

32. NOTES on the FISH-REMAINS of the BONE-BED at AUST, near BRISTOL ; with the DESCRIPTION of some NEW GENERA and SPECIES. By JAMES W. DAVIS, Esq., F.G.S. &c., Hon. Secretary of the Yorkshire Geological Society. (Read May 11, 1881.)

[PLATE XXII.]

I AM indebted for the material on which the following paper is based to Mr. W. T. Ord, of Bristol, to the Council of the Geological Society at London, who have kindly placed their collection at my disposal, and to Mr. Sollas, Professor of Geology at the University College, Bristol.

The specimens are in good preservation, the smaller ones, consisting principally of teeth, being unbroken; the larger bones, as for example, ribs or other bones of Saurians, the larger spines of Fishes, &c., are generally found in a more or less fragmentary and broken condition.

From the occurrence of the teeth which are characteristic of the older Carboniferous rocks, such as *Psammodus porosus*, *Helodus*, and *Psephodus magnus* of the Mountain Limestone, and *Ctenoptychius*, which has hitherto been found in the Carboniferous series, and more especially in the Coal-measures, it appears probable that some of the fossil remains found in the Rhætic beds at Aust have been derived from the disintegration of the older rocks. Either this must have been the case, or the genera of fishes named had a considerably longer period of existence than has hitherto been supposed. It may be objected that the remains are in a very perfect state of preservation (as, indeed, they are in most cases) and do not appear to have been exposed to much attrition by being washed on the shore or bed of the sea or a lake. It is probable, however, that the area over which the bone-bed was deposited was composed, in the neighbourhood of Aust at any rate, of the blue clays which at present underlie it. During the formation of the bone-bed the nodular masses of blue-grey stone which are now found composing a great proportion of its mass were pieces of clay, rolled round by the action of the waves or tides, so soft that they received easily an impression of the bones or teeth which lay scattered along the shore with them. From the immense number of fossil remains of Saurians and Fish which occur in the bed, it will be inferred that it required a long period of time for their accumulation, and that throughout all that time there was a peculiar absence of sedimentary deposits, the nodular masses being derived from the adjoining Keuper beds, which also formed the floor on which the bone-bed was deposited.

In a paper read to this Society in 1841* Mr. Strickland showed the bone-bed to extend over a surface of 120 miles; and since that

* Proc. Geol. Soc. vol. iii. part ii. p. 585.

time Mr. Charles Moore, in an elaborate series of papers*, has proved with extreme minuteness and care that there extended over the Somersetshire and South Wales Coal-fields, and over the Mountain Limestone, beds containing Rhætic fossils, the crevices, veins, and pot-holes in the Mountain Limestone being filled up with organic reliquæ of vertebrates as well as invertebrates of Rhætic age. These, according to Mr. Moore, have been washed in during the Rhætic and subsequent Liassic periods. Such being the case, the circumstances attending their deposition warrant the supposition that some of the fossils included in the Rhætic deposits were derived from the disintegration of the rocks on which they now rest. The bone-bed is variable in thickness, but rarely exceeds a few inches; at Aust it is from 3 in. or 4 in. to 9 in. thick; in many other places it is less, ranging over considerable areas with a thickness not exceeding one inch. There is also much diversity in the prevalence of organic remains. In a few localities the fish-remains occur in abundance, as at Aust, Axmouth, Coomb Hill, &c., whilst in other places they are entirely absent or are found very sparingly.

The fishes found in the bone-bed are comprised in the orders Plagiostomi and Ganoidei, the latter including, according to Prof. Miall†, the *Ceratodus*-remains. Besides *Ceratodus*, the Ganoids include the genera *Saurichthys*, *Gyrolepis*, *Lepidotus*, and *Amblypterus*.

Amongst the Plagiostomous genera may be enumerated *Hybodus*, *Acerodus*, *Sargodon* (?), *Nemacanthus*, *Sphenonchus*, *Lophodus*, *Squaloraiia*.

