

ART. XXXI.—*A Coal Measures Amphibian with an Osseous Tarsus*; by ROY L. MOODIE.

THERE are known at present eighty-eight species of Amphibia from the Coal Measures of North America, representing seventeen families and five orders. These forms were already highly specialized and diversified into distinct geographic groups, the members of which are not generically related. This wide diversity of structure among the earliest known faunas of air-breathing vertebrates is intensified by the fact that one species of this number has an osseous tarsus; which, in other forms, was apparently hyaline cartilage and left no impress of its structure in the rock or coal. A species, therefore, showing such an anomalous condition is well worthy of special consideration, and it is proposed in this place to give an account of the "oldest known" amphibian tarsus*, and to add what little is to be known of the anatomy of the vertebrate possessing this highly unusual foot.

The only known specimen of this anomalous amphibian is incomplete, representing the posterior half of the skeleton and an abundance of ventral scutellæ or calcified myocommata. The block of coal containing these interesting remains is from Linton, Ohio, and is preserved in the geological collections of Columbia University, from which institution Professor Gra-bau has very courteously forwarded it for study.

Ichthyacanthus platypus was described by Cope† from the Linton, Ohio, Coal Measures; locating it doubtfully in the Permian genus *Eryops*, on account of the unusual condition of the tarsus and reconsidering a former decision in favor of a Coal Measures genus, *Ichthyacanthus*‡. In this disposition of the species into the Permian genus he is followed by Hay§; but Baur|| regarded the form as a member of the Coal Measures genus, *Ichthyacanthus*, after commenting on the later definition by Cope (†). The type of the genus *Ichthyacanthus*, to which Cope (‡) first allied the species under consideration, is *I. ohioensis*, a supposed amphibian from the Coal Measures of Linton, Ohio, founded on incomplete material. There is no relationship indicated between *Ichthyacanthus* and the species

* Baur, George: Amer. Natl., 1886, p. 173; Zool. Anz., No. 216, 1886. At this time *Archegosaurus* was the earliest known amphibian form having an osseous tarsus.

† Cope, E. D., Trans. Amer. Phil. Soc., 1888, p. 289, fig. 1.

‡ Cope, E. D., Proc. Amer. Phil. Soc., 1877, p. 574.

§ Hay, O. P., Cat. Fossil Vert., Bull. U. S. G. S., No. 179.

|| Baur, George: Beiträge zur Morphogenie des Carpus und Tarsus der Vertebraten, Th. I, p. 16. Jena (G. Fischer), 1888.

of *Eryops*; in fact, it is not possible to find on the specimen all the characters indicated in Cope's figure († p. 509, fig. 1) on the basis of which he proposed to place the species in the Permian genus.

The majority of the American Coal Measures Amphibia were small and the form under consideration is no exception. The

FIG. 1.



FIG. 1. Left leg and pelvis of *Eosaurus copei* Williston, from the Coal Measures of Ohio. $\times 1$.

Original preserved in the United States National Museum.

animal when alive probably did not measure over eight inches in total length, and the structures, which are preserved in the block of coal fortunately rescued from the coal mine dump, indicate a very active habit of life, recalling the lizards of the present day. The femora are strikingly reptilian in appearance, as are also the ungual phalanges. The form combines in an unusual and remarkable degree reptilian and amphibian characteristics. The leg bones, the pelvis, the tarsus are all strikingly reptilian, but the phalanges in their arrangement of elements is so typically amphibian that if we had no other means of diagnosis we would incline to locate this Coal Measures species among the Amphibia. The leg recalls in its structure that of another Coal Measures species, *Eosaurus copei* Williston,* which is, however, clearly a reptile (fig. 1). While there is a general degree of similarity between the foot structure of *Eosaurus copei* and *Ichthyacanthus platypus*, yet there are very great differences in the phalangeal formula and the arrangement of the tarsal elements. These differences are clear, and indicate a separation of the species into distinct classes. The phalangeal formula in the *Eosaurus* 2-3-4-5-4, is typically reptilian; while in the *Ichthyacanthus*, 2-2-3-3-3 it is amphibian. The tarsus of the *Ichthyacanthus* is amphibian in the presence of an intermedium, but this is very small and the remaining tarsal structures have nothing which might not be found in an early reptile. There may be a single or even two centralia in the reptilian tarsus among the early forms.

The amphibian nature of the species having thus been established, it remains to give a detailed account of its skeletal

* Williston, S. W., Journ. Geol., xvi, p. 295, figs. 1-2, 1908.

anatomy, with comparative references to such other ancient forms as are available. Little can be said of the *vertebral column* since only the molds of a few vertebræ remain, and these are so obscured by a closely adherent pellicle of carbonaceous material that their form cannot be distinctly discerned. They are high with relatively broad neural spines. There are no ribs preserved. The *pelvis* is obscured, but it is possible to

FIG. 2.

