ART. XXVI.—*The Mazon Creek, Illinois, Shales and their Amphibian Fauna*; by ROY L. MOODIE.

THE Mazon Creek shales have been noted for many years for the excellence of the fossils which are found in them. These fossils are, for the most part, plant remains, but occasionally animal fossils are found, usually in nearly perfect preservation. Among the vertebrates which have been recorded from these beds are about twenty-five species of elasmobranch, dipnoan, crossopterygian and acanthopterygian fishes. Nine of these species are founded on scales and will doubtless be subjected to revision later. Other vertebrates are represented in the amphibian fossils, of which there are, at present, ten species known. These ten species are distributed among eight genera, five families and four orders; thus showing the amphibian fauna of the Mazon Creek shales to be a diverse one. This diversity undoubtedly indicates a long antecedent history for the group. The genera and species, even nearly all of the families, are exclusively Mazon Creek forms, not being known from elsewhere in the world. From this we know that in the Pennsylvanian the Amphibia were already a sufficiently old group to have established themselves into distinct, widely separate geographic groups. Just how long it may have taken for them to so establish themselves is, of course, a matter for conjecture.

The larger amount of the material representing the amphibian fauna of the Mazon shales is in the Yale University Museum, where it had been gathered by Professor Marsh. The writer is indebted to the authorities of the Museum for the privilege of studying this interesting collection. Seven of the species of the Mazon Creek Amphibia are known only in this collection at Yale. Seven of the species are founded on considerable portions of the skeleton, and some of them show many soft parts as previously described by the writer.* Two species are known from nearly complete remains of three individuals. The ten species are as follows:

1. *Amphibamus grandiceps*, Cope, 1865. Three nearly complete specimens.
2. *Amphibamus thoracatus*, Moodie, 1911. One incomplete specimen.
3. *Micrerpeton caudatum*, Moodie, 1909. One complete individual.
4. *Eumicrerpeton parvum*, Moodie, 1910. Three nearly perfect forms.

* American Naturalist, xliv, p. 367, 1910.

5. *Mazonerpeton longicaudatum*, Moodie, 1912. One nearly perfect skeleton.
6. *Mazonerpeton costatum*, Moodie, 1912. One imperfect skeleton.
7. *Cephalerpeton ventriarmatum*, Moodie, 1912. Skull and anterior part of body.
8. *Erpetobrachium mazonensis*, Moodie, 1912. Humerus, radius and ulna.
9. *Spondylorpeton spinatum*, Moodie, 1912. 12 dorsal (caudal?) vertebræ.
10. *Erierpeton branchialis*, Moodie, 1912. Impression of mandibles, parts of body and hyobranchial bars.

These species have been arranged zoologically according to the following plan :

Class—Amphibia, Linné, 1758.

Subclass—Euamphibia, Moodie, 1909.

Order—Branchiosauria, Lydekker, 1889.

Family—Branchiosauridae, Fritsch, 1879.

Micrerpeton caudatum, Moodie.

Eumicrerpeton parvum, Moodie.

Mazonerpeton longicaudatum, Moodie.

Mazonerpeton costatum, Moodie.

Order—(?) Caudata, Dumeril, 1806.

Family—Cocytinidae, Cope.

Erierpeton branchialis, Moodie.

Subclass—Lepospondylia, Zittel, 1887.

Order—Microsauria, Dawson, 1863.

Family—Amphibamidae, Cope, 1875.

Amphibamus grandiceps, Cope.

Amphibamus thoracatus, Moodie.

Cephalerpeton ventriarmatum, Moodie.

Family—Molgophidae, Cope, 1875.

Erpetobrachium mazonensis, Moodie.

Subclass—Stegocephala, Cope, 1868.

Order—Temnospondylia, Zittel, 1887.

Suborder—Embolomeri, Cope, 1885.

Family—Cricotidae, Cope, 1884.

Spondylorpeton spinatum, Moodie.

