species from Ireland in some of its members being provided with horns which are out-growths from the squamosal bone of the skull. An example of a horned amphibian is found in *Diceratosaurus,* a genus which is known from fairly complete material. They were small animals, with skulls measuring 35 mm, including the horns.

A family, *Nyraniidae,* is of great interest in that its members are covered with fish-like scales (Plate VII, B.) a character which they share with species from the Coal Measures of Ireland[26]. The species of the family are known from incomplete material, and future discoveries will clear up many points.

[26]Huxley, T. H., On a collection of fossil vertebrata from the Jarrow Colliery, County of Kilkenny, Ireland: Trans. Roy. Irish Acad. 1871. vol. XXIV, pp. 351-369, pls. XIX-XXIII. 1867.

Still another family, the *Ptyoniidae,* is likewise apparently common to Ohio and Ireland, as well as to Bohemia. They are extremely snake-like in form and structure, some of the species having the skeleton reduced to the skull and elongated vertebral column. *Ptyonius* was the most abundant of all the amphibians in the Ohio Coal Measures. Some of the individuals possessed over 100 vertebrae, but evidently did not exceed a total length of 200 mm.

The modern frogs are apparently represented in the Coal Measures by the *Peliontidae,* the single species of which is shown in Plate LVIII, A; plate LX, G. This species, *Pelion lyelli* was described in 1858, and we like to think it shows ancestral characters to the modem Salientia.

A family of large animals is that of the *Sauropleuridae,* some of which may have attained a length of several feet. The best preserved of the members of this family is *Saurerpeton latithorax* although only the anterior half of the animal is preserved.

Many other species of diverse character are indicated in the Pennsylvanian by fragmentary remains of large and small animals, some of which are shown on Plate LX. Fragments of teeth, vertebrae, jaws, and scattered skeletal material form the evidence on which our conclusions may, for the present, be based. It is a matter of great importance to discover new material, since this though fragmentary, will supplement that which is known.

CLASS REPTILIA

Geological Range, Pennsylvanian to Recent

Amphibians and reptiles of the Pennsylvanian are hard to discriminate. These animals were then at the parting of the ways, and their structural features are often similar. Our knowledge of these two groups during the Pennsylvanian is based on such fragmentary material that more complete data will doubtless clear up many matters, now obscure.

Williston[27] thought that the incomplete skeleton (here shown on Plate LXIV) of a small tetrapod, described by Cope as

[27]Williston. S. W., The oldest known Reptile: Journ. Geol. vol. XVI, pp. 175-192, fig., 1908.

Tuditanus punctulatus, represented the oldest known reptile, and proposed the name *Eosauravus copei*[28]. Case, Watsan[29] and others have accepted the form as reptilian, and regard it as a member of the Cotylosauria, a group already known from the Permian of Texas. Other forms of reptiles are suggested by fragmentary skeletal remains and by footprints.

The type specimen of *Eosauravus* is less than six inches in length. It was probably subaquatic. The hind limbs are very strong, with the foot much expanded. The tarsus is well developed and osseous. This is not in itself a reptilian character since some of the Pennsylvanian amphibians have an ossified tarsus.

Other, larger, reptiles or reptile-like amphibians, have been indicated in the Pennsylvanian of Pennsylvania[30] of West Virginia[31], and of Maryland. The cast of a bone[32], named *Pareiasauroides henneni* (White), in very fine sandstones, possibly represents an animal of a type known from South Africa; a group of clumsily built reptiles known as the Pareiasauria.

ICHNOLOGY

Since 1828 when the Rev. Dr. Duncan read his paper on fossil footprints from the New Red Sandstone of Scotland, before the Royal Society of Edinburgh, our knowledge of foot impressions has grown to a considerable body of knowledge. Dean William Buckland suggested the term *Ichnology* for the science of tracks and additions to our knowledge are still being made. Unsatisfactory as footprints are, they form our only evidence of the presence of tetrapods during the Devonian and the greater part of the Mississippian. There are many records of footprints in the Pennsylvanian rocks and these records indicate a broad distribution of early vertebrate life. It is not always possible to determine from the impressions alone whether the animal was amphibian or reptilian, hence the ward *tetrapod,*

[28]Bull. Geol. Soc. Amer., XXI, 272, 1910.

[29]Watson, D. M. S., On Seymouria, the most primitive known reptile: Proc. Zool. Soc. London, pp. 267-300, figs. 1-15, 1918.

[30]Matthew, W. D., Amer. J. Sci., (4), 11, 199, 1911.

[31]Case, E. C., West Virginia Geological Survey, Rept. Braxton and Clay Counties, pp. 817-822, 1917.

[32]Lull, R. S. and White, L. C. Paleontology. West Virginia Geological Survey, Rept. Mineral and Grant Counties, pp, 733-734, pls. XLII-XLIIII, 1927. In connection with Lull's discussion of large footprints from the Coal Measures.

which may be either. Even with the skeletons at hand paleontologists are not yet able to discriminate the amphibians of the Pennsylvanian from the reptilians.

