Vanadinite,	Wanlockhead.
Dechenite,	Leadhills.
Hæmatite.	
Uraniute, Pechuran,	Wanlockhead.
Plattnerite,	Leadhills.
Psilomelane.	
Minium.	
Cuprite,	Wanlockhead.
Melaconite,	„
Gold.	
Nickeline, Copper Nickel.	
Copper Pyrites, Chalcopyrite.	
Marcasite.	
Pyrrhotite,	Wanlockhead.
Galena.	
Stibnite, Antimonite.	
Blende, Sphalerite.	
Chalcanthite,	Wanlockhead.
Wad, Bog Manganese,	Leadhills.

NO. XLI.—ON A SPECIMEN OF *PSEPHODUS MAGNUS*, AGASSIZ, FROM THE CARBONIFEROUS LIMESTONE OF EAST KILBRIDE, LANARKSHIRE.* BY R. H. TRAQUAIR, M.D., F.R.S. With a Plate [No. XVI.]

[Read 17th May, 1883.]

IN his “Tableau générale des Poissons Fossiles,” published in 1844, and appended to the first volume of his great work, Agassiz enumerates five species of his Carboniferous selachian genus *Cochliodus*, of which he only described one, the well-known *C. contortus*; the others, of which names only were then published, being *C. magnus*, *C. acutus*, *C. oblongus*, and *C. striatus*.

C. magnus was, however, figured by Lieut.-Col. Portlock in his “Geological Report of Londonderry and parts of Tyrone and Fermanagh” (Pl. 14a., fig. 4). It is a large, broadly oblong convex crushing tooth, with crenulated edges, common at Armagh,

*This paper has subsequently to the date of reading been re-written by the author in consequence of the publication by Mr. J. W. Davis and by Messrs. St. John and Worthen of important matter bearing on the subject.

in Ireland, and not at all rare in the Carboniferous limestone of many localities in Scotland. In the same work (p. 462) Col. Portlock quotes a letter from Captain Jones, in which that gentleman, a zealous collector of fossils from the Armagh limestone, expresses the opinion that this tooth passes into *Helodus planus*, another Armagh species, named but not described by Agassiz.

Both *Cochliodus magnus* and *Helodus planus* were described, and the latter also figured, by M'Coy, who still retained them as belonging to separate genera and species, for though he mentions Captain Jones's opinion regarding them, he states that he himself had not seen the passage. As regards *C. magnus*, M'Coy assigned three teeth to each ramus of the jaw, so as to form an arrangement corresponding with that in *C. contortus*. He also doubted the position of the species in the genus *Cochliodus* on account of the slight enrolment, the little definition of the characteristic oblique ridges, and the strong crenulation of the edges.*

Agassiz having visited Great Britain again in 1859 extensively revised the names of the Carboniferous selachian remains in the magnificent collection of the Earl of Enniskillen, at Florence Court, in Ireland, and instituted a great number of new generic and specific names, involving in many cases considerable subdivision of former genera. A list of these MS. names was supplied by Lord Enniskillen to Messrs. Morris and Roberts, and published by them in the *Quarterly Journal* of the Geological Society, 1862, pp. 99-102. From this list it appears that out of the previously quoted species of *Cochliodus*, except the first, *C. contortus*, a number of new genera, as well as several additional species, were established. *Cochliodus magnus* from Armagh became *Psephodus magnus*, with which *Helodus planus* was merged; *C. magnus* from Bristol became *Tomodus convexus*; *C. acutus* became *Deltopychius acutus* and *gibberulus*; *C. oblongus* became *Streblodus oblongus*, *Colei* and *Egertoni*; and lastly, for *C. striatus* the genus *Xystrodus* was proposed with the additional species.

Teeth undoubtedly generically identical with Agassiz's *Psephodus* were in 1866 figured by Messrs. Newberry and Worthen, under the name of *Aspidodus crenulatus*.† The authors refer to the resemblance which these teeth bear to Agassiz's *Cochliodus magnus*, and suggest that the latter, as well as *Helodus planus*,

* "British Palæozoic Fossils." London and Cambridge, 1855.

