

ON THE RELATIONS OF THE FOSSIL FISHES OF THE SANDSTONE OF CONNECTICUT AND OTHER ATLANTIC STATES TO THE LIASSIC AND OOLITIC PERIODS.

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IN the publications of Professor W. B. Rogers and Mr. E. Hitchcock, Jr., on the red sandstone beds of Connecticut, New Jersey and other States, founded on some of the contained fossils, a higher geological position than that of the New Red Sandstone has been assigned to the formation by these writers.* Without questioning their conclusions, I would here observe that the fossil fishes of these rocks are the most characteristic and apparently reliable fossils for determining the age of the formation. The determinative value of these fossils is perhaps enhanced, also, by the small vertical range to which some of the species, and at least one of the genera, are probably limited. But these fishes, although numerous as well as characteristic, do not appear to have been referred to, in any manner, by the above named writers.

Attention is invited, therefore, to a descriptive account of one genus or group of these fishes, which was read to the New York

* Prof. W. B. Rogers *On the age of the coal rocks of Eastern Virginia*, Am. Jour. of Science, vol. xliii, p. 175, (1842). Also, in Proceedings of the Boston Society of Natural History, vol. v, p. 14, (1854).—E. Hitchcock, Jr., M. D. in Am. Jour. of Science, vol. xx, (N. S.) p. 22, (1855).

Prof. Rogers first assigns to the coal rocks of Eastern Virginia a position near the bottom of the Oolite formation of Europe; while from some fossils "discovered in a particular division of the New Red Sandstone of Virginia," he expects to be able confidently to announce the "existence of beds corresponding to the *Keuper* in Europe,"—doubtless in the extensions of the New Jersey Sandstones or *Newark group*. I propose the latter designation as a convenient name for these rocks, and those of the Connecticut valley, with which they are thoroughly identified by footprints and other fossils, and I would include also, the contemporary sandstones of Virginia and N. Carolina.

At a later period, (1854) Prof. Rogers recognizes the general equivalency of the eastern and middle belts of Virginia, and the eastern or Deep River coal belt of N. Carolina: all of which in his view ought to be placed in the Jurassic series, not far probably above its base. In relation to the more western belt, the occurrence of *Posidonie*, and *Cypride*, in Pennsylvania, with sauroid coprolites and imperfect impressions of *Zamites* leaves, he considers as sufficient to identify, as one formation, the disconnected tracts of this belt, in N. Carolina and Virginia and the prolonged area of the so-called New Red Sandstone of Maryland, Pennsylvania and New Jersey; and that they are of Jurassic date, but little anterior to the coal rocks of Eastern Virginia.

Prof. H. D. Rogers (1839) proposed the name of middle secondary to this group (for convenience sake) to distinguish it from the Appalachian formations on the one hand, and from the green sand deposits on the other.—Third Report on Geol. of Pennsylvania, p. 12.

Mr. Hitchcock describes a new species of *Clathropteris*, discovered in the sandstone of the Connecticut valley. This fossil fern, found near the middle of the series in Massachusetts, he refers to the liassic period.

Lyceum of Natural History, in Dec. 1836, by Mr. John H. Redfield, and is found in vol. iv of the "Annals" of that Society. It was founded upon a careful comparison of the genus *Catopterus* with the fossil fishes of different formations in Europe, as these are portrayed in the great work of Prof. Agassiz, then recently received. Such portion of the description and observations then made as relate directly to the geological age of the formation are here quoted.

Of the genus *Catopterus*, species *C. gracilis*, he says:—"Tail forked, equilobed. Scales extending a little upon the base of the upper lobe." And in regard to the equilobed tail, he adds in a subjoined note:—"This indeed is not *strictly* the case. Its structure, however, is analogous to that of the *Semionotus*, ranked by Agassiz among the *Homocerci*, and differs most decidedly from that of the true *Heterocerci*, where the scales, and probably the vertebræ, extend to the extreme point of the upper lobe." He adds:—

"In the arrangement of Agassiz, this fish would be comprehended in the order *Ganoides*, and family *Lepidoides*. Its equilobed tail would assign it to the second division of the family, the *Homocerci*, as he has termed them. From seven fusiform genera now arranged in this division it is entirely excluded by the posterior position of its dorsal. It may therefore be ranked between the genera *Semionotus* and *Pholidophorus*, being analogous to both in the structure of the tail, and in its serrated fins, and to the latter in the articulation of the rays. From the situation of the dorsal fin I have thought the name *Catopterus* to be applicable to this new genus."—Annals Lyc. Nat. Hist. vol. iv, pp. 38–39.