Lull[33] has described footprints from the Pennsylvanian of Massachusetts, which may be reptilian. Martin[34] has discussed the nature of some large footprints from the Pennsylvanian of Kansas. Jillson[35] discovered tetrapod footprints in the Pennsylvanian of Oklahoma. Henderson[36] described footprints of unusual tetrapods from the Pennsylvanian of Colorado. Lull[37] and Noble[38] have discussed the vertebrate footprints of the Grand Canyon of the Colorado. Mr. Charles W. Gilmore has made an extensive collection of these Ichnites for the U. S. National Museum, and will discuss them fully. Some of these indications of vertebrate life are later than the Pennsylvanian. I have discussed[39] an impression from Pennsylvania and others have added to the subject. The indications are that we may still hope to discover vertebrate remains of entirely different types to any now known. Recent discoveries from the Osage limestones of Kansas show that the knowledge of the footprints themselves is still incomplete. No footprints are known from the Pennsylvanian rocks of Kentucky itself but such discoveries may be confidently expected, since the state lies in the belt across the continent in which other discoveries have been made.

On Plate LXII are given illustrations of an unusual discovery of fossil footprints. They are derived from the Pennsylvanian of eastern Kansas. Martin[22] suggested the term *Onychopus gigas* as a name for the animal which made the footprints. Remington Kellogg has called attention to the previous use of the generic term so the name of *Wakarusopus* is proposed as a new generic name.

[33]Lull, R. S., An Upper Carboniferous Footprint from Attleboro, Massachusetts: Amer. J. Sci. L, pp. 234-236, figs., 1920.

[34]Martin, H. T., Indications of a gigantic Amphibian in the Coal Measures of Kansas: Sci. Bull. Uni. of Kan. vol. XIII, No. 12, pp. 103-114, 3 pls., 1922.

[35]Jillson. W. R., Preliminary Note on the Occurrence of vertebrate Footprints in the Pennsylvanian of Oklahoma: J. Sci., vol. XLIV, pp. 56-58, 1 fig., 1917.

[36]Henderson, Julius, Footprints in Pennsylvanian Sandstone of Colorado: Jour. Geol. vol. XXXII, no. 3, pp. 226-229, 3 figs., 1924.

[37]Lull, R. S., Fossil Footprints from the Grand Canyon of the Colorado: Amer. J. Sci.. vol. XLV, pp. 337-346, 1918.

[38]Noble, L. F., A Section of the Paleozoic Formations of the Grand Canyon at the Bass Trail: U. S. G. S., Prof. Paper, 131, p. 68, pl. XXV. fig. A, 1922.

[39]Moodie, Roy L., New or little-known forms of Carboniferous Amphibia in the American Museum of Natural History: Bull. Amer. Mus. Nat. Hist., vol. XXVI, pp. 347-357, 1909.

This discovery of huge footprints, possibly reptilian, in the Coal Measures of Kansas is rendered more interesting by the recent description by Lull[40] of similar, clawed, footprints in the Pennsylvanian of Maryland. The probable presence of large reptiles in the Pennsylvanian is further strengthened by the occurrence of a large cast of a reptilian bone found in West Virginia.

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More than seven hundred books and papers have been written about the animals and plants of the Coal Period. Since it is not possible or necessary to give a complete list here, a few titles are given from which the interested student may follow further the discussion of the life of the Pennsylvanian.

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The Larger Coal Measures Amphibia. Proc. Manchester Lit. and Philos. Soc., LVII, pp. 1-12. 1912.

[40]Lull, R. S., Probable reptilian Footprints from the Maryland Carboniferous: West Virginia Geol. Survey, Mineral and Grant County Report, pp. 731-734, 6 pls., 1927.

