V.—NOTES ON THE DEVONIAN FISHES OF SCAUMENAC BAY AND CAMPBELLTOWN IN CANADA.¹

By Dr. R. H. TRAQUAIR, F.R.S., F.G.S.

THE researches of the officers of the Geological Survey of Canada have brought to light, in the Devonian rocks of Scaumenac Bay and of Campbelltown, a series of fossil fishes which are of especial interest to the geologist as well as to the zoologist, on account of the analogies which they bear to the fishes of the Old Red Sandstone of Great Britain. Principally collected by Mr. G. H. Foord, these fishes have been described by Mr. J. F. Whiteaves,² and are indeed remarkable for their beautiful state of preservation, which enables them to throw fresh light on many points in the structure of these ancient forms. From a purely geological standpoint their interest is not less, as we shall see.

The Edinburgh Museum having been fortunate enough to obtain a valuable collection of these fishes, I am enabled to supplement Mr. Whiteaves's descriptions, as well as to add at least two additional species to the list.

I. Fishes from the Upper Devonian of Scaumenac Bay.

CTENODONTIDÆ.

Phaneropleuron curtum, Whiteaves.—As Mr. Whiteaves points out, this species is distinguished emphatically from the Scotch *Ph. Andersoni* by its comparatively short and deep outline, which in this case is certainly not due to distortion. Some of the Edinburgh specimens show the Ctenodont dentition very clearly, but in no case have I seen the "smooth, conical and somewhat compressed teeth," which Mr. Whiteaves mentions as arming both the upper and under jaw. And here I must make an important correction. In his second quarto memoir (1889) Mr. Whiteaves refers to a fragment collected by Mr. Foord in 1881, in which the eye is situated very far forwards and surrounded by a complete circle of about 26 circumorbital plates. Referring also to the suborbitals and preoperculum, which are also shown in the specimen, he says that they are "exactly similar to the corresponding plates in *Eusthenopteron*." Now, if we refer to the figure given of this specimen (ib. pl. x. fig. 1), it will be seen that this exact similarity is shared also by the anterior half of the cranial buckler which is present, as well as by the maxilla, and the jugular plate. Moreover, the orbit does not occupy that position in *Phaneropleuron curtum*; for according to a specimen now before me, it is placed, as in *Ph. Andersoni*,³ comparatively far back, and not much in front of the

¹ Read before Section C of the British Association at Newcastle-on-Tyne, September 16th, 1889.

² Am. Journ. Sc. and Arts (3), xx. 1880; Canad. Naturalist, n. ser. x.; Am. Naturalist, xix. 1885; Canad. Nat. and Quart. Journ. Sc. n.s. vol. x. 1881. Mr. Whiteaves's detailed descriptions are given in two quarto memoirs entitled "Illustrations of the Fossil Fishes of Canada," from the Trans. Roy. Soc. Canada, vol. iv. sec. iv. 1886, and vol. vi. sec. iv. 1888.

³ On the position of the orbit in *Phaneropleuron Andersoni* see Traquair, GEOL. MAG. Vol. VII. 1871, pp. 530-531.

operculum. In fact, there can be no doubt that the specimen referred to by Mr. Whiteaves belongs to *Eusthenopteron Foordii*, and not to *Phaneropleuron* at all. The "circumorbital" plates are, as we shall see under *Eusthenopteron*, sclerotic in their nature.

PTERICHTHYIDÆ.

Bothriolepis Canadensis, Whiteaves.—Remarks on this species will be found in my paper on the "Structure and Classification of the Asterolepidiæ," Ann. and Mag. Nat. Hist. for Dec. 1888.

CEPHALASPIDÆ.

Cephalaspis laticeps, sp. nov.—Only one specimen, which shows the cranial shield, with badly-preserved traces of the body. Shield proportionately rather broad, length $1\frac{3}{8}$ inch, breadth $2\frac{3}{4}$ inches, cornua short: orbits rather close together, oval, large: tessellated divisions of middle layer very small: external surface ornamented by small, smooth, polished and rounded tubercles, moderately close in position.

This is the first occurrence of a Cephalaspid in rocks of later age than the Lower Devonian, and as such is worthy of the attention of the geologist.

ACANTHODIDÆ.

Acanthodes concinnus, Whiteaves.—This is a true *Acanthodes*, and differs remarkably in the sculpture of the scales from all the other species of the genus.