† Geological Survey, Illinois, vol. ii., p. 92.

should be included in *Aspidodus*. In this Messrs. Newberry and Worthen would have been perfectly right had *Psephodus* been a mere MS. name like so many others which Agassiz left behind him at Florence Court. For though no definition of *Psephodus* appeared along with the publication of the name in 1862, its type species, *magnus*, had been sufficiently well figured and described by Portlock and M'Coy to enable naturalists throughout the world to identify the genus. We may, therefore, grant priority to Agassiz's name, though solely on the grounds above given. And in the sixth volume of the Geological Survey of Illinois the name *Aspidodus*, given by Messrs. St. John and Worthen, is relinquished in favour of *Psephodus*.

It is indeed much to be regretted that Agassiz did not himself publish figures and descriptions of the numerous genera and species of fossil fishes to which in various collections he affixed MS. names, and in hardly any department did the non-completion of his work hinder progress more than in the case of those selachian remains from the Carboniferous limestone contained in the Florence Court collection. Many of those names given by him in his revision of 1859 became current among collectors without their having any published means of verifying their identifications, and the names themselves being MS. names still, in spite of their publication by Messrs. Morris and Roberts, were liable at any moment to be superseded. This want, has, however, been supplied by Mr. J. W. Davis, who, having been entrusted by Lord Enniskillen with the task of working up the Carboniferous limestone selachian remains in his collection, last year published descriptions and figures of the genera and species there named by Agassiz, along with many others established by himself as new. And the Enniskillen collection itself having been recently acquired by the British Museum, the scientific public at large have now ample opportunity of knowing the present condition of this branch of palæichthyological science, so far at least as specimens from British Carboniferous rocks are concerned.

In this work* Mr. Davis follows M'Coy in assigning three principal teeth to each ramus of the jaw of *Psephodus magnus*, and has given a figure representing three such teeth placed together in the position he supposed them to occupy. Admitting *Helodus*

* "On the Fossil Fishes of the Carboniferous Limestone Series." Sc. Trans. Roy. Dub. Soc. Vol. i. ser. 2. 1883. (Read May 15, 1882.)

planus as a synonym, he assigns to these "Helodoid" teeth a position—some in front of the larger plates, others on the palate between them.

Mr. Davis summarizes his views as follows:—"That a row of three principal teeth, increasing in size backwards, were attached to each cartilaginous ramus of the jaw; that the diameter of the jaw, as indicated by the groove or channel on the under surface of the teeth, diminished towards the symphysis; that a long narrow tooth was placed in front of the anterior one, and that a series of at least three Helodoid teeth were placed behind it, extending over the palate and increasing in size backwards." The following sentences may also be quoted:—"It is not probable that more than three teeth existed on each side of the jaw; and the teeth hitherto known as *Helodus planus*, Ag., occupied the intervening portion of the palate. An example (Pl. LV., fig. 6) shows a Helodoid tooth to have occupied a position in front of the anterior tooth, as well as the palatal space behind."

These views appear, however, to be in the main hypothetical. The "three principal teeth" have not, so far as I am aware, been found together in the positions ascribed to them; nor does it seem clear what Mr. Davis means by the "intervening portion of the palate," or the "palatal space," unless he supposes these Helodoid teeth to have been unsupported by the cartilaginous jaw arches, mandibular below and palato-quadrate above, which is certainly improbable. One of his figures (Pl. LV. fig. 4), however, shows three of the Helodoid teeth in longitudinal apposition; another (fig. 9) two similarly related to each other, and to a broad tooth; and again (fig. 6) we have one of the narrow teeth lying alongside the trigonal one, supposed by M'Coy and himself to be "anterior."