It will be seen from the above arrangement that nearly all of the orders of extinct Amphibia are represented in the Mazon Creek fauna. Since these animals are the oldest known land vertebrates of which there are skeletons, and since the beds in which they occur have never received adequate

description, it was thought that it might be of interest to present a short discussion of these remarkable fossil-bearing beds.

The writer was enabled to spend a week studying the fossil beds of Mazon Creek last summer with the aid of funds from the Department of Zoology of the University of Kansas and the Elizabeth Thompson Science Fund. It is fitting to express, in this place, to Mr. J. C. Carr of Morris, Illinois, my appreciation of the favors shown me while collecting at Mazon Creek. My purpose in visiting the locality was primarily to collect Amphibia, but although several thousand nodules were examined, none contained amphibian remains. Mr. Carr has collected on Mazon Creek for more than thirty years and knows more of the conditions of fossilization and location of the various beds than any one else. It is, however, a significant fact that during all these years of assiduous collecting he has never found an amphibian nor a fragment of one. It was this fact, together with the further one that the Amphibia referred to above represent over sixty years collecting from these beds, which interested me in making the following comparative table of the rarity of the various kinds of organic remains found in these beds.

If we take 100,000 nodules as a basis for computation of the rarity of the various forms, something like the following will be the approximate result:

Of 100,000 nodules,
20,000 will be barren or contain only indeterminate fragments.
68,500 will contain plant remains.
7,500 will contain insects, Crustacea, myriapods, scorpions, spiders and other Arthropoda.
3,900 will contain fish coprolites or scales.
95 may contain fish or fragments of fish.
4 may contain molluscs.
1 may contain an amphibian.

Total 100,000 nodules.

Perhaps even 100,000 is a little low as a basis of estimate. Mr. Carr was of the opinion that one nodule in every 500,000 might contain an amphibian. The table given above will, at least, be serviceable in giving an insight into the relative abundance of the various forms.

The beds where the nodules are usually collected occur along both banks and in the bottom of the creek (figs. 1 to 4) in two localities.

One locality, known as the Bartlett place, where I camped (fig. 1), is situated eight miles southeast of Morris, in Grundy county, Illinois, Wauponsee township; N. W. quarter section

FIG. 1.

The "Upper Beds."

FIG. 1. Nodules weathering out of the soft blue clay shale. Two quite long ones may be seen near the lower left hand corner of the figure, one of them still in place.

FIG. 2.

The "Upper Beds."

FIG. 2. "The stream bed is filled with glacial boulders, which form an excellent base on which to crack the nodules." Mr. J. C. Carr looking for nodules in the creek bed. He usually carries a basket and fills this, then sits down by a good boulder and cracks the nodules collected.

30 ; Twp. 33 ; Range 8 ; the land now being owned by Mrs. Emma Akerly of Wilmington, Illinois.

The fossil-bearing nodules occur throughout six to eight feet of shale, just above the coal, along both banks of the creek at the "upper beds," as the Bartlett place is called. They may be also seen in the creek bed, when the water is low, still embedded in the shale. With a common potato fork the shale is easily turned and the nodules come out for all the world like potatoes. Once in a while "pockets" are struck from which one may secure a peck or more of nodules. Nearly every nodule has a fossil at the "upper beds" but all of the fossils are not well preserved, possibly only one or two out of every eight or ten being worth carrying to the museum. The stream bed at the Bartlett place is filled with glacial bowlders (fig. 2) which form an excellent base on which to crack the nodules. The nodules crack best when wet and it requires some skill and practice to crack them evenly. The nodules vary in shape and form from perfectly round ones, one-half an inch in diameter, to oval, elongate ones 17 inches or more in length. Many are quite irregular and it is soon noticed that the irregular nodules seldom have good fossils, often none at all. The nodules seem quite light, and in one place, where the stream curves, they are piled in a long windrow. On this pile were found several good specimens of Crustacea and many good plants, in nodules cracked open by the frost.