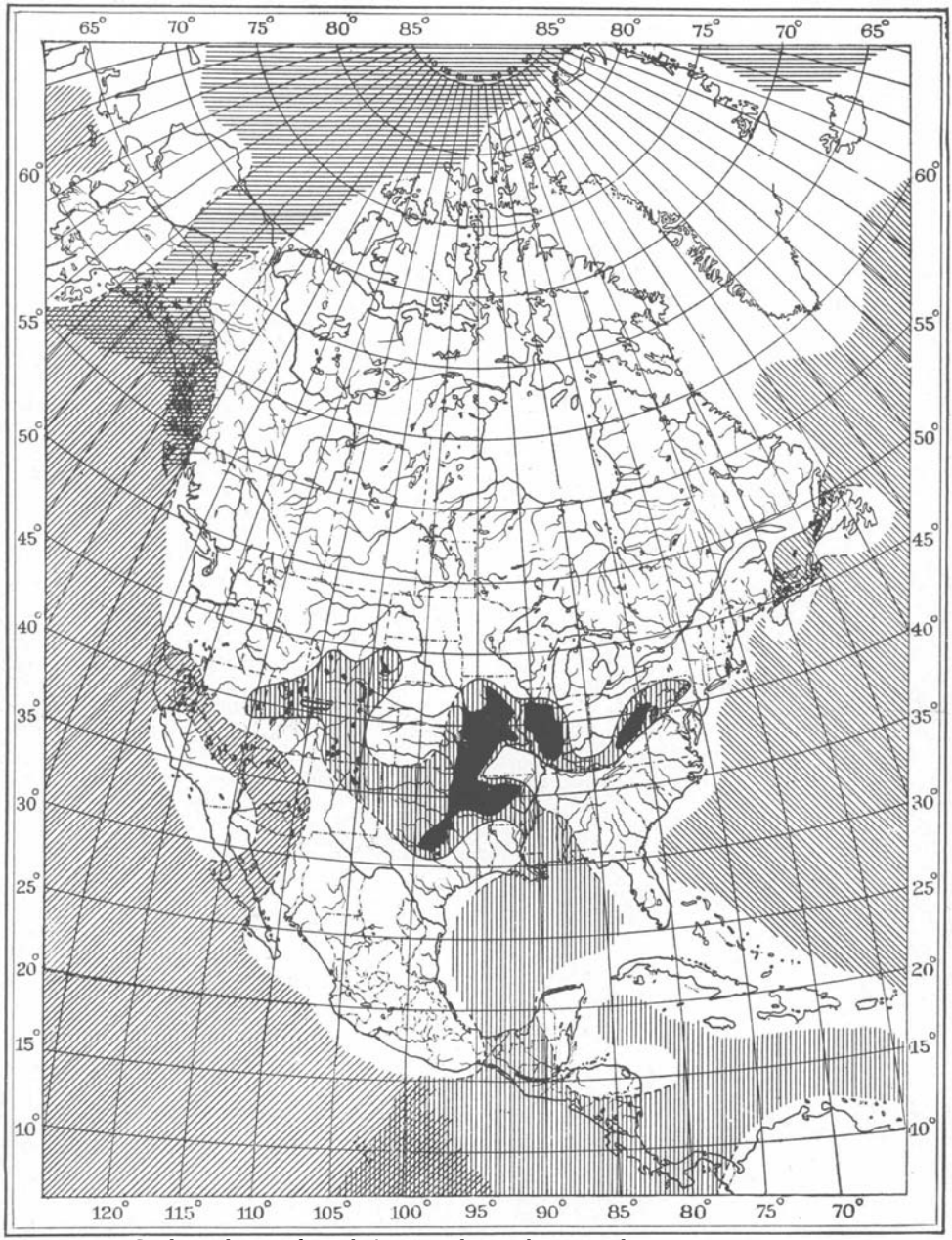
Explanation of Plate LV

A Map of North America during the Upper Pennsylvanian showing land and water conditions under which the Coal Measures fish and amphibian fauna lived. It will be noted that the chief deposits which have furnished amphibian remains are on the margins of the heavily shaded areas. The state of Kentucky was in this area of land a swamp during the periods when coal was being formed. After Schuchert.

Explanation of symbols: Lands are white. Water areas are lined.

Formation outcrops are black or dotted. Known shore lines are solid lines: probable ones broken. vertical lines in middle of continent indicate Gulf marine. During the coal period and the life of the amphibians the Pennsylvanian water areas were either fresh or somewhat brackish waters. No amphibian has ever been proved to be marine, although Wiman has suggested such for the fauna of the Trias of Spitzbergen and the Mazon Creek fauna of Illinois may have been brackish. The evidence is not clear enough in either case to warrant making a positive statement.

PLATE LV



Geological map of North America during the Pennsylvanian.

Explanation **of Plate LVI**

PENNSYLVANIAN FISHES

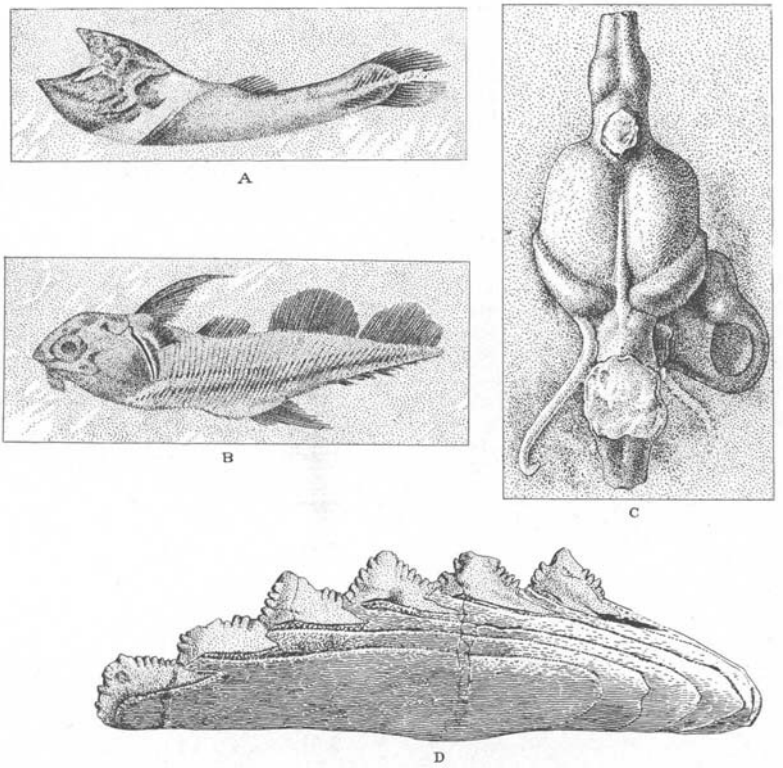
A. *Coelacanthus exiguus* Eastman. Coal Measures shales of Mazon Creek, near Morris, Illinois. Nearly complete individual, lacking posterior dorsal and anal fins. X 2/1 After Eastman. Original in Yale Museum.

B. *Elonichthys perpennatus* Eastman. Pennsylvanian shales of Mazon Creek, near Morris, Illinois. Complete individual, the distal portion of medium fins not fully shown. X 2/1 After Eastman. Original in Museum of Comparative Zoology at Harvard University.

C. A fish brain, possibly one of the Paleoniscidae, from the Coal Measures shales near Lawrence, Kansas. The original brain was about 18 mm. in length. The brains are enclosed in small rounded nodules and they occur in abundance' at two localities in Douglas County, Kansas. Some of the Kentucky shales also may have these same fossils.

D. A salt water fish from the Pennsylvanian of Illinois; a shark-like animal known as *Edestus crenulatus.* The right portion of the dental armature of a large fish. Original in the U. S. National Museum. After Hay.