Mr. Davis's paper was read before the Royal Dublin Society, May 15, 1882, and published during the following year. But also in the same year (1883) appeared the seventh volume of the Geological Survey of Illinois, containing extensive new researches among the Carboniferous selachian remains of that region by Messrs. St. John and Werthen, and made independently of Mr. Davis's work. In this volume a considerable share of attention is given to the germs *Psephodus*, and the results certainly do not correspond with the views of Mr. Davis. While the authors state that "in reference to the dentition of *Psephodus* our infor-

mation is still meagre," they seem to have come to the conclusion that "while the median portion of the rami of the jaws of *Psephodus* was enveloped by a moderately-contorted dental plate, this plate was flanked on either side by series of teeth disposed in rows from within outwards, similar to the occurrence of the teeth upon the jaws of *Cestracion*." And as regards the allocation of the larger dental plates, one form apparently corresponding with the supposed "posterior" tooth of M'Coy and Davis is provisionally referred to the lower jaw, while another resembling the supposed "middle" tooth is in like manner referred to the upper jaw.* Moreover, on the 8th December, 1881, prior to the reading of Mr. Davis's paper, Mr. James Coutts exhibited before the Geological Society of Glasgow a remarkable specimen of *Psephodus magnus*, discovered by Mr. A. Patton in the shale accompanying the cement-limestone of East Kilbride, and his remarks upon it were published also in 1883. In this specimen we have remains of the cartilage of the jaws, along with an aggregation of teeth, which undoubtedly belonged to the same mouth. Concerning the teeth here exhibited, Mr. Coutts remarks:—"The two largest teeth evidently belong to *Cochliodus magnus*, or, as it is now given in the 'Catalogue of Western Scottish Fossils,' *Tomodus convexus*, Agassiz. Others of the teeth agree closely in form with *Helodus planus*, now *Psephodus magnus*, Agassiz, thus confirming Captain Jones's opinion that the teeth of *Cochliodus magnus* and *Helodus planus* belong, in all probability, to the same fish. Some of the teeth in this specimen agree very closely with *Helodus mamillaris*, Agassiz, while others differ in form from any of the species indicated; indeed, it is very doubtful if there are any two teeth exactly alike, but this is a feature common to the group of fishes to which the specimen belongs." From the dates it will be seen that the remarks of Mr. Davis and Mr. Coutts, in this form, were written and published altogether independently of each other.

Through the kindness of Messrs. Patton and Coutts, this very interesting specimen has been entrusted to me for re-examination, and in the present communication I propose to give a more detailed description of the facts and features which it displays.

The specimen is contained on a nearly rectangular slab of shale $9\frac{1}{2}$ inches in length by 4 in breadth. That which we may call the

* p. 64.

anterior half of the surface (Pl. XVI., fig. 1) is occupied by remains of cephalic cartilage, with teeth, behind which, on the posterior half, we find some obscure remains of a vertebral column. The most prominent object which strikes the eye on the anterior part of the slab, and lying close to what may, for convenience, be called the lower margin, is a piece of calcified cartilage, $3\frac{1}{2}$ inches in length, of an elongated form, gently curved, and broader behind than in front, which one feels much tempted to regard as the ramus of a jaw. Close to and slightly above the hinder extremity of this cartilage is one of the large dental plates of *Psephodus magnus* (*a*), lying with its deep or concave surface upwards; but it may be lifted from the matrix and freely examined on all sides. This dental plate (seen isolated and from the convex surface in fig. 3) is one of these trapezoidal teeth, considered as "middle" by M'Coy. All its margins are crenulated, save the so-called inner margin, with which very distinct lines of growth run parallel.

In front of this tooth, and extending to the anterior margin of the slab, are seen many irregularly placed small Helodoid teeth, above which again the surface is mainly covered by calcified cartilage, through which (at *b*) the broken margin of another large tooth may be seen projecting. A fracture enables us to raise this cartilaginous portion of the specimen, bringing into view upon its under surface (fig. 2) a large number of additional teeth, among which is the large one whose broken edge I have already alluded to. This is firmly fixed to a stout long-shaped piece of cartilage, resembling a jaw ramus, which is not, however, preserved in its entirety, being obliquely broken off in front. The tooth itself (fig. 4) belongs to the category reckoned by M'Coy and Davis as the "posterior" tooth of *Psephodus magnus*, and of this it represents one of the rude convex varieties. The margin regarded by M'Coy as "inner" is broken away; the anterior and posterior margins are crenulated; the so-called "outer" bent margin is entire and smooth.