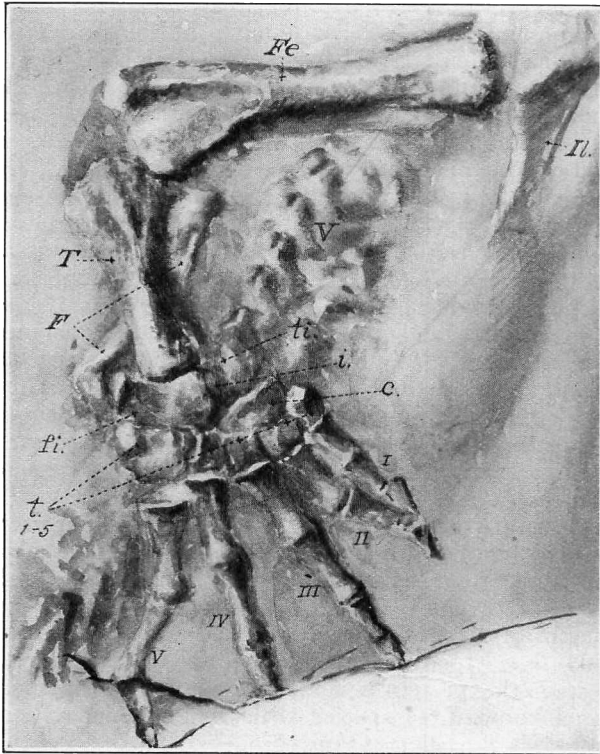


FIG. 2. Left leg and pelvis of *Ichthyacanthus platypus* Cope, from the Coal Measures of Ohio. $\times 1.5$. Original the property of the Department of Geology of Columbia University.

c = centrale; F = fibula; fi = fibulare; Fe = femur; i = intermedium; II = ilium; T = tibia; t. 1-5 = distal tarsalia; ti = tibiale; V = caudal vertebræ; I-V = digits.

determine the presence on an elongate ilium and an ischium. The leg of the left side is the best preserved of all the ele-

ments and it is to this that our attention will be confined. The opposite leg is not so complete, yet all the long bones and a part of the tarsus are preserved with sufficient clearness to corroborate the findings of the left side.

The femur, as has been stated, is reptilian in appearance. This is due to the well-rounded articular surfaces, as though the endochondrium were well developed, and to the large development of the greater and lesser trochanters, which are quite prominent, though these are distorted and depressed in fossilization. The bone is stout and well built (fig. 2) and its form suggests an active habit of life. The *tibia* and *fibula* are separate, and do not otherwise have sufficiently noteworthy characters as to call for a special description in this place except to note an unusual anterior crest on the tibia. To the lower ends of these bones articulate the first row of tarsal elements; the tibiale, intermedium and fibulare. The *tarsus* is composed of nine elements arranged in three rows.

The proximal row is composed of the tibiale, the intermedium and the fibulare. On the edge of the tibiale there lies a portion of one of the caudal vertebræ, so that the form of this tarsal element is slightly obscured. The intermedium is a small rounded element lying between the larger elements. The fibulare is rectangular and projects a considerable distance out from the tibia, but articulates directly with the large lateral distal tarsal. The centrale is triangular in form and is opposed directly by the tibiale and tarsalia 1-3. The phalanges are robust in appearance. The entire foot gives one the impression of a very broad structure. The ungual phalanges were apparently bluntly clawed.

The unusual nature of this foot and its disturbing nature in an attempted analysis of amphibian descent has already been commented on,* and further discussion in this place is unnecessary.

The tarsus of *Archegosaurus* described and figured by Baur|| (page 509) is so incomplete and scattered that a direct comparison with the present form is not possible. Further than this form I know of no species with which we may compare the structures of *Ichthyocanthus*.

Department of Anatomy, University of Illinois, Chicago.

* Science, N. S., vol. xli, No. 1044, p. 34.

ART. XXXII.—*Contributions to Sardinian Petrography: I. The Rocks of Monte Ferru*; by HENRY S. WASHINGTON.

Introduction.—A considerable number of chemical analyses have been made in past years of the igneous rocks of Sardinia which were collected in 1905 and are still unpublished. As there seems to be no immediate prospect of making the additional analyses needed for the rather complete study of Sardinian lavas which was originally contemplated, it has been decided to publish those already made, along with the proper descriptive matter, so as to make them adequately available to petrographers. The rocks of Monte Ferru will be first described, then those of the recent small cones, and finally the lavas of the early sheets. I have to thank Prof. J. V. Lewis for the photographs of the trachyte.

MONTE FERRU.

Bibliography.—The volcano of Monte Ferru was often mentioned and its main characters were well described (according to the science of his day) in La Marmora's classic and monumental work on Sardinia.* Twenty years later Doelter published brief descriptions of its geology† and lavas,‡ with some analyses and a geological map.

Subsequently Bertolio§ gave a brief description of a few of the rocks. The short notices of Zirkel and Rosenbusch appear to have been based entirely on Doelter's work. The first modern description of the volcano is found in two papers by Dannenberg,|| who gives a geological map. In two more recent papers¶ Deprat discusses very briefly the structure of the volcano and the general chemical characters of its lavas, though, unfortunately, he does not communicate the new analyses which he made. The most important part of the volcano is covered by the Santu Lussurgiu and Bosa sheets (Folio 206, III and IV) of the Italian military map, scale 1:50,000.

Topography and geology.—The volcano of Monte Ferru is situated at about the center of the west coast of Sardinia, midway between the towns of Bosa on the north and Oristano on the south and 40 km. north of Monte Arci. The area covered by its lava is at least 700 square kilometers. Its greatest

* A. de La Marmora, *Voyage en Sardaigne, Description Géologique*, 2 vols., Turin, 1857.

† C. Doelter, *Denkschr. Ak. Wiss. Wien*, xxxviii, p. 193, 1877.

‡ C. Doelter, *op. cit.*, xxxix, p. 41, 1878.

§ S. Bertolio, *Boll. Com. Geol. Ital.*, 1896, p. 190.

|| A. Dannenberg, *Sb. Preuss. Ak. Wiss.*, 1903, p. 853; *Neues Jahrb.*, Beil. Bd., xxi, p. 1, 1903.

¶ J. Deprat, *C. R.*, cxlv, p. 820, 1907; *C. R.*, cxlvi, p. 702, 1908.