PLATE LVI



Fishes from the Pennsylvanian Rocks

Explanation of **Plate LVII**

PENNSYLVANIAN FISHES

A. *Acanthodes beecheri* Eastman. A tiny shark from the Coal Measures shales of Mazon Creek, near Morris, Illinois. Restoration showing outline of body and position of fins. X 2/1. After Eastman.

B. *Cheirodus orbicularis* Newberry and Worthen. A fairly well-preserved specimen, from the Pennsylvanian shales of Mazon Creek near Morris, Illinois. Nat. Size. After Eastman.

C. *Elonichthys hypsilepis* Hav. A nearly complete specimen from the Pennsylvanian shales at Mazon Creek., near Morris, Illinois, X 1/3. After Eastman.

D.-G. Lung fish remains from the Coal Measures of Ohio. After Hussakof.

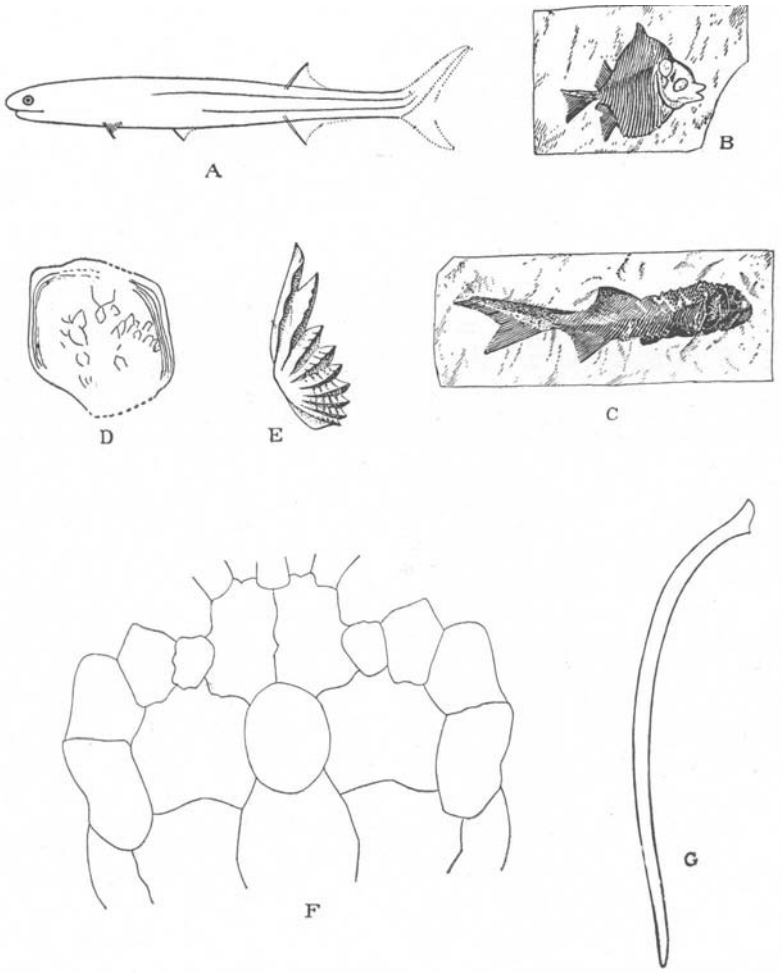
D. Scale of *Sagenodus.* Natural size.

E. Tooth of *Sagenodus serratus.* Natural size.

F. Part of cranium of *Ctenodus ohiensis.* X 1/2.

G. Rib of *Sagenodus.* Natural size.

PLATE LVII



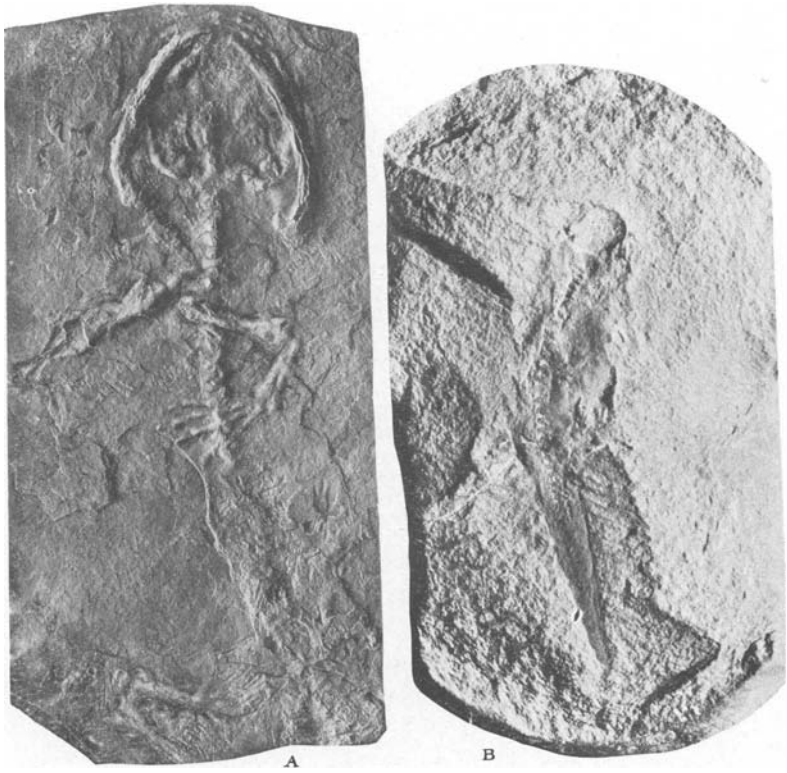
Sharks among fishes from the Coal Measures

Explanation of Plate LVIII

A. Type specimen (and the only one known) of *Pelion lyelli* Wyman, from the Ohio Coal Measures at Linton. This animal is thought to represent the ancestral group from which the frogs were derived. Original in the American Museum of Natural History. length of specimen as preserved 110 mm.