There are also large numbers of bones, teeth, and other remains of Saurians, including *Ichthyosaurus*, *Nothosaurus*, *Scelidosaurus*, and others found and identified by Mr. Moore‡.

A consideration of the characteristics of this mixed group of organic remains may afford some reasonable basis for deductions as to the circumstances under which they were accumulated. The Saurians would undoubtedly exist near and partly on land. The *Ceratodonts*, judging from a comparison of the forms of their teeth with the still existing *Ceratodus* of Australia, were vegetable feeders, and would require a shallow-water area from which to obtain their food. With respect to the remaining Ganoids, it is probable that they could freely exist in deeper water, and, from the character of their teeth, were probably predaceous in their habits. The Plagiostomous Sharks, with their sharp teeth and strong fin-spines, often attaining a large size, as evidenced by the great length of the latter, would be equally adapted for either deep or shallow waters. Taking all the items together, it would appear that the Rhætic beds were deposited in a shallow sea not far from the coast; that the Saurians passed a large proportion of their existence in the water, the remainder on

* Quart. Journ. Geol. Soc. vol. xvi. p. 483 (1860), vol. xxiii. p. 449 (1867), vol. xxxvii. p. 67 (1881).

† Palæontographical Soc., vol. xxxii. (1878).

‡ Locc. cit.

the land; of the fishes, the Sharks and some of the Ganoids frequented the shallow waters, probably in search of food. That they did so in large numbers, and spent considerable time there, is amply proved by the large number of coprolites.

Microscopical sections of the coprolites exhibit abundant evidence that the food of the Fishes or Saurians to which they owe their origin consisted of smaller fishes—fragments of bone, teeth, and other similar objects belonging to smaller or more slightly armed species of fish being found in larger proportions than any thing else with structure.

HYBODUS AUSTLENSIS, Davis. (Plate XXII. fig. 1.)

In the third volume of the 'Poissons Fossiles' M. Agassiz described a spine of *Hybodus*, of which there were several specimens in the cabinets of Lord Enniskillen and Sir P. Egerton, and in the museums at Oxford and Bristol; and an example is figured from the latter, which is about 6 inches in length. The spine is described as being round (that is, the sides are not so much compressed); and the ribs are more prominent, with deeper grooves between than in any other species described. The ribs do not anastomose, but run parallel to the anterior portion of the spine, and disappear along the posterior margin. There is a large cavity along the posterior surface; and the base of the spine is large proportionally to the remainder. The examples seen by M. Agassiz did not exhibit any traces of denticles sufficiently well preserved to enable him to describe them. Dr. Buckland and Sir Henry de la Beche knew the spine, and had previously considered it a variety of their *Ichthyodorulites dorsetiensis* (= *Hybodus reticulatus*, Agassiz) found at Lyme Regis. M. Agassiz further remarks that *H. minor* is not a small spine when compared with others he had described; but, at the same time, the spines found at Aust Cliff are not of large size, and are very different from the great spines found in the Lias at Lyme Regis. The teeth accompanying the spines are also different from those found at Lyme Regis; and altogether the differences are so great as to necessitate the institution of a new genus.

Since M. Agassiz wrote his great work, many fossil spines of *Hybodus* have been found in the Rhætic beds of Aust; and the collection at the Bristol Museum contains specimens which very nearly approach the sizes attained by the fine examples of *Hybodus reticulatus* and *formosus* of the Lias of Dorset. One of the largest examples would measure, when perfect, 13 inches in length, and fully an inch and a quarter in greatest diameter. The base presents the usual fibrous structure; it has been deeply and strongly implanted in the flesh. There is a large orifice or groove opening to the back of the spine at its base, and afterwards continued as an internal cavity towards the apex. The width of this orifice, from back to front, is about double that between the sides of the spine. The line dividing the base from the exposed portion extends with a convex curve from the anterior to the posterior portion of the spine, the convexity being towards the base. The anterior and