Mesacanthus affinis, Whiteaves, sp.—At first Mr. Whiteaves was inclined, though doubtfully, to refer this little fish to *Acanthodes Mitchelli* of Egerton, from the Forfarshire beds; subsequently, however, he decided to retain it as distinct, though still apparently with doubt, as he speaks only of there being "some reason for supposing that this interesting little fish is distinct from the *A. Mitchelli* of the Devonian rocks of Scotland." It is, however, only necessary to place specimens of the two forms side by side to see that they are quite distinct, as the scales of the Canadian species are proportionally very much larger than in *Mitchelli*.

Owing to the very distinct presence of a pair of small spines intermediate between the pectorals and ventrals in *A. Mitchelli*, and in *A. Peachii*, Eg., I have proposed to include them in the new genus *Mesacanthus*,¹ including also, from its general aspect, *A. pusillus*, Ag., from the Moray Firth beds, although our specimens of the latter are not well enough preserved to show them. Here I would also place *M. affinis*, as in one specimen I at least imagine I see one of those minute intermediate spines.

HOLOPTYCHIDÆ.

Glyptolepis Quebecensis, Whiteaves.—The collection in the Edinburgh Museum contains one head of a small Holoptychian fish which I provisionally refer to this species, although unfortunately no body is present: equally unfortunately, the head in the only specimen described by Mr. Whiteaves is not well enough preserved to show

¹ GEOL. MAG. Dec. III. Vol. V. 1888, p. 511.

its structure or markings. This head displays the typical Holoptychian osteology and dentition, the laniaries of the under jaw being acutely conical, and striated to near the apex : they seem, however, to be round in transverse section.

Mr. Whiteaves at first referred his *Glyptolepis* to *G. microlepidotus* of Agassiz, though with some doubt, and even in his subsequent detailed description, in which he adopts the name *Quebecensis*, he still seems to be uncertain as to its distinctness or the contrary. For he says : "As it seems impossible to decide from the description and figure of *G. microlepidotus* in Agassiz's monograph whether the Canadian species is identical with it or not, it seems safer to give the latter a provisional name until the true specific relations of each shall have been ascertained by a direct comparison of specimens from both sides of the Atlantic."

There is, however, no need for regarding the name *Quebecensis* as provisional, so far as any possible identity with *microlepidotus* is concerned. For Mr. Whiteaves's figure shows a true *Holoptychian*, and probably a *Glyptolepis*, whereas Agassiz's *G. microlepidotus* is not referable to *Glyptolepis* at all, nor even to the same family. That fish is, as I have shown (*GEOL. MAG.* Dec. III. Vol. V. 1888, p. 514), a true Rhizodont, and is, I believe, both generically and specifically identical with McCoy's *Gyroptychius angustus*.

RHIZODONTIDÆ.

Eusthenopteron Foordii, Whiteaves.—The characters which Mr. Whiteaves gives as distinguishing his genus *Eusthenopteron* from *Tristichopterus*, Egerton, are briefly as follows :—

1. That "the vertebral centra of *Eusthenopteron* do not seem to have been ossified at all," whereas "in *Tristichopterus* on the other hand the vertebral centres are stated to be completely ossified."
2. That the large bones bearing the three ossicles which directly support the second dorsal and the anal fin in *Eusthenopteron* are interspinous in character, whereas "the corresponding bones in *Tristichopterus* are represented as spinous rather than interspinous in their character, and as each abutting directly on the vertebral axis."
3. The much greater vertical symmetry of the caudal fin in *Eusthenopteron*.
4. The presence of two cutting edges in the laniary teeth of *Eusthenopteron*.

Reasons 3 and 4 certainly hold good whether they be of generic value or not. But such is not the case with the first and second. For specimens of *Eusthenopteron Foordii* now before me show undoubtedly the presence of vertebral centra in the anterior part of the body at least, these being in the form of hollow rings as in *Rhizodopsis*, and I am firmly of opinion that the vertebræ of *Tristichopterus* are in the same condition, and that "in this genus the ossification and segmentation of the vertebral column" was not "complete," as supposed by Sir Philip Egerton. And also as regards the large fin-supporting bones alluded to in the second reason, I am equally of opinion that Sir Philip Egerton was in error in consider-

ing them to be spinous, and not interspinous. It would indeed be odd if so great a morphological difference existed between such similar elements in such closely-allied fishes. Comparing specimens of *Eusthenopteron* and *Tristichopterus* in the Edinburgh collection, there can be no doubt as to their *exceeding* similarity of structure, though the differences mentioned in reasons 3 and 4 seem to me to justify the retention of the former generic name. It must be remembered, however, that in such questions much depends on the idiosyncrasy of the individual writer—differences, which to some minds may seem generic, are not always of the same importance in the eyes of others.