The fossils at the "upper beds" are localized into special strata. At one place in the upper part of the deposit in a reddish shale one finds that insects are more abundant than they are lower down. The Crustacea appear to come from a definite locality in apparently the same shale. At the lower end of the deposits certain definite species of *Pecopteris* are localized. It is an interesting fact that one seldom finds a *Neuropteris* at the "upper beds." The most abundant fossils are various species of *Pecopteris* and *Annularia*. When specimens of *Neuropteris* are found they are usually discovered at the lower end of the exposures. In one place behind the "island" very blue nodules, hard and flinty, with sometimes well-preserved fronds of *Pecopteris*, are found quite definitely localized. These nodules are more likely to assume an irregular shape. These localizations of the various species of fossils are, of course, what we would expect from our knowledge of the manner in which the recent fauna and flora are distributed. There is, to be sure, more or less intermingling of species. The myriapods, as far as they have been found, are localized. Mr. Carr found three within a space of a few feet. But again these are found widely scattered. The exposures at the "upper beds" are about a quarter of a mile long. They disappear under a heavy ledge of sandstone.

FIG. 3.

The "Lower Beds."

FIG. 3. Looking south up Mazon Creek. The pebbly banks are covered with nodules and the stream bed is filled with them. They are easily collected by wading. Just above the rushes in the upper right corner the nodules are non-fossiliferous. Note the high bluff to the back. This continues along the west bank for some distance.

FIG. 4.

The "Lower Beds."

FIG. 4. A nodule just weathering out of the shale (at the head of the hammer). Others may be seen at the base of the slope. This shows the shales in position. The nodules contain, for the most part, species of *Neuropteris*.

At the "lower beds" (figs. 3, 4), so-called because farther down the creek, conditions are quite different from those just described. The west bank of the creek is higher and almost perpendicular, and the east bank is low and flat, the bluff being a quarter of a mile away, so that the chances for collecting from the shales are fewer. The bed of the creek, however, is wider and there are more nodules washed out. The most abundant fossil at this place is *Neuropteris*. The nodules at the upper end of the exposure are all, almost without exception, barren of fossils. The exposures here are of about the same thickness and extent as the "upper beds," though the species, contained in the nodules, are not so varied. Judging from the collections made while there, the Arthropoda are the more abundant in the lower beds. This is, however, a matter which needs further investigation.

Besides the place near Morris mentioned by Bradley there are no other localities known where the nodules are collected. Bradley* says of the Mazon Creek beds: "The outcrop (i. e., the Coal Measures) along Mazon Creek appears nearly continuous, but still I have not been able to satisfy myself as to the connection of the above beds with those of the lower part of the stream. The strata there developed consist of very variable sandy clay shales and sandstones, in some places becoming nearly pure clay shales, but containing many nodules of carbonate of iron. Pine Bluff, at the lowermost crossing of the Mazon, is composed of about forty feet of heavily bedded but rather fissile sandstone, partly nearly white, partly nearly ferruginous. Less than a mile up the creek, the lower part of this bed changes to highly argillaceous sandy shales, with occasional streaks and nodules of sandstone. The section is not quite continuous, but there is no distinct line of demarkation to separate these latter beds from the ferruginous sandy shales, twenty or thirty feet, of section 24, of township 33 north, range 7 east, which contain large numbers of the fossiliferous nodules of carbonate of iron, for which this locality has become famous. * * * * These nodules range from about two to ten feet above the main coal seam of all this region, the intervening space being occupied by the soft, blue clay shales, filled with fossil plants, which, at most points, overlie this seam. About a mile farther up the stream, coal has been dug in the bed and banks of the stream but is now abandoned. * * * * On the north side of the Illinois river, in the neighborhood of Morris, the coal outcrops in the banks of the canal, and in the stretch of lowland about one mile to the northward. The overlying beds are here mostly blue clay shales, with occasional irregular layers of sandstone. The iron nodules

* Geol. Surv. Illinois, IV, pp. 196-7, 1870.

above mentioned occur at the same level, but not in so great numbers as at the Mazon locality. The shales immediately above the coal frequently yielded magnificent specimens of fossil ferns and other plants."