lateral surfaces are ornamented with strongly marked ridges of enamel, which anastomose frequently, and present a somewhat wavy outline on account of the enamel forming the ridges not being of uniform thickness, in some places presenting a beaded appearance. The ribs lie roughly parallel with the anterior surface of the spine, and run out along the posterior edge, but not in a very well defined manner. The junction of the ribs with the basal portion is not so well defined as in *H. reticulatus*: in the latter the ends of the ribs rise above the surface of the base; whilst in the Aust specimen the ridges blend with the fibrous structure of the base, and the hollows between the ridges are below the level of the basal surface. The anterior and lateral portions of the spine have a circular or, rather, dome-shaped form in section. The posterior forms a wide base, not flat, but a little produced outwards towards the centre. The whole of the posterior portion higher than the open part of the cavity retains the fibrous structure of the base; and along each side of the median portion extends a row of blunt, laterally compressed, enamelled denticles; they are about $\cdot 2$ inch across the base, and rise $\cdot 1$ inch from the surface of the spine. Each denticle is separated from the next by a distance a little greater than its own diameter.

These spines differ from those of *H. reticulatus* in several particulars: their form is stronger and more robust; the lateral surfaces are rounder, and the base and cavity wider. In comparison with its width, the spine is shorter, not so gradually pointed, and less curved. The posterior denticles are not pointed and recurved towards the base, as they are in *H. reticulatus*; nor do its characters agree with those ascribed by M. Agassiz to *H. minor*, as already stated; and it appears necessary that a specific name to indicate this spine should be instituted: I suggest that it be *Hybodus austiensis*.

HYBODUS PUNCTATUS, Davis. (Plate XXII. fig. 2.)

An imperfect spine from the bone-bed possesses characters which remove it from any other species hitherto described. It consists of the upper portion of a small spine 1 inch in length; the antero-posterior diameter is $\cdot 2$ of an inch at its broadest part; the transverse diameter is a little less; the spine is slightly curved, more so on the anterior than the posterior surface, and tapers gradually to a point. The lateral surfaces are covered with longitudinal ridges, separated by grooves of about equal diameter, numbering five on each side. Along the bottom of each groove there are a number of minute pittings extending in a line parallel with the groove. Towards the points the ridges become less prominent and gradually disappear, the apex being quite smooth and without striæ. There is a row of denticles along each latero-posterior surface; they are prominent, obtusely pointed, laterally compressed. The internal prolongation of the pulp-cavity is comparatively small (less than one third the diameter of the spine), situated nearer the posterior than the anterior surface, and conforming in outline with the oval form of the spine.

Besides *Hybodus minor*, the only spine of this genus described by Prof. Agassiz from the Aust bed was *H. læviusculus**. The original which served for the description of the latter was a small fragment about half an inch in length, in the museum at Bristol. It is described as having smooth sides, slightly compressed, with an internal cavity rounder than the external form of the spine. There are denticles along the posterior border; and these are long, pointed, and recurved towards the base.

The spine I have from Aust, the only other small form of *Hybodus* which I have seen, differs in every respect, except size, from *H. læviusculus* of Agassiz. Its sides are deeply furrowed; the posterior denticles are short and blunt; and the internal cavity is much longer than broad in section.

The number of well-defined species of teeth of *Hybodus* found in the Rhætic beds of Aust would lead to the inference that there should be a similar variety in the fin-defences of the fishes. Under the most favourable circumstances it is an extremely difficult matter to correlate the dermal defences, either spines or scutes, of the Selachians with the teeth of the same genus; but in this instance the difficulties are greatly increased by the rolled and mixed state in which the specimens are found; and it appears improbable that remains will be discovered whose relationship will be rendered certain by the position or circumstances under which they are discovered. The pittings along the grooves suggest the name *punctatus* as appropriately designating this spine.

Remarks on the Genus NEMACANTHUS, Ag.