B. Type and only specimen of a true branchiosaur, *Micrerpeton caudatum* Moodie, from the Coal Measures of Mazon Creek, near Morris, Illinois, showing skeletal elements, preserved as kaolin form of head and tail, the lateral-line sense organs, banded color markings, ventral scutellae, and small body scales. On the edges of the tail impression are indications that in life the tail had a thin fold of skin above and below the fleshy portion, much as in the larvae of modern salamanders. Original in Walker Museum, University of Chicago. Length of entire animal as preserved 49 mm.

PLATE LVIII



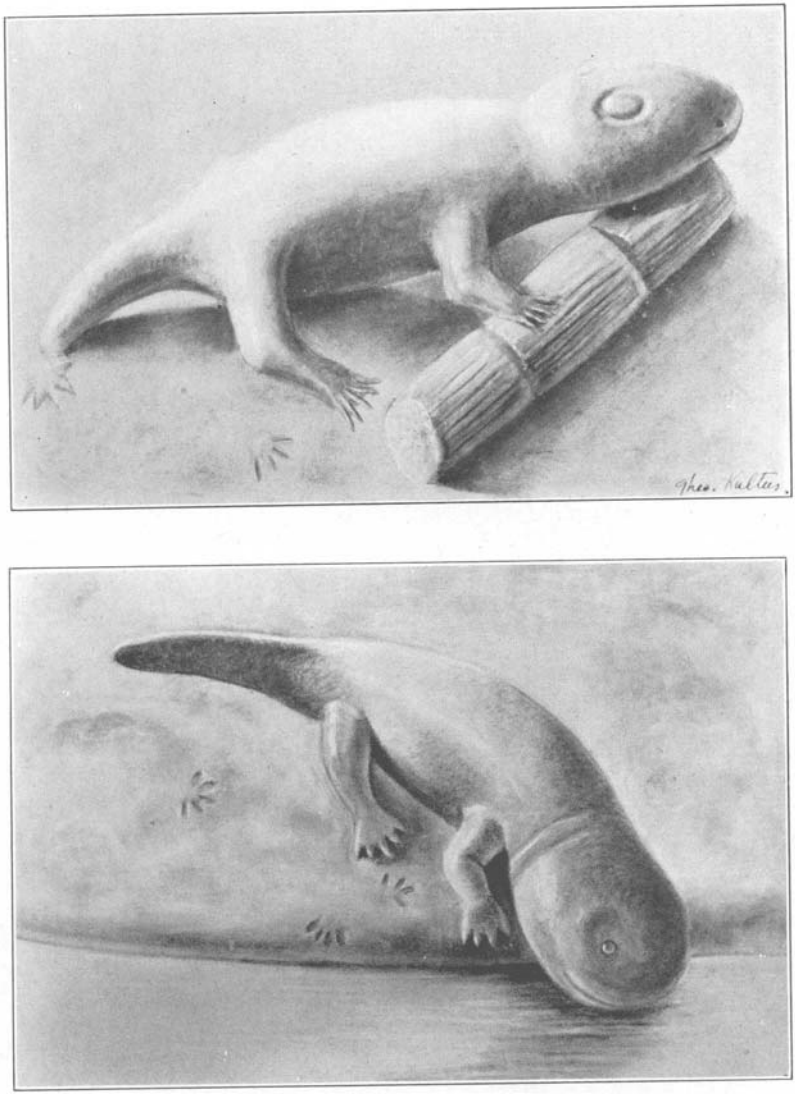
Fossils of two Pennsylvanian Amphibians

Explanation of Plate LIX

Upper. Restoration of probable appearance of a small (slightly longer than five inches) reptile-like amphibian from the Mazon Creek shales of Illinois and known as *Amphibamus. grandiceps* Cope. The restoration is based on complete material at the University of Chicago and at Yale University. *Amphibamus* was a low, flat, short, creeping or crawling animal, possibly spending a part of the time in the water.

Lower. A reconstruction of the possible appearance of the small branchiosaurian *Micrerpeton caudatum* Moodie from the Mazon Creek shales of Illinois. The animal was about two inches in length. This figure is based on a single example now preserved in Walker Museum, University of Chicago, aided by an examination of other specimens of a related species, *Eumicrerpeton parvum* Moodie, the originals of which are preserved in the Peabody Museum at Yale University. The animal was a small, salamander-like amphibian frequenting the borders of pools in the marshes of Coal Measures time.

PLATE LIX



Restorations of Pennsylvanian Amphibians

Explanation of Plate LX

This plate shows the usual type of material on which our knowledge of the Pennsylvanian amphibians is based. Some of these animals may, originally, have been represented by fairly complete skeletons, but the accidents of mining, weathering and collecting account for the loss of much of the skeleton. Most of the material from the Ohio Coal Measures was collected from the dump. Some of it was derived from splitting hundreds of tons of cannel coal, both methods liable to result in loss.

A. A portion of the left mandible of a large amphibian, *Macrerpeton deani* Moodie, the largest animal of the Ohio coal. Type specimen, No. 2934, American Museum of Natural History. Length of specimen, 115 mm.