Mr. Whiteaves describes the cranial buckler as divided by a transverse suture into two unequal parts, an anterior or *frontal*, and a posterior or *parietal* plate. This is of course true, but he makes no mention of the constituent bones of these two great divisions of the cranial shield, which can, in fact, only be made out when the shield is viewed from the internal or non-sculptured aspect. The posterior part may be seen in this way to consist of two elongated parietals, each of which is flanked by two smaller plates, a squamosal behind and a postfrontal in front, exactly as in *Rhizodopsis*, *Osteolepis*, etc. Likewise the anterior portion consists of two frontals in contact with each other in the middle line, but without the pineal foramen seen in many Osteolepids (*Osteolepis*, *Diplopterus*, *Thursius*), while in front of these, and received posteriorly in an angle between their anterior extremities is an oblong median ethmoidal, flanked on each side by a lateral ethmoidal, while the space between these and the premaxillæ is apparently covered by a number of small polygonal plates as in Holoptychids, Rhizodonts, and Osteolepids generally. I have remarked above that the sutures between these plates can only be seen when the cranial shield is examined from the internal aspect; on the outside nothing is seen but a median groove, noticed by Whiteaves, separating the two frontals, and bifurcating in front behind the median ethmoid.

A circle of small quadrangular or slightly wedge-shaped plates occurs in the position of the eye, of which six are seen in one specimen before me, while in Mr. Whiteaves's paper five are represented in his restored figure (pl. vi. of his second quarto paper), and the whole circle, "about twenty-six," in the specimen erroneously referred to *Phaneropleuron* (*ib.* pl. x. fig. 1). Of these plates Mr. Whiteaves observes that they "are probably homologous with the circumorbitals of Traquair's restoration of *Dapedius*, as well as suggestive in a general way of the still more highly specialized sclerotic plates in the eye of *Ichthyosaurus* and *Megalosaurus*."

Now, as it is clear that these little plates cannot be both of two such very different things at once, a choice must be made, and from their shape and their position relative to the other bones in the head in which I have observed them, I have no doubt that they are sclerotic and not circumorbital in their nature. If this view be correct, we have in *Eusthenopteron* a condition almost unique among fishes, for though sclerotic ossifications are not uncommon amongst them, in no fish except certain Cœlacanthos do they assume the form

of a continuous ring of quadrangular plates as they do in recent Birds and Lizards and in extinct Ichthyosauria and Stegocephala.

The plate labelled "preoperculum" by Whiteaves consists in reality of three pieces, as in *Rhizodopsis*, *Megalichthys*, etc., of which only one, the narrow semilunar posterior division (see my figure of the head of *Rhizodopsis*),¹ can be supposed to represent a preoperculum, the other two being cheek-plates. Here I must confess to have also failed to observe this in my previous study of *Tristichopterus*,² as a re-examination of the same specimens incontestably proves the presence of the same elements in that genus.

The mandible shows very distinct evidence of being composed of the same elements as in *Rhizodopsis* and *Rhizodus*. The laniary teeth are like those of *Rhizodus* in miniature, being rounded and fluted at the base, smooth and two-edged higher up. A transverse section of the fluted portion shows that the dentine is here thrown into complex labyrinthine foldings. I can see none but small teeth on the maxilla, as in other *Rhizodonts* and *Osteolepids*, but the vomers are, as usual, armed with strong tusks. Mr. Whiteaves states that "in *Eusthenopteron*, as in *Tristichopterus*, no trace can be detected of an azygos jugular plate, or of any small lateral plates." There is certainly no median jugular, but in one of our specimens the presence of five narrow lateral jugulars is very distinctly shown. No specimen of *Tristichopterus* as yet known is well enough preserved in this region to show these small lateral plates.

A very great interest attaches to the internal skeleton of the paired fins, which in the case of the pectoral is tolerably accurately figured by Mr. Whiteaves, though he does not seem very decided as to the interpretation to be placed upon the arrangement shown. There is a segmented axis consisting of four bony segments or mesomeres, placed end to end, each being slightly constricted in the middle. Each of these, except the last, has likewise attached to it on the preaxial side of its distal extremity, a small bone, also constricted in the middle and passing outwards and backwards at an acute angle; these small bones being clearly parameres. The first mesomere, and in one case also the third, gives off likewise on its postaxial side a flat backwardly directed process, which is certainly only a process and not a distinct bone. I may here also state that there is some evidence of an additional mesomere in advance of or proximally situated to that which I have termed the first, and bearing no paramere. A very similar arrangement is found in the pelvic fin, whose internal skeleton was not perfectly preserved in Mr. Whiteaves's specimens; here I find at least two mesomeres, each bearing a paramere, there being, I think, also a probability of the presence of a third or distal mesomere.

