Palace Craig and Airdrie blackband ironstone, and shale above the splint coal, at Newmains, Wishaw, and Newton, Cambuslang.

EXPLANATION OF PLATE.

PLATE IV.

Fig. 1.—*Acanthodes Wardii*, Egerton, reduced in length two inches.

„ 1 *a*, Part of rhomboidal scales magnified.

„ 2.—Dorsal spine.

„ 3.—Anal spine.

„ 4.—Ventral spine.

VI.—On CTENACANTHUS HYBODOIDES, *Egerton*.

By JAMES THOMSON, F.G.S.

PLATES II., III.

(Read December 2, 1869.)

MANY of the spines found in carboniferous strata have been enshrouded in so much obscurity, that any observation which will contribute to their proper classification is of importance to the palæontologist.

The form and structure of the spines of *Ctenacanthus* have been described by Professor Agassiz ; but I am not aware that the spines of the species which forms the subject of this communication have been described as constantly or intimately associated with other head-parts, such as might suggest the particular animal to which they belonged. Teeth and spines have received distinct generic names. Our information not sufficing to determine the spines and teeth which belonged to the same animal, I propose to attempt such a determination in the case of *Ctenacanthus hybodoides*.

In the spring of 1869 I was fortunate in obtaining a slab of the Palace Craig ironstone from Carnbroe, near Airdrie, which contained, 1st, a mass of shagreen ; 2nd, two spines of *Ctenacanthus hybodoides** (Plate II., fig. 1, 1 *a*, and 1 *b*) ; 3rd, a number of the teeth *Cladodus mirabilis* (Plate III., fig. 1), all evidently in their proper relative positions, the slightly curved lines in which they are disposed suggesting the contour of the mouth ; and, lying at a higher level than these, there is exposed, 4th, a fragment of a small spine, the cross section of which gives in outline an oblong

* Described as *C. magnus* in Brit. Assoc. Report, 1869.

CTENACANTHUS HYBODOIDES, EGERTON.

sphere, with the posterior side shorter than the other. The anterior face is round and smooth, while the posterior is flat, and along the margin of which there are two rows of pointed tubercles curving inwards and downwards. Being thus found on the upper surface of the head, it is natural to infer that it was situated on the occipital region of the fish. Subsequently, I removed a portion of the ironstone that enveloped the posterior face of the spines, which revealed a double row of tubercles passing from the apex to the base along the lateral margins of the posterior face, a character which distinguishes this species. (Plate III., fig. 1 a.)

On removing the ironstone from the under side of the slab immediately over the mouth, I exposed the skin, and found embedded in its substance numerous minute bodies, consisting of two, three, and four curved diverging points rising from an expanded base, from which a sharp keel on the convex side passed to the apex of each of the points. On other parts of the slab, I found other pieces of the skin, larger than those found on the crown of the head, but possessing similar tooth-like bodies, divided into two, three, four, and in a few instances into six divergent points, and keeled along the convex or dorsal side. (Plate II., fig. 4, 4 a, b, c, d; 5, 5 a, b, c, d.)

Subsequently, I found other slabs of the ironstone at the same place, one of which contained the teeth of *Cladodus mirabilis*, and a fragment of a spine similar in structural character to the one formerly mentioned, all embedded in a patch of shagreen. I was thus led to suppose that they might be referred to the same genus. In another slab, I found embedded on a patch of shagreen the so-called teeth of *Diplodus gibbosus*, very numerous, and crowded together without order; and associated with these there is another form of tooth-like tubercles, smooth, enamelled, circular in section, and relatively larger, while the recurved apex is more pointed than the tubercles before described. They are occasionally found in patches of greater numbers, in some instances in clusters of eight and nine, and are all attached to broad, flat bases. Finding such an amount of co-related evidence, I was led to prepare microscopic sections of patches of the shagreen, which I detached from the mass. (Plate II., 3, 3 a.)

After doing so I was led to consult the results of other investigators, and found that Professor Owen, in a paper published by the Odontological Society, had described a number of similar

forms discovered by Mr. Craggs in the Newcastle coal field. He describes them as teeth, and to some he has given the names of *Ditodus divergens*, *Mitrodus quadricornus*, *Ochlodus crassus*, *Gastrodus prepositus*. (Transactions of the Odontological Society of Great Britain.)