B. Fore-limb of an amphibian uncertainly identified as *Pleuroptyx clavatus* Cope, X 0.75.

C. Interclavicle of *Sauropleura pauciradiata* Cope from the Ohio Coal Measures, Nat. Size.

D. Left clavicle of same. Natural size.

E. Part of the body of a snake-like amphibian known as *Molgophis brevicostatus* Cope. Linton, Ohio, Coal Measures.

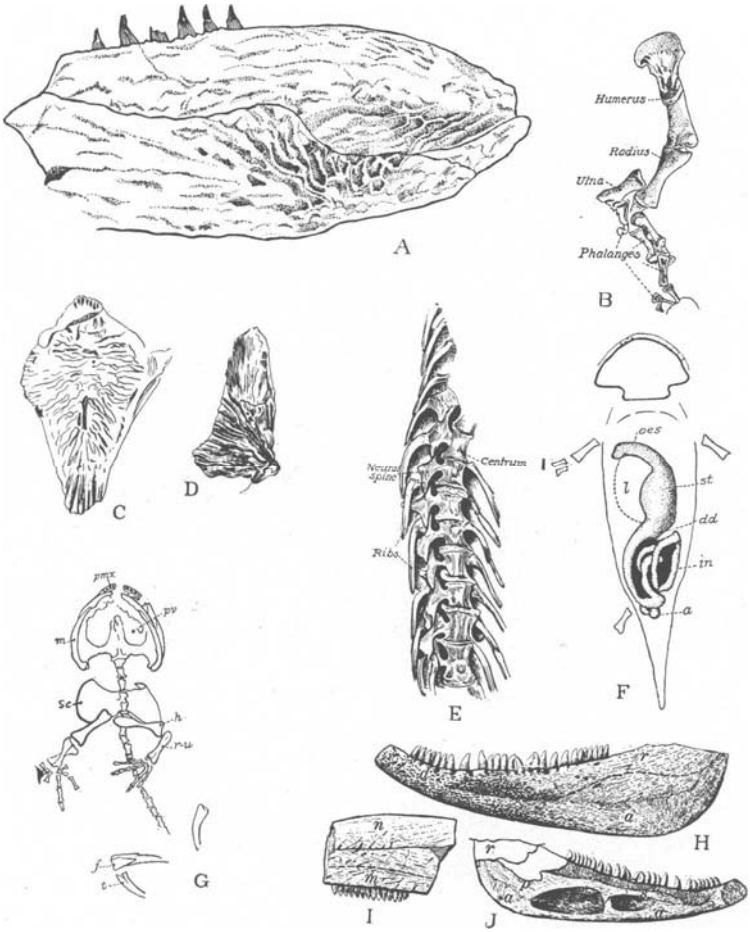
F. A small branchiasaur, *Eumicrerpeton parvum* Moodie, showing preservation of alimentary tract. Mazon Creek shales, near Morris, Illinois. Yale University Museum.

a=anus
in=intestine
l=liver
st=stomach
oes=oesophagus

G. *Pelion lyelli* Wyman, an amphibian from the Coal Measures of Ohio, the supposed ancestral salientian (After Wyman) Slightly less than natural size.

H. I. J. Remains of *Eobaphetes kansensis* Moodie, from the Coal Measures of Washington County, Kansas. Originals in U. S. National Museum.

PLATE LX



The imperfect skeletal remains of Pennsylvanian Tetrapoda

Explanation of Plate LXI

Much of our knowledge of the Pennsylvanian Tetrapoda is based on very fragmentary remains or impressions, but in the plate shown herewith are drawings of our unusually well preserved Coal Measures Amphibians.

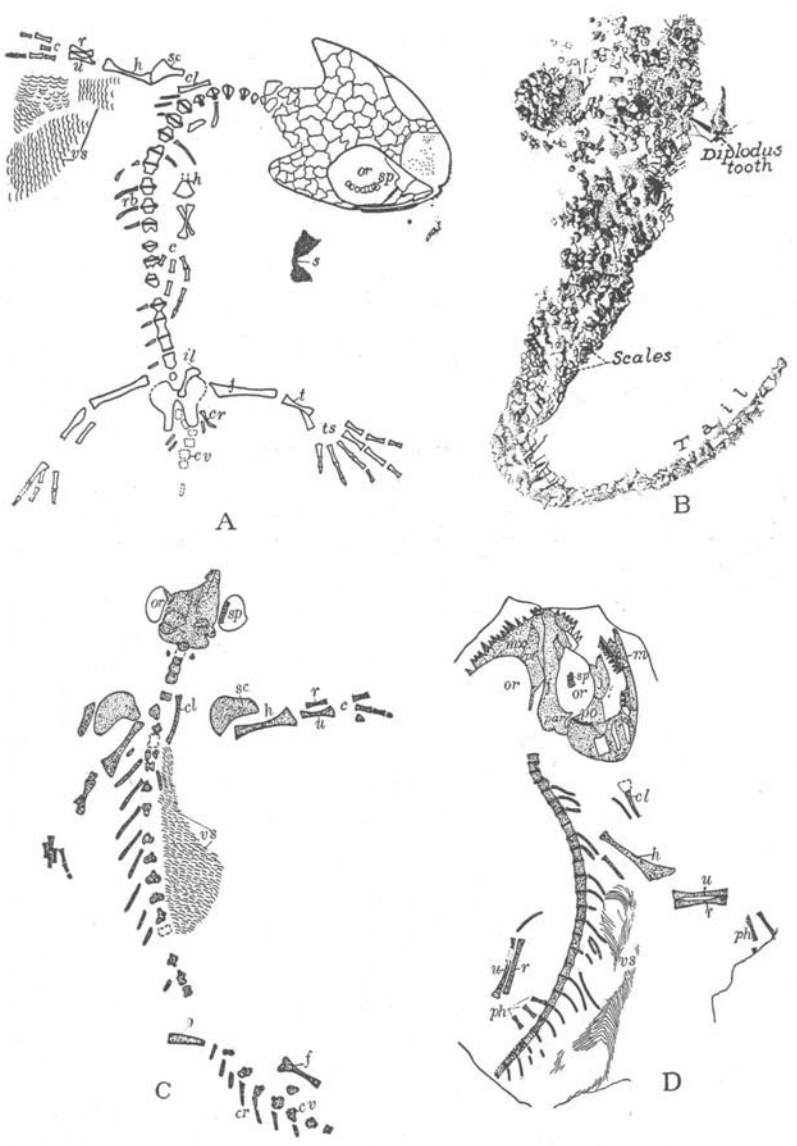
A. A Skeleton of *Amphibamus grandiceps* Cope, Mazon Creek shales, near Morris, Illinois. About natural size. Original specimen is No. 794, Marsh Collection, Peabody Museum, Yale University.