The arrangement seen in the pectoral fin of *Tristichopterus*, which I figured in 1874,³ is essentially the same as that described above, though at the time I wrote my description of the last-mentioned genus, and taking the condition of preservation of the specimen into

¹ Trans. Roy. Soc. Edin. vol. xxx. 1881.

² Trans. Roy. Soc. Edin. vol. xxvii. 1874.

³ Trans. Roy. Soc. Edin. pl. xxxii. fig. 9.

account, I did not feel quite certain as to whether I should consider the postaxial processes of certain mesomeres as parameres or not. The internal skeleton of the pectoral in the Carboniferous *Rhizodopsis*, as I have observed it in specimens belonging to Mr. Ward, F.G.S., of Longton, is also constructed on the very same plan.

It follows, then, that the skeleton of the paired fins in the Rhizodontidæ is an abbreviate uniserial "archipterygium," and if, as seems probable, the Holoptychiidæ are the more archaic group, then the Ceratodus-like pectoral of *Holoptychius* is a more primitive form of limb. This paired-fin skeleton in *Eusthenopteron* and its allies may therefore, along with the corresponding conditions in *Pleuracanthus* and *Cladodus*, be considered of special interest in connection with the "archipterygium question."

PALÆONISCIDÆ.

Cheirolepis Canadensis, Whiteaves.—Unfortunately the Edinburgh Museum contains only a few fragments of this species, so that I have no means of comparing it thoroughly with the Scottish specimens of the genus, all of which, in my opinion, are referable to one species only, *Ch. Trailli*, Ag.

II. Fishes from the Lower Devonian of Campbelltown.

COCCOSTEIDÆ.

Phlyctænius, nov. gen. *Ph. Acadicus*, Whiteaves, sp.—On examining several pretty good specimens of this curious Coccosteian, named by Mr. Whiteaves *Coccosteus Acadicus*, I find that it exhibits certain characters which are neither in accordance with those of the genus *Coccosteus*, nor with Mr. Whiteaves's diagram of its cranial shield. Allied to *Coccosteus* it is, as the arrangement of the sensory grooves, correctly indicated in Mr. Whiteaves's figure, clearly shows. But the sutures between the bones are only seen with the greatest difficulty; indeed Mr. Whiteaves admits that the dotted lines in his figure only represent their "supposed outlines." Accordingly he has indicated by means of those dotted lines certain plates having the same general outline as the median-occipital, lateral-occipital, and central plates in *Coccosteus decipiens*, Ag., whereas the real outline of these plates seems to me to be very different. The median-occipital, instead of being trapezoidal, with long posterior margin, shorter anterior one, and convergent sides, appears elongated and five-sided, there being an anterior acute angle which is received in a notch between the two centrals in front, which are themselves also elongated and more or less of a six-sided contour. Laterally the external occipital, marginal, and postorbital may be easily made out, and I think the preorbitals are also apparent enough. The orbital portion of the shield (= the part between the letters *d* and *e* in Whiteaves' figure) are rather more anterior and look more forwards than in *Coccosteus*. None of our specimens show Mr. Whiteaves's "rostral" plate, which is evidently the equivalent of that which I have called anterior ethmoidal in *Coccosteus decipiens*.¹

¹ *Homosteus* compared with *Coccosteus*, GEOL. MAG. Dec. III. Vol. VI. Jan. 1889, Pl. I. Fig. 2 *a*, *e*.

The difference in the form of those bones of the cranial shield seems to me certainly to be of generic importance, and I doubt not but that many other important differences would be apparent were the remains more complete. (I may remark that the plate figured by Mr. Whiteaves as a "ventro-median (?) plate" cannot be so, as it is not bilaterally symmetrical.) I therefore propose for it the generic name *Phlyctænius*.

It is also of considerable interest to note that the Edinburgh Museum also possesses a small Coccostean head from Cradley, Herefordshire, which is referable to the same genus as the above. A description of this, the first known Coccostean from the West of England, is reserved for the next Number of the GEOLOGICAL MAGAZINE.