The same nodules are thrown out of a coal mine at Braidwood, Illinois, and doubtless close search would reveal other localities where the shale is cut through in mining. The beds at both localities, along Mazon Creek, are slightly folded. This is especially true of the "upper beds," where a conspicuous fold causes the beds to disappear, to reappear in the bed of the creek a mile and a half north. This is directly across the large "ox-bow" bend of the creek. Mr. Carr said that he had followed the creek around the bend without discovering any new outcrops of the shales.

The beds at Mazon Creek were first explored in 1857 by Mr. Joseph Evans, who sent his specimens to Berlin, Germany, where they excited great interest. It was he who collected the type specimen *Amphibamus grandiceps*, Cope. Since the time of Mr. Evans many have collected at Mazon Creek, and without doubt the fossil-bearing nodules from the locality are more widely scattered in the museums of the world than are organic remains from any other one bed. The most eager and faithful collector at these beds has been Mr. J. C. Carr. He has presented many collections to schools and individuals, as well as furnishing material for many paleontologists. The writer is indebted to him for the presentation of an excellent series of nodules. The nodules at Mazon Creek will always be abundant, and the collecting will always be good so long as the creek continues to carry away the drainage of the region. We may thus hope to learn much, in the future, of the animals and plants of this wonderful locality. It is not possible, on account of the value of the land, to do extensive excavating, and this is not necessary, for the waters of the creek will, in time, make all the necessary excavations.

It is quite interesting to note in this place the discovery of a similar bed of fossil-bearing nodules in the banks and bed of Rock Creek near Twin Mounds Post-office, some 22 miles southwest of Lawrence, Kansas. The nodules have been known and collected for some time, and their similarity to those of Mazon Creek has been noted. The nodules at Twin Mounds contain identically the same genera and species of plants, insects, spiders, Crustacea, and a *Prestwichia* (*Euproops*) *danae*, M. & W., as are found at Mazon Creek. There have been, so far, no evidences of vertebrates; even fish coprolites and scales are wanting. Further search may reveal these, as well as an interesting amphibian fauna. The beds at Twin Mounds will be fully described elsewhere, and further mention need not be made of them here.

The paleogeographic conditions of the beds containing the Amphibia at Mazon Creek, as well as those at Twin Mounds, are well represented in Doctor Schuchert's map.* A reference to this map, that of the Upper Pennsylvanian times, will show that the Mazon Creek deposits and the Twin Mounds deposits occur on the margin of the heavily shaded portion of the Upper Pennsylvanian sea. Doctor Schuchert suggests that the Twin Mounds beds represent a peninsula or a small island near the shore during Pennsylvanian times.

So far as our knowledge goes there is no evidence of vertebrate life of the uplands at this time. It was confined to the waters and to the borders of the waters. To be sure, we know very little of upland deposits, but there should be some suggestion of the vertebrates did they occur. It is a matter of the profoundest interest to witness here in the Upper Pennsylvanian the appearance of the earliest types of that branch of the animal kingdom which, in later epochs, was to dominate the entire world, some of these types returning to the water as a secondary adaptation. It is not possible for us to examine these lowly organized creatures without thinking that in them, or in creatures like them, lay the possibilities for the development of that race of animals to which we ourselves belong. Dr. Jennings has recently† expressed this idea, approaching the subject from an entirely different point of view when he says: "I was in actual material existence as a living organism, and indeed thousands or millions years old, when the pyramids were built, . . ." Is it possible for us to conceive that the habits of these amphibian creatures of the Mazon Creek region have left an impress on our own characters? If so, are they not worthy of our very careful attention?

Just what the details of the mode of evolution from these small creatures may have been we do not yet know, but patient and faithful search will reveal many new facts of the profoundest importance.

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* Plate 84, *Paleogeography of North America*, Bull. Amer. Geol. Soc., xx, 1910.

† *Science*, N. S., xxxiv, p. 904.