Finding some of the forms described by the learned Professor agreeing in detail with the sections I had made, I felt much puzzled at finding all the different forms distributed over and attached to the same shagreen; and in order that I might arrive at a somewhat satisfactory conclusion, I examined a number of the recent Rays, and found on the male fish of *Raia clavata* very satisfactory results. On closely examining the skin of this species, I found tooth-like dermal spines as varied in form and number of denticulations as in the fossils under consideration. Around the orbits, all over the head and along the mesial ridge to the posterior extremity, they are diffused in considerable numbers; but more especially towards the posterior extremity are those large tooth-like dermal spines, broad at the base, and attached to the skin of the fish, while on the body of the fish they are much more sparingly developed. But all over the body there are profusely developed small dermal processes, in general tripartite, the central denticle being much longer than the two laterals; others are divided into four—the latter form much less frequent than the former; while on the dorso-lateral extremity and around the orbits there are minute dermal processes, with only one conical sharp-pointed denticle. On other parts of the body some are delicately pointed, while others are bent nearly at right angles to the plane of the base, and they all are recurved towards the posterior extremity.

On the head of the female of *Raia clavata* I found the large dermal processes much more obtuse than those of the male, and the small dermal tooth-like processes in general terminating in one denticle; but, instead of having an even contour as in the male, they are keeled.

Founding my observations on the analogy of existing Rays and Sharks, my conclusions are—

1. That the two spines of *Ctenacanthus* belonged to the same animal—both probably spines of dorsal fins, the smaller being the anterior.

2. That the animal was provided with the teeth known as *Cladodus* of Agassiz.

3. That the body of the animal was covered with fine shagreen.

4. That among this fine investiture were scattered the so-called teeth of *Ditodus*, *Mitrodus*, *Ochlodus*, and *Gastrodus*, which bear the same relation to the shagreen as the placoid armature does to the fine denticulate tubercles of existing Rays.

5. That among the living forms, sexual differences are to be noted in the dermal developments—differences which find their probable counterpart in the fossils. The dermal characters in the fossils are those of Rays—the teeth are more like those of Sharks, to which section also belong the two spinigerous dorsal fins.

Whether the views here stated be accepted or rejected, I hope the identification here attempted may serve as a basis for further observations.

EXPLANATION OF PLATES.

PLATE II.

Fig. 1.—Slab of the Palace Craig black-band ironstone, reduced to one-fourth, containing two dorsal spines, figs. 1 *a* and 1 *b*, and shagreen, with dermal tooth-like bodies.

Fig. 2.—Spine of *Otenacanthus hybodoïdes*, Egerton, restored.

Fig. 3.—Microscopic section of shagreen, magnified 12 diameters, 3 *a*, vertical section of shagreen, magnified 7 diameters.

Fig. 4.—Dermal tooth-like bodies, natural size; 4 *a*, 4 *b*, 4 *c*, dermal tooth-like bodies, in groups of two, three, and four, respectively, magnified 9 diameters; 4 *d*, side view of same, showing its curved outline and groove on the anterior face, magnified 9 diameters.

Fig. 5.—Natural size; 5 *a*, 5 *b*, 5 *c*, 5 *d*, tooth-like bodies, in longitudinal section, magnified 9 diameters.

PLATE III.

Fig. 1.—Ironstone, containing part of the gape of *Otenacanthus hybodoïdes*, with teeth *in situ*; 1 *a*, ironstone, with impression of headspine removed from the mass.

Fig. 2.—Headspine, natural size, restored; 2 *a*, side view of the same; 2 *b*, transverse section, natural size; 2 *c*, the same magnified 11 diameters.

Fig. 3.—Tooth removed from its position in the mouth, magnified two times; 3 *a*, microscopic vertical section of the same.

Fig. 4.—Dermal structure, natural size; 4 *a*, dermal structure, magnified 9 diameters.

NOTE.—I beg to thank Professor Young for his assistance in the identification of the different parts of *Otenacanthus*.