This genus was formed to embrace two species of fossil spines of Selachians found in the bone-bed at Aust. The spines are about 5 or 6 inches in length and .7 inch in breadth in the larger species, viz. *N. monilifer*, and little more than half that size in the second one, *N. filifer*. The genus is characterized by the spine having its sides much compressed, and finely striated, with a small posterior cavity reaching half the length of the spine; where the cavity terminates on the posterior surface there commences on the sides a number of rounded tubercles: they originate near the anterior surface, extend obliquely across the spine, and run in parallel lines thence to its apex, a row extending along the junction of the lateral with the posterior face having some resemblance to a row of small blunt tubercles along each side. Along the anterior portion of the spine there extends a round keel, which is marked off from the body of the spine by a lateral canal along each side. In the larger species the lateral keel is of about the same diameter as the tubercles arranged along the sides. The smaller species, *N. filifer*, differs from the larger, *N. monilifer*, in the tenuity of its anterior keel, the smallness of the tubercles on its sides, and also of those extending along the posterior edges.

* Poissons Fossiles, tome iii. p. 46, tab. 10. figs. 24, 25, 26.

In the species described by M. Agassiz the spines are as nearly as possible twice as much in their antero-posterior as in their transverse diameter. In a specimen from the Bristol Museum (Plate XXII. fig. 3) the spine from back to front has a diameter of $\cdot35$ inch; and its width across the posterior surface is $\cdot3$ inch, or very nearly equal to the antero-posterior diameter; the external posterior groove is shallow; and no denticles or tubercles are present. There is a very large median keel along the front of the spine. It is almost round, but rather wider than deep. It is composed of shining black enamel, and constitutes one fourth of the entire diameter of the spine. The spine is imperfect, the apical portion missing; so that it is impossible to say whether the sides were tuberculated. It appears to have been less curved than the common forms, the portion preserved being straight.

A second specimen, more closely resembling *N. filifer*, is a flat-sided spine of the ordinary kind (Plate XXII. fig. 4), finely striated along each lateral face. The anterior keel is small and threadlike; along the posterior surface are blunt, widely separated denticles. This spine is $\cdot25$ inch in diameter, and, when perfect, would probably be about 2 inches long. The sides of the spine are covered with longitudinal striæ as in the type specimens.

Both the varieties noticed above are from the collection of Mr. Ord, of Bristol, and were collected from the bone-bed at Aust Cliff.

NEMACANTHUS MINOR, Davis. (Plate XXII. fig. 5.)

Spine imperfect. Length 1.1 inch, diameter $\cdot1$ inch, when perfect probably nearly or about 2 inches in length. In section it is circular. A canal or internal cavity of similar form ascends the centre of the spine towards the point (the latter broken off in this specimen). There is no evidence that the cavity was open along the posterior surface; but it appears to have been terminal. The spine is slightly curved in form. Its surface is slightly and irregularly grooved, and is further ornamented by a number of minute papillæ. In the latter respect the spine resembles the genus *Nemacanthus*; but it differs in other essential respects from either of the two species described by Prof. Agassiz*. It does not exhibit any trace of having a ridge of any kind along the anterior surface; instead of that, it is round and indiscriminately spotted with papillæ or tubercles. The section of the spine is round, and not, as in the species of Agassiz, oval or triangular. It appears probable that the spine may belong to the genus *Nemacanthus*; but it is quite separated specifically. I propose the name *N. minor* in allusion to its small size compared with those previously described.

The specimen figured is in the museum of the Geological Society and is labelled "from the Fucoid bed, Wainlode Cliff," and was presented to the Society by H. E. Strickland, Esq.

* Poissons Fossiles, vol. iii. p. 26, tab. 7. figs. 9 & 10-15.

PALÆOSAURUS? STRICKLANDI, Davis. (Plate XXII. fig. 6.)

In the museum of the Geological Society, London, there is a tooth which I believe to be unique. It is from the Rhætic bone-bed of Combe-Hill, near Cheltenham, and was presented to the Society many years ago by Mr. H. E. Strickland.

The base of the tooth is wanting; the portion remaining is slightly more than $\cdot 6$ of an inch in length. In section (fig. 6*b*) the front portion is seen to be more compressed than the back. The lateral extremities of the tooth are slightly produced, and end in a serrated margin ascending to the crown or apex of the tooth, which is smooth. The width nearest the part of the base preserved is $\cdot 35$ inch. The surface of the tooth, except along the lateral margin, is covered with fine longitudinal striations, which finally disappear before reaching the point.