These two teeth, above described, are the only large ones seen in the specimen. They undoubtedly belong to *Psephodus magnus*, Agassiz, and not to *Tomodus convexus*, as stated by Mr. Coutts; but his mistake is readily excusable when we consider the difficulty and, in many cases, impossibility, of identifying Agassiz's MS. genera, until the appearance of Mr. Davis's work.

There are no less than forty-four smaller teeth exhibited in the

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 1.

specimen. Mr. Coutts mentions thirty-two, including the two large ones; but by careful working out I have been able to uncover the additional number. They are mostly rather confused in position; but, as seen in fig. 2, several groups occur of two, three, and four in apposition. The most posterior of these smaller teeth (*c*) is isolated from the rest, and somewhat resembles *Helodus rudis* of M'Coy, though smaller in size. It is oval in shape, $\frac{1}{4}$ -inch in length by $\frac{1}{8}$ in breadth, slightly convex on the surface, and with its margin sloping and complicated.

More than twelve of the teeth (*d*) in front of this and lying between the two larger ones are clearly identifiable with *Helodus planus*, though they exhibit considerable variety in size as well as shape; the largest being nearly one inch, the smallest $\frac{3}{8}$ -inch in length. Some of them are much broader behind than in front, with oblique posterior margins, others are more rectangular; some exhibit considerable lateral convexity of the crown, on others the surface is more flattened; in all, the margins are crenulated.

Closely behind the large tooth (*b*) may be observed four teeth of a peculiar form (*e*), three of them being in apposition. The largest of these is $\frac{1}{2}$ -inch in length by $\frac{1}{4}$ in breadth; the shape somewhat rectangular, but from the middle of one margin a small angular point projects over the tooth next in advance. The margins are crenulated.

The remaining teeth are placed in advance of those already described, and most of them, where their shape is clearly exhibited, present the characters of Romanowski's genus *Lophodus*,—a genus instituted for those Helodont teeth which possess a well-marked, more or less compressed, and vertically striated or crenulated root. Among these considerable variety of form may be observed. One at least (*f*) is referable to *L. didymus*, Ag. sp., showing a broad prominent central elevation or boss, which "posteriorly" is distinctly divided into two smaller ones, below which and close to the margin of the crown is a small angular prominence. Though the division of the central elevation of the crown is feebly indicated in at least one of the others, in the rest it disappears, and the teeth assume the characters of *L. levissimus*, Ag., sp. (*g*); finally, all definition of the boss ceases, the crown ultimately becoming nearly flat. In some of these "*levissimus*" forms the boss is markedly unsymmetrical, being much more sharply defined on one side than on the other.

Concerning the rest of the specimen not much is to be said. Immediately behind the large tooth (*a*) there is a flat piece of osseous matter $\frac{1}{12}$ inch in length by $\frac{5}{8}$ in breadth, concerning which I am unable to offer any opinion. The remains of the vertebral column, of which a length of three inches is preserved, are limited to a set of elongated closely-placed spinous processes, which are, however, very obscurely seen; there is no trace of vertebral bodies, so that, as might be expected in a Palæozoic Selachian, the notochord must have been persistent. One or two minute, sharply-ridged, shagreen bodies may also be observed.