B. An amphibian whose body was scaled. Type specimen of *Cercariomorphus parvisquamis* Cope, from the cannel coal of the Ohio, Linton, Coal Measures. The original is in the American Museum of Natural History, Length of entire specimen is 180 mm.

C. Skeleton of *Mazonerpeton longicaudatum* Moodie. a Coal Measures branchiosaur, from the Mazon Creek shales at Morris, Illinois. Specimen No. 795, Yale Museum; length of entire specimen is 64. mm.

D. Skeleton of *Cephalerpeton ventriarmatum* Moodie. Mazon Creek shales of Illinois. Natural size. Specimen in Yale University; length of entire specimen 98 mm.

PLATE LXI

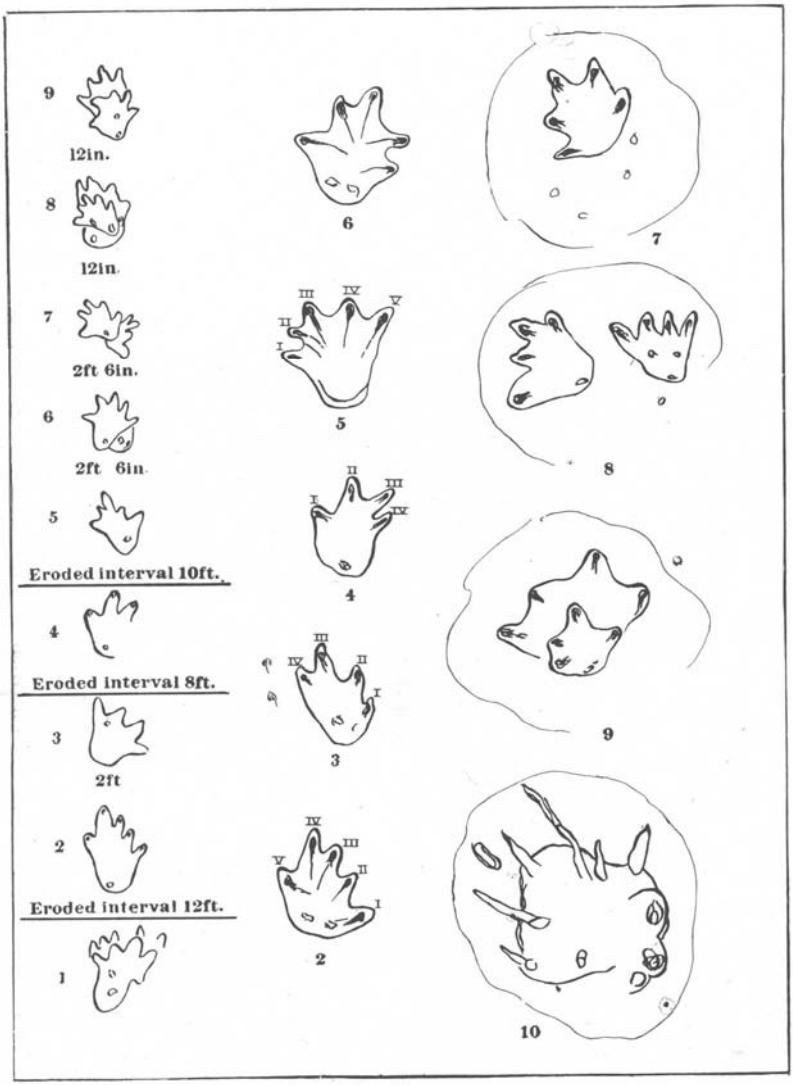


Four of the most perfect skeletons of Pennsylvanian Tetrapods

Explanation of Plate LXII

Footprints of a gigantic amphibian, *Wakarusopus (Onychopus) gigas* Martin as they occur in the sandstone ledge of the Upper Coal Measures, just above the Weston shales. Wakarusa Creek at Dightman's crossing, Douglas County, Kansas.