Nearly twenty years have elapsed since the promulgation of these careful and apparently conclusive observations, which do not appear to have been weakened or set aside by any subsequent researches. It is proper to state that the two analogous genera above mentioned are found in the Oolitic series as well as in the Lias, and it is believed that few, if any of the kindred genera have a lower range.* The above observations afford at

* A single case of semi-heterocerical structure as occurring in the coal rocks of Autun in France, was mentioned to us by Professor Agassiz in 1846. As we learn nothing more of its appearance in the palæozoic series, may there not possibly be an error as regards the authenticity or position of this fish? If otherwise it does not seem to have appeared again until after the Permian period. On the other hand, it appears to be admitted that the true heterocerques, of the *Palæoniscus* type, do not appear above the Trias, and I think they are not found above the Permian.

It should be noted that Sir P. Egerton has described a most singular fish from the upper strata of the New Red, of a genus hitherto unknown, which has but little inequality in the structure of its caudal base. This fish, the *Dipteronotus cyphus* Eg., is very short and broad, with a double dorsal, and is altogether so *unique* in its character that its occurrence may be deemed to affect but little the chronological inferences which are drawn from the varied structure of the numerous genera and species of the Lepidoid family.—See Geol. Jour. 1854, p. 369, with a figure.

least sufficient warrant for the cautious and perhaps too limited inferences with which Mr. R.'s paper in the *Annals* is concluded: viz.

"It has of late years been generally admitted that the sandstone from which these fishes are derived is of much later date than the old red sandstone, to which it was once referred, and these remains confirm this belief. The *Palæonisci*, of Europe [true heterocerques] have never been found below the coal measures, while they extend upward to the copper slate of the *zechstein*, or magnesian limestone. In the case before us, we find a species of *Palæoniscus* accompanied by a fish, the structure of whose tail approaches that of the *Pholidophorus*, and of other fishes never found below the lias. This fact would seem to imply for this formation, even a higher situation in the series than that which is now assigned it by geologists."—*Annals*, &c., p. 40.

The American Association of Geologists and Naturalists at the meeting held in Albany in April, 1843, requested Mr. John H. Redfield to prepare a report on the fossil fishes of the United States. His report was presented to the Association, at New Haven, in May, 1845. It was withheld from publication by its author, on account of the expected visit of Prof. Agassiz to this country, and with a view of commending the whole subject to his examination.—In the review of the fishes of our new red sandstone, so called, the report stated as follows:

"NEW RED SANDSTONE.—Under this term I include the extensive sandstone formation of the Connecticut river valley; the small and isolated basin on the Pomperaug river near Southbury, Ct.; the New Jersey Sandstone, extending from the border of the Hudson river, southwesterly, to the interior of Virginia; and, also, the formation known as the coal rocks of Eastern Virginia.—(Report, p. 4.)

"All of the fishes hitherto found in these rocks belong to the order GANOIDÆ, and to the family LEPIDOIDÆ."—Report, p. 5.

"Prof. Agassiz has made two subdivisions in this, as in other families of the order Ganoidæ, founded on differences in the structure of the tail. In the first of these, (*Heterocerci*) the upper lobe of the tail, is vertebrated and is usually longer than the lower, and the scales of the body extend upon the upper lobe nearly or quite to its extremity. The other division, the *homocerci*, have the tail regular, either forked or rounded, and the scales do not extend upon the upper lobe, though in some genera they are slightly prolonged in that direction. The fishes of our sandstone formation above mentioned, would seem to belong to the first of these divisions, or those with heterocercal tails. They do not, however, exhibit this structure in the same degree which obtains in the fishes of the older European rocks, or even in those of the new red sandstone or magnesian limestone of Eng-

land and Germany. The only two genera which have yet been found in our rocks differ somewhat from each other, also, in the degree of heterocercal structure which they present, those species which, following Prof. Agassiz in *P. fultus*, I have allotted to the genus *Palæoniscus*, having the heterocercal structure more decided. But even in these, the tail has a different aspect from the *Palæonisci* of Europe. In the latter, the upper lobe of the tail seems hardly to partake of the character of a fin, and the lower lobe appears to be only a fin-like appendage of the upper, like a second anal fin, while the scales and no doubt the vertebrae extend to the extreme point of the upper lobe."