Observations.—Although the above-described specimen is one of great importance for Carboniferous Selachology, our first reflection must be that we are far from having the entire dentition of the fish before us, and that a considerable portion of the specimen must have been lost. It is very improbable that the species possessed less than four of the large tooth plates—one on each side above and below—but were only one pair present the two would be symmetrical with each other. Here we have two of these plates present, belonging respectively to the forms supposed by M'Coy and Davis to be the first and second tooth of a cochlodont dentition, but the mode in which they occur lends no support whatever to that theory. Much more probable does it seem to me that the view of Messrs. St. John and Worthen is correct, namely, that these two forms of teeth belong to different jaws, upper and lower. Which belongs to which we have, however, no really accurate means as yet of determining. Messrs. St. John and Worthen refer the broader teeth (*b* of the present specimen) to the lower jaw on account of "the somewhat stronger resemblance" which they have in form "with the contour of the mandibular teeth of typical cochlodonts."

But whether the form (*a*) or the form (*b*) be upper or lower, I must hold that these larger tooth-plates in *Psephodus* present an unmistakeable analogy in form with those of *Cochliodus*. And if this be the case, the long side of each along which the progressive increase of the tooth took place as indicated by the lines of growth, must be *internal* in position, and not *external* as it is placed by Mr. Davis in his figures. This position also brings the oblique directions of the undoubted anterior and posterior margins into harmony with those of the anterior and posterior margins of the great posterior tooth of *Cochliodus*, and of the lines separating the

rows of teeth in the recent *Cestracion*, which all cross the jaw obliquely from within outwards and forwards—a direction precisely opposite to what is seen in Mr. Davis's hypothetical figure of the dentition of *Psephodus*. Mr. Davis seems to be quite aware that in placing the teeth so he has departed from the analogy of *Cochliodus*, for, while he admits that in that genus and in *Cochliodontidæ* generally, the inrolled teeth increase from the inner side, he states that in *Psephodus* the increase takes place along the opposite or outer side (*op. cit.* p. 416). It does not seem clear on what reasons this opinion is founded.*

The imaginary nature of Mr. Davis's restoration is further illustrated by the fact that in the present specimen the two teeth of the forms supposed by Mr. Davis to be "posterior" and "middle" are nearly exactly of the same length. This is indeed what we might expect if they belonged to upper and lower jaws, whereas in the figure referred to, the supposed "middle" tooth is, to suit the tapering form of the jaw, much smaller than the "posterior" one behind it.

On the whole, I consider that view to be most likely to be correct, which would ascribe to the mouth of *Psephodus* four large tooth-plates—two above and two below—each occupying on the ramus a position similar to that of the row of largest teeth in *Cestracion*, or of the so-called median tooth of *Cochliodus*, but that of the upper jaw differing slightly in form from the one opposed to it below. If Messrs. St. John and Worthen's allocation of these larger teeth be correct, the tooth (*a*) of the present specimen will belong to the right half of the upper jaw, while (*b*) will be that of the left half or ramus of the mandible.

The subtrigonal tooth considered by M'Coy and Davis as "anterior" does not occur in our specimen, but it clearly appertains also to *Psephodus*, and there is no reason why it should not also have occupied a position in front of the large ones (*a*) or (*b*).

Teeth of different forms seem to have been present in the jaw external to and in front of the large plate, those in its immediate vicinity belonging more or less to the category of *Helodus planus*,

* In placing the long or obtusely angulated margin of the supposed "posterior" tooth (*b* of our specimen) outwards, Mr. Davis apparently follows M'Coy's description. But in describing the supposed "middle" tooth (*a*) M'Coy calls its long margin "inner," and though Mr. Davis quotes this description verbatim, he, nevertheless, with some inconsistency places the long margin in exactly the reverse position, namely, *external*.

