XVI. *On a new Species of Coelacanthus (C. Tingleyensis) from the Yorkshire Cannel Coal.* By JAMES W. DAVIS, F.L.S., F.G.S.

(Plates XLVI.-XLIX.)

Read June 19th, 1884.

SPECIMENS vary very much in size, and occur in all stages of growth between 3 inches and six times that length; their form is somewhat long and slender, with a series of powerful fins well adapted for rapid progression through the water. Examples which appear to have attained the maximum size of about 18 inches in length are taken for the following descriptions. In such a one the head occupies one fourth the entire length, the body, from the pectoral arch to the base of the tail, two fourths, and the tail the remaining fourth. The greatest depth of the body is immediately behind the pectoral fins, where it is 3·5 inches; posteriorly the depth diminishes gradually to the base of the tail, which is 2 inches. The body was probably more or less cylindrical in form, and the lateral diameter little less than that between the dorsal and ventral surfaces. The anterior portion of the caudal fin expands to a diameter of 4 inches, and the rays radiate from the base 3 inches: beyond this the second portion of the tail extends about 1·3 inch, its termination supporting a second series of rays, forming the peculiar prolongation of the caudal appendage characteristic of the genus. In addition to the caudal fin there are seven others—two dorsal and one anal fin, a pair of pectorals, and a pair of ventrals. The posterior dorsal fin (Pl. XLVI. d^2) is located 2·5 inches in front of the caudal (c^1), and is supported by a scale-invested lobe from the body. The anterior dorsal fin (d^1) is about 3 inches in front of the posterior one: in several specimens where this fin is present there does not appear to be any lobe supporting it. The pectoral fins (p) are situated immediately behind the thoracic arch, and, like the ventrals (v) and anal (a), they are lobate. The ventrals are powerful and large fins, placed opposite the space intermediate between the two dorsal fins. The anal fin, 3 inches behind the ventrals, is situated at a considerably shorter distance from the caudal than is the posterior dorsal fin. The whole of the body is invested in a covering of comparatively thin, enamelled, and beautifully ornamented scales; those on the dorsal and lateral regions are broader and have a more obtuse termination than those on the ventral surface. The scales covering the lobes of the fins are smaller than those of the body, and are proportionately thinner. The head is protected by dermal ossifications, the surface of which is covered with enamel raised into, and arranged in, an exquisite series of parallel but sinuous ridges. The external covering of the head is preserved in many specimens, but in all cases more or less crushed and disturbed. The cranial bones include frontals (f), parietals (p), and occipitals (o): a restored outline of their forms, one half the natural size, is attempted on Pl. XLIX. fig. 2, from which it may be inferred that the several bones

constituting the upper surface of the cranium form a compact and closely attached group. Anterior to the frontal bones there is one forming the snout, probably the ethmoid (*eth*), which reaches over and more or less envelops the anterior extremities of the rami of the upper jaw. The orbit (*orb*) is moderately large; its upper boundary is formed by the frontal and parietal bones: between these and the maxilla the structure of the lateral surface of the head is somewhat obscure. There was an important osseous plate extending from the orbit to the opercula, apparently the temporal bone (*t*); and one or more smaller ossicles filled up the interval between the maxilla, the anterior portion of the orbit, and the bones of the cranium. The opercular bones are three in number; the operculum (*op*) was a large bony plate, subtriangular in outline, extending to and overlapping the scapular bones of the pectoral arch. In addition to the operculum there are two other plates, similar in form, but only about one fourth its size: they were probably the suboperculum (*i.op*) and interoperculum (*s.op*), and are represented on Pl. XLVII. fig. 1, and also in the restoration represented on Pl. XLIX.

The upper jaws (*mx*) are frequently observed in specimens, but in no instance with sufficient certainty and clearness to enable an exact description to be given of their form. They were considerably shorter than the mandibles (*M*) of the lower jaw, thickest and strongest beneath the orbit; and, tapering towards the symphysis, the most anterior portion was probably divided by the insertion of the premaxillaries (Pl. XLVII. fig. 11). The mandibles are strong, about 3 inches in length; the lower margin is straight, and was grooved and smooth where attached to the jugular bones; the upper margin is anteriorly depressed, but expands towards the median portion to a height of .35 of an inch above the inferior margin; towards the posterior extremity the surface is again depressed. The presence of teeth in either the maxilla or mandible is somewhat problematical. An examination of many specimens has failed to show an example with teeth *in situ*. At the same time, a number of teeth are occasionally seen mixed with the bones of the head, and it is possible may have been so loosely attached to the jaws that they have invariably become separated after the death of the fish. The teeth are about .1 of an inch in length, smooth, slightly curved, and acutely pointed. The whole of the under surface of the head between the two rami of the lower jaws is occupied by the jugular plates (*ju*): they are large, elliptical in form, internally strengthened by a median process traversing the longitudinal axis of the plate, and externally ornamented by an extremely beautiful arrangement of ridges on the surface of the ganoine, varying much in detail, but running for the most part parallel with its longer axis.

The scales are moderate in size and rather thin. About one third of the surface of each scale is exposed, the remaining portion being covered by the succeeding scales. The outline of the exposed part forms a parallelogram, the exposed margin forming a more or less acutely pointed angle, whilst the margin hidden by overlapping scales is circular. The scales covering the ventral surface are the largest and broadest; they measure .3 of an inch across; the length of the scale is .35 of an inch, of which the exposed surface occupies .2 of an inch. The scales on the sides average the same length as the ventral ones, but are only about .2 of an inch across. The scales decrease in size towards the tail: they do not appear to exhibit any well-defined lateral line; they run

in parallel rows from the dorsal to the ventral surface, diagonally, with a slight sigmoidal curvature. The scales enveloping the lobes of the several fins differ from those of the body only in size; they are much smaller, decreasing as they approach the distal extremity of the lobe.