"The other genus, the *Catopterus* of our rocks, exhibits the heterocercal structure in a still more modified degree. So nearly does it approach in this respect some genera classed as homocercal fishes, such as *Semionotus* and *Pholidophorus*, that in an early memoir published in the Annals of the Lyceum of Natural History, vol. iv, I was led to rank it in that division, subject to a qualifying note. Its relations are however, rather to the heterocercal fishes, or perhaps to an intermediate group."

"This point is an important one in its bearing upon geological questions, for it is now well ascertained that the true heterocercal tail [in the lepidoids] is peculiar to the palæozoic, and lower mesozoic rocks, no fish of that character having been found higher in the series than the triassic rocks, while the true [strict] homocercal tail does not occur below the lias. When therefore we find in the fishes of our sandstone rocks, a structure which seems to be intermediate between the true homocercal and the heterocercal divisions of Agassiz, the conclusion seems irresistible that the including rock *cannot be older* than the triassic, while it must be placed *at least as low* in the series as the lias or oolite." Report, pp. 5-6.

"— Only four species of the genus *Catopterus* are yet known; three of which are found in the red sandstone of New England and New Jersey and the fourth in the coal rocks of Eastern Virginia."* Report, p. 7.

His descriptions of these four species of *Catopterus* are found in the report, and were then prior to any known notice or description of these fishes, other than our own, and together with the descriptions of the more numerous species of the genus *Ischypterus*, are yet withheld from publication, on account of the contemplated arrangements for completing a monograph of the fishes of this formation in the United States.

I have thus shown the examinations and conclusions of Mr. J. H. Redfield on these fishes, as first published in 1837, and as found in his report to the American Association in 1845. In

* Others have since been obtained.

the first of these he points out the age of the containing rocks, and within the same limits which now appear to result from all the subsequent researches.

At the meeting of this Association held in Cincinnati in April, 1851, the present writer made a communication on the Post-Permian character of the red sandstone rocks of Connecticut and New Jersey as shown by their fossils. I then exhibited, together with two species of *Voltzia*, some specimens of the genus *Catopterus* from these rocks, showing the homology of their caudal structure with that of the *Catopterus macrurus* from the coal rocks of Eastern Virginia. This was induced in part by the fact that Sir Philip Egerton, in a paper of Sir Charles Lyell, in the Journal of the Geological Society, had separated this Virginia species from its congeners in the New Jersey and Connecticut rocks, on the ground that the former belonged to the homocercal and the latter to the heterocercal divisions of Prof. Agassiz.* Previous however to this publication of Sir Charles, repeated and careful examinations, with Prof. Agassiz, of the numerous specimens of *Catopterus* in my possession, collected from the localities of the three different States, had appeared to establish fully their similarity in respect to the structure of the tail. Also, that the *Catopteri* of all the localities, including Virginia, might continue to be referred to the *homocerci*, as in the case of several European genera, or that, more properly both they and the other fishes of these rocks might be referred to a distinct and intermediate division, which is *sub-heterocercal* in its character, if I may so speak. I therefore reclaim the *Dictyopyge* of Sir Philip Egerton, founded on my species *C. macrurus*, as still belonging to the genus *Catopterus*. I refer to this matter on the present occasion on account of the important bearing which it has on the geological age of these fishes, as found in the several states.

It may be added in further explanation, that Sir Charles Lyell in the paper referred to, states that "the genus *Catopterus* was instituted by Mr. Redfield for certain species of heterocercal fish from the Connecticut red sandstone." He seems not to have noticed that the genus was instituted by Mr. J. H. Redfield in 1836 for a *homocercal* fish, according to the characteristics afforded in the *Poissons Fossiles* of Agassiz; and he probably alluded only to my own later notices in this Journal, 1841, vol. xli, p. 27. All the fishes obtained by him from the sandstone of the Connecticut river are also pronounced heterocercal, while the Virginia fish is stated to be homocercal, and this he supports by the opinions of Prof. Agassiz as given on first seeing his specimens

* Sir Charles Lyell *On the Structure and Probable Age of the Coal-Field of the James River, near Richmond, Virginia*: Jour. of the Geol. Soc., vol. iii, 1847, pp. 275-278.

of these fishes in Europe. Based on this designation, Sir Philip Egerton proposed his new genus *Dictyopyge* for the *C. macrurus* of the Virginia rocks.