This tooth has the appearance of having been washed and water-worn. The broken portion is smooth and polished; and it is probable that it may have been derived from an older rock, and redeposited amongst the remains of the Fishes and Saurians of the Rhætic age.

At a meeting of this Society held December 15th, 1841*, a paper was read by Mr. H. E. Strickland on the Bristol bone-bed, in which, along with other fossil remains, he mentions a "portion of a tooth with two finely serrated edges, and considered as probably belonging to a Saurian allied to the genus *Palæosaurus*;" there can be little doubt this is the same specimen. I have taken the liberty of associating the tooth with his name.

SPHENONCHUS (HYBODUS) OBTUSUS, Davis. (Plate XXII. fig. 7.)

The genus *Sphenonchus* was originated by M. Agassiz for the designation of certain objects which are regarded as teeth. It appears probable, as I shall attempt to show, that these objects were not teeth, but dermal defences. The specimen I am about to describe is $\cdot 45$ inch in length and $\cdot 35$ broad at the base: it is perfect, with the exception of a small fragment which is broken from the right portion of the base. The object, which appears homogeneous in structure, contracts rapidly from the base for a distance of about half its length. At this point its diameter is little more than a third that of the basal portion; and it remains the same to within a little of the point, which is slightly wider and thinner than the stem. The general form is that characteristic of the genus. It is arched forward, and does not possess any secondary denticles. The upper portion is nearly cylindrical, with the point flattened out like a chisel; near the base the form is three-sided; right and left it is produced so as to form wing-like processes; whilst down the centre of the anterior curved portion a third process is developed, which is continued and increases in size to the lowest portion of the base. The posterior surface, in its basal portion, is slightly hollowed inwards (fig. 7*b*), compensating a little for the ridge in front. The whole of the surface is smooth and covered with shining enamel.

* Proc. Geol. Soc. vol. iii. pt. ii. p. 585.

Agassiz, in the third volume of the 'Poissons Fossiles,' describes three species of this genus:—*S. hamatus*, from the Lias of Lyme Regis, in the collection of the Earl of Enniskillen; *S. elongatus*, found by Dr. Mantell in Tilgate Forest; and *S. Martini*, Rob., from the Portland Oolites of Linksfield. These species vary greatly in form and general appearance; but in each the generic characters are well developed. The cylindrical cone forming the upper tooth-like portion is bent over anteriorly, the basal portion spread out in aliform processes; and a third median ridge or process is developed from the anterior surface of the base. The specimen I have described from Aust shares these peculiarities; but in detail it appears sufficiently distinct to form a new species. It is also from a horizon earlier and lower than any of those mentioned above; and though it may probably be found necessary to modify the specific relationship of these objects when more is known of them, at present evidence is wanting to indicate that they are not distinct species.

Sphenonchus hamatus, Agass., is remarkable for its extremely arched form and the pointed termination of the tooth-like part: it is an inch in length; and its base is widely expanded. *S. Martini*, Rob., is somewhat similar to *S. hamatus*, but is shorter and less curved. The third species, *S. elongatus*, is much larger than either of the others; the cylindrical portion is expanded at first, contracting nearer the extremity, and ending in a second expansion, "en sorte que sa forme ressemble un peu à celle d'une bouteille qu'on aurait recourbée." *Sphenonchus obtusus* differs from *S. hamatus* in its smaller size, less expanded base, and in its curvature being at a considerably smaller angle: its apical termination, wide, flattened and obtusely rounded, is in marked contrast to the finely pointed end of *S. hamatus*. *S. obtusus* has altogether a finer and less stumpy form than that of *S. Martini*, whilst from *S. elongatus* it is easily distinguished by its smaller size and the nearly uniform diameter of the upper portion.

I suggest the specific name *obtusus* to designate this species, in reference to its wide and expanded apex. The specimens are from the cabinet of Mr. Ord.