CEPHALASPIDÆ.

Cephalaspis Campbelltownensis, Whiteaves.—Mr. Whiteaves mentions as a character of this species that the surface displays little pits instead of the characteristic tuberculation. The outer surface does not seem to me to be preserved in the Campbelltown Cephalaspidæ any more than it is in those from some localities in Forfarshire.

In its contour the shield of *C. Campbelltownensis* is, however, proportionally considerably broader than in *C. Lyelli*, though this may partly be due to these shields in the Campbelltown deposits being always crushed out quite flat. The orbits are proportionally further back from the front of the shield.

Cephalaspis Whiteavesi, sp. nov., Traq.—Buckler triangular in general appearance, rather acutely and conspicuously pointed in front, cornua rather prolonged and incurved, orbits large, polygonal tessellation somewhat coarse. Surface ornament not seen.

This is a most striking form, no hitherto described species of *Cephalaspis* having that remarkably pointed anterior contour which indeed reminds us of the front of a Skate. I beg therefore to dedicate the species to Mr. Whiteaves, who has been the first to describe the fishes from Scaumenac and Campbelltown.

ACANTHODIDÆ.

Mr. Smith Woodward has already pointed out that the species named by Whiteaves *Otenacanthus latispinosus* and *Homacanthus gracilis* are Acanthodian in their nature, and are not distinguishable from those of *Climacanthus*.¹

GYRACANTHUS.

A veritable Selachian ichthyodorulite has, however, turned up in the shape of a new species of *Gyracanthus*, to which I apply the name *G. incurvus*. The length of the spine is $2\frac{1}{2}$ inches, but though the point is entire, some of the base has been lost, so that originally it must have been a little longer. It shows an antero-posterior curvature of a very much stronger and more pronounced description than is found in the young forms of any hitherto described species, and this together with the great delicacy of its ornamentation distinguishes it as new. The ornamentation consists of rather fine

¹ Ann. and Mag. Nat. Hist. (6) iv. p. 183.

ridges passing with a very slight obliquity over the side of the spine; this obliquity increases towards the base as well as towards the anterior aspect, where the ridges are also rather coarser than posteriorly. The ridges are plain at the apex, but soon become crenulated, the crenulations being more pronounced on the anterior aspect.

That this species belongs to the genus *Gyracanthus* is fully shown, not merely by the nature of the ornament, but by the obliquity of the posterior area, the prominent edge of which is armed with a row of minute denticles.

Gyracanthus has hitherto not been known to exist below the horizon of the Carboniferous rocks. Its occurrence in the Lower Devonian of Canada is therefore as interesting a fact as the occurrence of *Cephalaspis* in the Upper Devonian of the same country.

VI.—NOTES ON THE GEOLOGY OF THE GIRONDE, WITH ESPECIAL REFERENCE TO THE MIOCENE BEDS.

By GEORGE F. HARRIS, F.G.S.

DURING the past summer I had the pleasure of studying the Miocene and Upper Oligocene beds at various places in the Bordelais, mostly under the guidance of the amiable Professor of Geology in the Faculté des Sciences in Bordeaux, Monsieur E. Fallois; and the following notes are mainly intended to give an idea of the present appearance of the classical Miocene sections in that district, and to say something concerning their classification and that of the other Tertiary beds of the Gironde, following the most recent researches on the subject. In doing so, the names of the principal localities rich in fossils will be prominently brought forward (supplemented by a table at the end of the article), chiefly with a view to enable us readily to fix the exact horizons of specimens in museums and private collections in this country.

The Tertiary beds overlie the Upper Cretaceous, and these, the only Secondary beds cropping out in the Department of the Gironde, are found near Villagrains and Landiras. They mostly consist of yellowish compact limestone with flints and the few fossils that have been collected, especially the Echinoderms, indicate that both the Sénonien and Danien divisions are present.

Eocene.

The Lower Eocene nowhere rests on the yellow chalk at its outcrop, but in well-borings, beds probably of this age are met with. M. Benoist believes¹ that a limestone with *Crenaster* and *Orbitoides* in a well at the Chateau of Vigneau is about the age of the Calcaire de Mons of southern Belgium, which latter it might be mentioned is intermediate in age between our Thanet beds and the uppermost Chalk. Above the *Crenaster* limestone, a conglomerate surmounted by clays and lignites appears, and these the same authority regards as the equivalents of the lignites of the Soissonais of the Paris

¹ Journ. d'Hist. Nat. de Bordeaux, 1887.