PLATE LXII



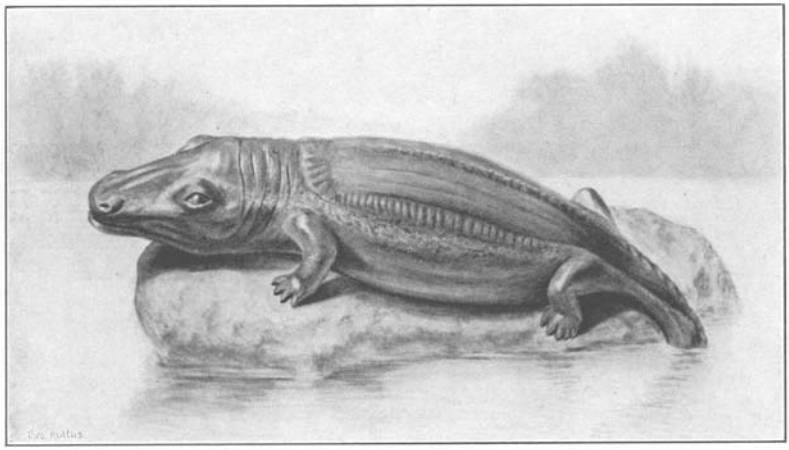
Gigantic footprints from the Pennsylvanian

Explanation of Plate LXIII

Reconstruction of the probable appearance of one of the large labyrinthodonts which lived at the close of the Pennsylvanian period and on through the Permian and Triassic. Several discoveries in North America, in rocks of undoubted Pennsylvanian age, indicate that these large, reptile-like amphibians, from six to fifteen feet in length, existed in the borders of swamps with their smaller relatives. The skeletal material, on which this supposition is based, is scanty, consisting of parts of ribs, vertebrae, skulls and jaws of the genera: *Baphetes, Eobaphetes, Eosaurus, Macrerpeton, Eryops* and others.

Adapted from Fraas.

PLATE LXIII

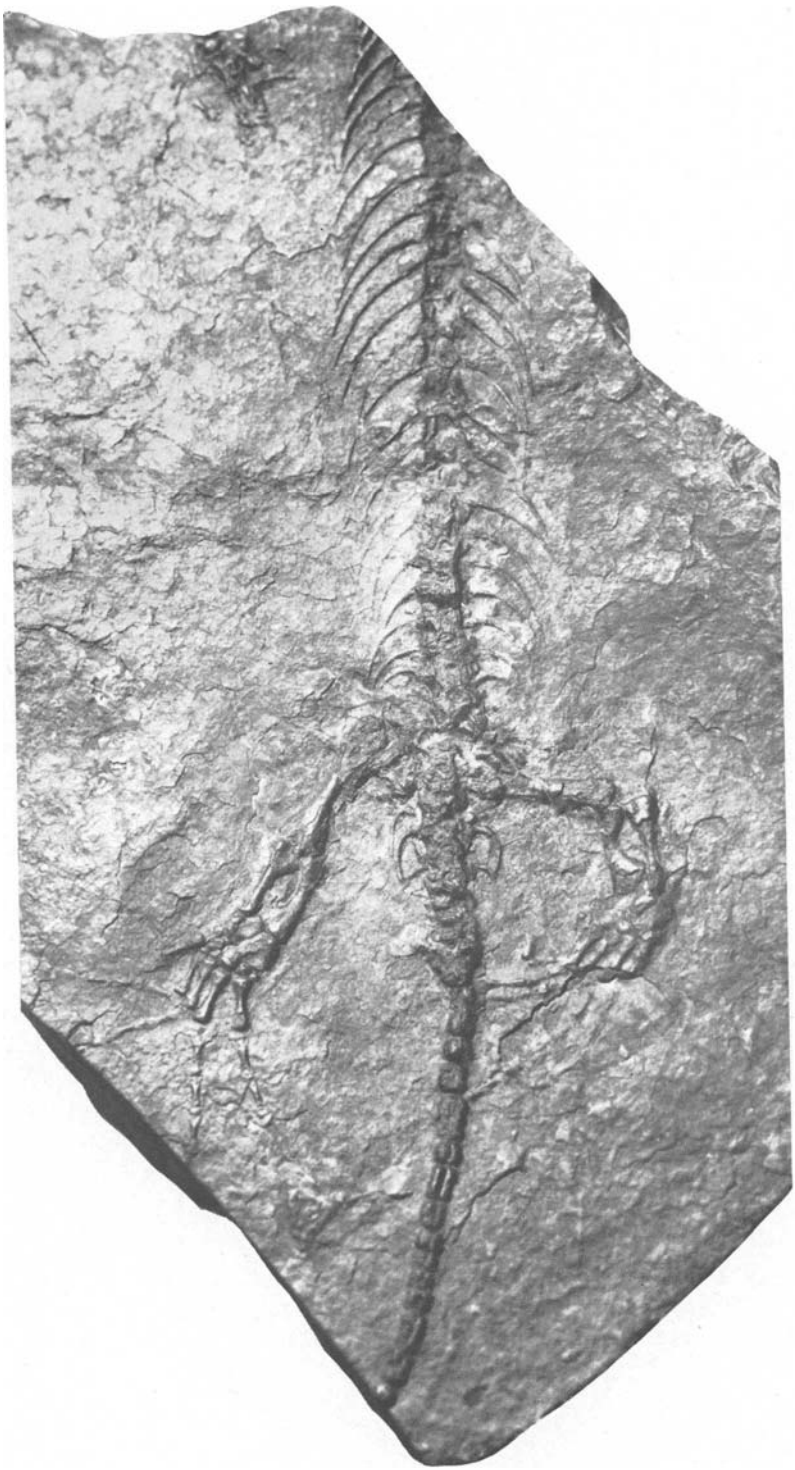


A Labyrinthodont

Explanation of Plate LXIV

Type and only specimen of the *"oldest known reptile"* Cannel coal at Linton, Ohio; known as *Eosauravus copei* Williston. The Original is in the United States National Museum. No. 457. The fossil animal as it is preserved measures 132 mm in length.

PLATE LXIV



The oldest known reptile