including the peculiar forms figured (e), and that resembling *Helodus rudis*. But the front of the jaw was armed with small teeth belonging to the type, which has been designated as *Lophodus* by Romanowsky, and the forms *didymus* and *lævissimus*, both named as species of *Helodus* by Agassiz. Hence, not only must those species be merged in *Psephodus*, but the genus *Lophodus*, founded upon *H. didymus* and allied forms, ceases to have any but a conventional existence. It would, I think, have been well, before separating off any new genera from the old *Helodus* of Agassiz, to have sought for more precise information as to the essential characters of the coal-measure species *H. simplex*, which, as it occurs first both in Agassiz's systematic catalogue and in his descriptions, must, according to the rules usually followed, be considered as the type of the genus. It is to be hoped that more satisfactory information as to the real characters and affinities of that form may soon be forthcoming. Meanwhile it would seem that the teeth known as *Lophodus* are in fact those situated in the anterior part of the mouth of genera more or less allied to *Cochliodus*. For although Professor Owen, in his paper "On the Teeth of Cochliodonts," held that there was "no ground for assuming that the symphysis were prolonged, as in *Cestracion*, for the support of conical or any other teeth," * Messrs. Newberry and Worthen have, as is well known, described a species of *Cochliodus* (*C. nobilis*) from the Carboniferous limestone of Illinois, in which, with the Cochliodont plates, were associated teeth of decidedly Lophodont configuration (*Helodus nobilis*, N. & W.) in such a way as to lead to the belief that these "occupied the central portion of the jaw in two or more rows between the large convoluted teeth which we have described under the name of *Cochliodus nobilis*." And regarding the very species of *Lophodus* occurring on our present specimen, these authors remark on a previous page:—"The median teeth of *Cochliodus*, a group which must include several described species of *Helodus* (e.g., *H. lævissimus*, *H. didymus*, *H. turgidus*, &c.) have been found in regularly diminishing series like some of those now figured." † It is now shown that two of those (viz., *lævissimus* and *didymus*) occupied a position in the front of the mouth of *Psephodus*, which, although not *Cochliodus*, has certain obvious points of affinity with it. *Psephodus* is still included in the Cochliodontidæ by Messrs. St. John and Worthen. ‡

* Geol. Mag., vol. iv., 1866. † Geol. Survey of Illinois, vol. ii., Palæontology.

‡ Geol. Survey of Illinois, vol. vii., Palæontology.

EXPLANATION OF PLATE XVI.

Fig. 1. Anterior part of the specimen of *Psephodus magnus* described in the text, showing what remains of the teeth and cartilage of the jaws.

(a) Tooth supposed to be the "middle" tooth of *Psephodus magnus* by M'Coy and Davis, seen from its attached surface.

(b) Portion of tooth supposed by these authors to be the "posterior" tooth.

(g) Teeth referable to *Helodus* or *Lophodus lævissimus*.

Fig. 2. Portion of the same specimen split off and turned up showing additional teeth.

(b) Tooth whose broken margin is shown at *b* in the previous figure.

(c) Tooth of type of *Helodus rudis*, M'Coy.

(d) *Helodus planus*.

(e) *Helodont* teeth of peculiar form.

(f) *Helodus* or *Lophodus didymus*.

(g) *Helodus* or *Lophodus lævissimus*.

Fig. 3. Tooth *a* in fig. 1, seen from its convex surface.

Fig. 4. Tooth *b* in figs. 1 and 2, seen from its convex surface.

NO. XLIII.—SOME NOTES ON A FOSSILIFEROUS SHALE, A LITTLE BELOW THE CLOCH LIGHTHOUSE. BY THOMAS SCOTT, *Cor. Mem.* WITH A SECTION. [PLATE XVII.]

[Read 8th May, 1884.]

ONE day in October of last year while walking round by the Cloch, I happened to take a look at the rock sections seen near the shore in that neighbourhood. Being aware that the sandstone rocks exposed for a considerable distance along our coast line—that is south-westwards, from Greenock and Gourock—belong to the calciferous sandstone series, and being also aware that organic remains have been found in this series of rocks in different parts of Scotland, the thought often occurred to me that vegetable or animal remains might be found in the similar strata here. I was thus often tempted, while botanizing by the shore, to take a look at the rocks in passing, and on the day mentioned I examined some alternating beds of sandstone and shale exposed near the shore, about a quarter of a mile below the lighthouse.

Some of the sandstones contained carbonaceous matter, which was quite structureless, but on carefully examining one of the beds of shale I found part of it crowded with vegetable remains, consisting for the most part of ferns and calamites—one species of