Prof. Agassiz described the genus *Sphenonchus* as a member of the family of Hybodontes, associated with *Hybodus*, *Cladodus*, and *Diplodus*. Since the classical work of Agassiz was completed, *Diplodus* has been proved to be the tooth of *Pleuracanthus*, and must consequently be removed from the family of Hybodontes, and considered in connexion with the spine as nearly associated with the recent Rays, according to Agassiz; or, as I have attempted to show in a former communication, it may have some affinities with the group of the Siluroids. *Sphenonchus* and *Diplodus* are referred to in the 'Poissons Fossiles' as offering considerable difference in microscopical structure from *Hybodus* and *Cladodus*, especially the former, which, whilst having a dense coating of dentine, has a large internal pulp-cavity, which is very different from the tooth-structure of either

of the others. In the Magazine of Natural History* Mr. Charlesworth has described the fossil remains of a species of *Hybodus*, collected by Miss Anning at Lyme Regis. In connexion with the spine and teeth there is a bone which is undoubtedly an example of *Sphenonchus*, and is regarded by Prof. Agassiz in that light; in the same volume (p. 605) there is a letter from Miss Anning, saying that the hooked tooth (*Sphenonchus*) is by no means new, but that it has been frequently found at Lyme Regis in connexion with the teeth and spines of *Hybodus* or the teeth of *Acrodus*.

Mr. Charlesworth suggested that the hooked tooth is a dermal appendage or defence, probably situated immediately behind the head. Specimens since discovered prove that this suggestion was correct, and that two or three of these bodies were located on the occipital region of the head of *Hybodus*. The microscopical structure of the teeth and dermal defences of the Elasmobranch fishes is very similar, one of the principal differences being the large size of the pulp-cavity of the dermal processes as compared with that of the teeth; and in this respect Prof. Agassiz has shown that there is a great difference between the teeth of *Hybodus* or *Cladodus* and *Sphenonchus*. The base of *Sphenonchus* is excessively expanded, especially in *S. hamatus* from the Lias; and its fibrous structure without enamel indicates that it was imbedded in the flesh; it appears in this respect to resemble the dermal defences of *Raia clavata* from the Tertiary deposits.

In addition to the specimens already named, there are a number of the bones of the head, including jaws with teeth, of *Saurichthys*?; these I have handed to Mr. Sollas, who has already in preparation a paper on the same genus, derived from the examination of similar specimens in his possession.

Large numbers of fragmentary bones and small teeth are found scattered throughout the mass of the bed, but without sufficiently well established characters to enable an account to be given of them. A large operculum, nearly $2\frac{1}{2}$ inches in diameter, probably belonging to *Ceratodus*, and several bones with articular extremities, which may belong to the same genus, are included in the collection of Mr. Ord.

Besides the palatal teeth of *Psammodus* and *Cochliodus*, in all probability derived from the Mountain Limestone which underlies the Rhætic beds in some parts of the area, the following species of *Ctenoptychius* have probably been derived from the Coal-measures, and the *Petalodus* from within the Coal-measures or the Limestone. Specimens of *Helodus* have also been met with; they appear to belong or are very nearly related to *H. simplex*.

Ctenoptychius ORDII, Davis. (Plate XXII. fig. 8.)

Tooth. Length .55 inch. Depth .3 inch. A portion of the base is wanting.

The superior surface is folded so as to form a pectinated edge

* Vol. iii. p. 242, 1839.

extending along the crown, which occupies the greatest diameter of the tooth. It is slightly circular towards each end, the central part being almost straight. It is very thin, and appears to have constituted a sharp cutting-edge. The foldings are produced at their extremities into small and separated denticles, about 24 in number, whose diameter is greater from back to front than laterally. Some of these are broken at the tips; and the section thus exposed, when magnified, shows that a hollow tube ascended in the centre of each. The sulci descending to the body of the tooth from the denticulations are much more marked towards the lateral extremities than in the median region. Towards the base the tooth becomes gradually thicker; at the same time it also converges laterally to two thirds the diameter of the crown; from this part the tooth is broken off; but, from the impression on the matrix, it appears to have terminated in a broadly expanded rounded base. The tooth is attached to the matrix; and consequently the posterior surface is not exposed. The whole of the upper part of the anterior surface, above the root or base, is covered with a smooth polished surface of ganoine. From the base of the plications or foldings forming the crown of the tooth the surface extends towards the base in the form of a semicircular hollow.