In regard to the other fishes of New England and New Jersey, Mr. J. H. Redfield had reluctantly followed the work of Prof. Agassiz in assigning them to the genus *Paleoniscus*, although this eminent naturalist had then only seen two imperfect specimens; but Mr. R. then alluded to their structural affinity with the liassic fishes, as we have seen in his conclusion already quoted, and impliedly in the descriptive portion of his paper. It is well seen, also, in his figure of the *P. latus*, attached to his paper in the Annals. In my own notices of 1841, referred to above, I suggested that their less heterocercal forms, and the peculiar structure of their fins warrant their being placed in a separate genus. Sir Philip Egerton recognizes the division, as did Prof. Agassiz in 1846, and Sir Philip proposes for the new genus the name *Ischypterus*.

The question to which of the divisions of Agassiz the *Catopterus* of Connecticut and this fish of Virginia belong, is simply one of degree. Even if we were to admit a slight difference in this case, it could hardly imply the wide separation which has been claimed. Such a marked division, founded on the structure of the tail, cannot depend on the use of a term, but must be decided by the fishes themselves.

In regard to this point of distinction, may I not quote the matured views of Sir Philip Egerton, so well expressed in the Journal of the Geological Society, 1854, p. 368:—"Although this character, derived from the organization of the caudal fin, is one of great value and significance in the determination of various genera of fossil fishes, it is nevertheless necessary, in drawing general conclusions, to be careful not to assign to it more importance than it is strictly entitled to; for we find, by the comparison of several genera, that it is not one of those well defined trenchant characters which can be affirmed to exist or not, as the case may be, but that it is variable in amount, passing from extreme *heterocercy* to absolute *homocercy* by a sliding-scale so gradual, that it is (at all events in fossil examples) most difficult to define a positive line of demarcation between the two forms."

As the terms have hitherto been used, such line of demarcation, if it exist, appears best indicated at the division between the palæozoic and the mesozoic strata; and perhaps in lesser degree, at the close of the triassic period.

In all our *Catopteri* the scales of the caudal base terminate near the middle rays of the upper lobe, "and not on the upper margin, as in a true heterocercal tail."* Good figures by Din-

* See Egerton as last quoted p. 370.

kel of the species *C. macrurus* of Virginia are given in the above-mentioned paper of Sir Charles Lyell.

It has been seen that Mr. J. H. Redfield considers the other fishes of the Connecticut river and New Jersey rocks as more heterocercal in degree than the *Catopterus*. In some of the species, however, this difference seems less obvious after a close examination of the structure, than it appears at first view. One or two of the species in my possession I think are even more nearly homocercal than the Virginia fish.

I desire to add, that two of the *Lepidoti* from the table land of India of which figures are given in the Jour. of the Geol. Society, show very strong resemblances to two or three of my fishes from the sandstone of Connecticut river at Sunderland, to one of which I had proposed the name *Ischypterus Marshii*. Is it not probable that the vast extent of sandstone and trap in that distant region, is of like age with our Newark group?

Already I have ventured to state verbally to the Association, that in the valuable collection of fossils from the coal-field of Deep River in North Carolina, now exhibited by Prof. Emmons, I have recognized several well characterized fragments of the genus *Catopterus*. A close comparison of these with specimens in my cabinet may perhaps show a difference of species. But my present impression is that of identity with one of the New Jersey species.

It would be premature to conjecture how far the new fossils of Prof. Emmons may affect the question of the relative age of these rocks. But when we consider that these fishes evidently belong to fresh water or estuary deposits, as is shown by the entire absence of any remains of large marine fishes, by an almost equal absence of shells, and by the numerous fossilized fragments of vegetation with which the fishes are associated, the chronological evidence afforded by their characteristic organization would seem to be more determinate than that of saurians, plants, or marine fishes, whose general habitat and power of distribution, enable them to occupy a greater range in the geological series.

P. S. It is proper to add, that having now compared the remains of *Catopterus* of Prof. Emmons's collection with my own specimens of the genus, I find them scarcely distinguishable from most of those of the New Jersey and Connecticut rocks. Indeed they appear to be identical with *C. gracilis*. The chief differences appear in the larger size of most of the Carolina specimens which may be due to conditions more favorable to their growth, and in the less flattened condition of the basal portion of the strong and elongate front ray of the pectoral fin,—owing, probably, to a nearly equal pressure on all sides, in the carbonaceous paste or sediment in which they were fossilized.



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