This genus of Selachians was instituted by Agassiz (Poiss. Foss. tom. iii. p. 99) for the accommodation of teeth obtained from the Coal-measures of Staffordshire and Lancashire. Since that time specimens have been found in the Limestone of Armagh, and also in the Coal-measures and Limestones of Virginia, Illinois, and other localities in America. Hitherto specimens of the genus have been restricted to the Carboniferous group of rocks.

The specimen now described may either have been derived from the disintegration of coal-measure strata, and washed into the Rhætic beds during their deposition; or it may have belonged to a fish which lived during the period when those deposits were accumulating. It is probable that the former is the correct supposition.

The species from Aust differs materially from the type species of Agassiz, *C. apicalis*. The latter is possessed of only seven or eight protuberances from the crown of the tooth, the centre one being considerably larger and forming an apex to those on either side. *C. semicircularis*, N. & W., from the Coal-measure limestone of Ohio, bears a remarkably close resemblance to *C. apicalis* of Agassiz, and seems to be so little removed as scarcely to necessitate a separate specific name. *Ctenoptychius Ordii* bears some resemblance to *C. denticulatus*, Agass. (*loc. cit.* p. 101), in possessing a large number of serrations closely ranged along the crown of the tooth, whose lower portions form a series of plications extending to the body of the tooth and there disappearing; but in *C. denticulatus* the curvatures extend quite straight across the crown, whilst in the Aust specimen they form a semicircle. The base of the tooth in *C. denticulatus* is also much wider than in *C. Ordii*.

Ctenoptychius serratus, Ord (Sedgw. and M'Coy, Brit. Pal. Fos-

sils &c. p. 626, pl. 3. i. figs. 21, 22, 23), from the limestone of Armagh, bears a greater resemblance to this specimen than, perhaps, any others; but it may be easily distinguished by the greater breadth of the crown of the tooth compared with its depth, the comparatively wide and short, somewhat cone-shaped character of the denticles, and the tips of such denticles appearing minutely crenulated under the lens.

The specimens serving for the above descriptions were collected at Aust by Mr. Ord, and are from his cabinet. In recognition of his energetic and painstaking labours, I have ventured to employ his name to distinguish this species of *Ctenoptychius*.

Ctenoptychius pectinatus, Ag.

A second species of *Ctenoptychius* has also been found at Aust, and forms a part of the collection of Mr. Ord, of Bristol. It is .2 inch across the crown, and has a depth from the upper edge of the crown to the base .15 inch. The crown is composed of about 12 denticles, the tips of which extend almost in a straight line; at the apex the denticles terminate in short pointed cones. Towards the body of the tooth these speedily coalesce and form plications extending more than half the distance towards the base; they form a concave surface anteriorly, the base becoming thicker and convex. The two outermost denticles, stronger than the remainder, are continued in a semicircle, and converge towards the base. The whole of the exposed surface is covered with a black, shining enamel.

In the third volume of the 'Poissons Fossiles'*, M. Agassiz describes and figures under the name of *Ctenoptychius pectinatus*, some small teeth obtained from the Burdie-House Limestone. The specimens figured present very considerable variations in form, but are each characterized by the denticles forming the crown of the tooth being less distinctly separated towards the apex, and the points, instead of extending vertically, as in *C. apicalis*, diverge or radiate from the centre, somewhat in the form of a fan. The beautiful little specimen from Aust agrees sufficiently well with this description to warrant its inclusion in the same genus and species. Its more rounded basal termination is the most striking point of divergence, *C. pectinatus* having a more contracted stem-like or prolonged basal portion.

Cladodus curtus, Davis. (Plate XXII. fig. 9.)

This tooth offers some peculiarities which give it a distinctive character. It is imbedded in the matrix; and on the lower part it is slightly imperfect. It consists of a wide and thick base, from the centre of which springs a cone-shaped cusp. On either side the central cone there are indications that at least one secondary cusp has existed. The bony structure is very dense, and now of a deep brown colour. The length of the base is .4 inch; and the height of the central cone is .3 inch. The latter is rather less

* Page 100, tab. 19. figs. 2, 3, 4.

than .2 inch in diameter, and it ends in a rounded apex; rising from the body of the tooth, it first curves a little outward and backward, and then again bends forward, the end projecting, as shown in fig. 10*a*, Pl. XXII. It appears to be thin in proportion to its width, and has quite a tongue-shaped appearance. The surface of the part of the tooth forming the cone is deeply indented with numerous pitting. The tip is smooth and is covered with a thick coating of ganoine. The basal line of the lower portion of the tooth is curved inwards from each lateral extremity; and from the cone the tooth swells with a well-rounded forward curve to the base. Near each lateral extremity of the base a part has been broken away with the matrix. The portion left exhibits the base of a secondary denticle or cone, in the centre of which is the cavity which ascended towards its point. The secondary denticles were placed forward in comparison with the principal centre one, and were rounder in section.

This specimen more resembles Agassiz's species *C. marginatus* than any other; it may be easily distinguished, however, by the absence of the deeply striated surface which characterizes the latter and by its shorter base. I suggest the nomen triviale *C. curtus*.

EXPLANATION OF PLATE XXII. figs. 1-9.

- Fig. 1. *Hybodus austiensis*, Davis.
 2. *Hybodus punctatus*, Davis.
 2*a*. Transverse section.
 3. *Nemacanthus monilifer*, var. α .
 3*a*. Transverse section.
 4. *Nemacanthus monilifer*, var. β .
 4*a*. Transverse section.
 5. *Nemacanthus minor*, Davis.
 5*a*. Portion of spine, magnified.
 5*b*. Transverse section.
 6. *Palæosaurus Stricklandi*, Davis.
 6*a*. Tooth, magnified.
 6*b*. Transverse section, nat. size.
 7. *Sphenonchus obtusus*, Davis.
 7*a*. Ditto, magnified.
 7*b*. Antero-lateral form.
 7*c*. Posterior view.
 7*d*. Postero-lateral form.
 8. *Ctenoptychius Ordii*, Davis.
 8*a*. Longitudinal section.
 9. *Cladodus curtus*, Davis.
 9*a*. Longitudinal section.

DISCUSSION.

Prof. SEELEY remarked on the curious survival in the Aust deposit of Palæozoic types of fishes mingled with forms peculiar to the Mesozoic as offering a parallel to the mixture of Palæozoic with Secondary Mollusca in the Upper Trias of the Austrian Alps. He

stated that *Sphenonchus* always occurs on the head of *Hybodont* fishes in the Secondary rocks.

Mr. TAWNEY thought the Palæozoic forms in the Aust bed are fossils derived from the Carboniferous strata, and not, as Prof. Seeley contended, surviving types.

Mr. LONGE stated that there is a great difference between the contents of the bone-bed at Garden Cliff at Westbury and Aust Cliff respectively. He thought the fossils in the bone-bed do not belong to the period at which the materials were accumulated.

Mr. USSHER thought that the working-out of the Rhætic beds might afford evidence of the unconformities due to changed conditions of deposit. He alluded to an appearance of unconformity between Rhætic and Trias at Newark, where a thin band of derived fragments occurred at the base of the former.

Rev. H. WINWOOD argued against the theory of the bone-bed being a *remanié* bed from the fact of the delicate fossils in it not being waterworn.

The PRESIDENT thought that most of the fossils at Aust Cliff and Westbury are not *remanié*, but are of the true Rhætic age; but some Carboniferous forms are undoubtedly derived. The specimens of *Ceratodus* were not at all worn. The form called *Sphenonchus* is certainly the head-spine of *Hybodus*, as proved by specimens from Lyme Regis.

The AUTHOR stated that the details that he had given represented the examination of only three collections, and that there yet remained much work to be done in this field.