The external surface is covered with glistening enamel, which is minutely furrowed. The intervening ridges vary considerably in detail, both as to arrangement and form: in some instances the ridges extend parallel with each side of the scale and meet at the point, the successive ridges forming a series of triangles whose apices extend in a line down the middle of the scale; this is especially the case along the lateral surfaces of the body. On other scales, especially along the ventral surface, the ridges extend more or less along the axis of the scale, the longest being in the middle, and becoming gradually shorter on each side, and running out on the margins of the scale, giving it a somewhat jagged and rough outline. The ridges are not unfrequently broken by furrows extending across them, and where this happens the surface has the appearance of being covered with elongated tubercles. Various modifications of the several forms described occur on the scales of a single specimen, and sometimes in close proximity one to another (Pl. XLIX. fig. 3).

The *fins* are supported in each instance, with the exception of the anterior dorsal fin, by a pedunculate, lobate expansion of the teguments of the body. The lobes of the posterior dorsal and the pair of ventral fins are large: in the specimen depicted on Pl. XLVI. they are quite half an inch in diameter; those of the anal fin and the pectorals are not so large. The anterior dorsal fin exhibits the ordinary arrangements of the fin-rays, though they appear to be attached, in the specimen already referred to, without the intervention of a lobe, apparently in close connexion with the neural spines. It is impossible to distinguish the exact number of rays which compose each fin; but twenty rays may be counted fringing the extremity of the lobe of either the dorsal or the ventral fins, and it is probable that this number is fewer than actually exist, because the rays are more or less folded and bent under each other. The pectoral and anal fins were composed of a smaller number. The rays vary considerably in length: those springing from the extremity of the lobe are an inch and a quarter to an inch and a half in length, whilst those above and below gradually diminish, the shortest being less than half an inch in length. The basal portion of each fin-ray, for about two thirds the entire length, is formed of a single bone pierced by a hollow tube, like the spinous bones of the body; the remaining third is divided by numerous transverse jointings into small ossicles.

The caudal fin is very large and powerfully built. The vertebral column extends in a straight line from the body of the fish through, and some distance beyond, the caudal fin. Its length beyond the extremity of the fin-rays shows a considerable amount of variation in different specimens. In the one figured on Pl. XLVIII. fig. 2 the vertebral prolongation barely extends beyond the fin; but in others, and in many instances smaller specimens, there is fully an inch between the termination of the caudal-fin rays and the beginning or basal portion of the smaller rays which form the second caudal appendage. Throughout the whole length of the vertebral support for the second caudal fin there are small rays on both the upper and lower surfaces, which appear to have served as a fin-like

connexion between the first and second caudals. The rays of the larger caudal fin are similar to those already described in connexion with the fins of the body; they are formed of a single pierced ray, connected with the interspinous bones to be mentioned further on, the distal extremity of which is divided by a number of joints with articulating surfaces. The rays are thirty-eight or more in number, half of which are above and half below the median extension of the vertebral column. The second caudal also consists of a number of short rays, which form a duplicate in miniature of the larger caudal fin, without the continuation of the vertebral axis beyond its extremity.

The specimen of which a figure is given on Pl. XLVII. fig. 1 affords an almost perfect representation of the structure of the under surface of the head. The anterior external boundary of the specimen is formed by the right and left ramus of the lower jaw (*m*), each 3·3 inches in length. The space between the rami of the jaw was wholly occupied, when the fish was living, by a pair of jugular plates (*ju*); these extended from a position immediately under the point of contact between the mandibles backwards a distance of nearly 3 inches. The external lateral margins of the jugulars fit to and occupy a groove along the under surface of the mandibles, whilst mesially one appears to have slightly overlapped the other: this is indicated by there being no ornamentation on the inner surface of the left jugular, whilst that of the right one extends to the margin of the plate. On either side may be seen the operculum (*op*), a large subtriangular bone 1·3 inch in diameter. The under surface is represented in this figure; the upper or external surface is covered with a beautiful arrangement of striæ, very minute but distinct, feebly represented by a separate operculum on Pl. XLVII. fig. 7. In addition to the opercula there are two similar but smaller bones on each side, which were probably connected with the operculum, and may have been suboperculum and interoperculum (*s.op* and *i.op*). Fortunately the external bones have been pressed aside and separated, so that the internal arrangement of the branchial arches (*br*) is exhibited. There are five branchial ossifications, extending diagonally from each side of a median support: they are strong, with a more or less sigmoidal curvature, and vary in length between 1·7 and 1·2 inch, the anterior arch being longest, and those placed posteriorly gradually decreasing in length; they have a diameter of about ·2 of an inch. The median support is a strong bone 2 inches in length, ·2 of an inch in breadth near the middle, widening out anteriorly to ·3 of an inch, and terminating in an acute point: posteriorly the surface expands to ·5 of an inch, and bifurcates at the posterior extremity. A detached specimen is represented by fig. 10 on Pl. XLVII. Between the two jugular plates and in front of the median branchial support there is an ossified mass, which may represent the cruciform bone which Prof. Huxley describes as forming the anterior extremity of the strong median ossification in *Cœlacanthus lepturus* (Memoirs of Geol. Survey, decade xii. p. 19). In this instance, if the mass represents the cruciform extremity, it is a separate bone. The opposite extremity also differs from the enlarged figure in the Decades, which is described as a "posterior elongated spatulate portion."

The specimen drawn on Pl. XLVIII. exhibits a further extension of that portion of the body forming the junction of the head with the trunk of the fish. The jaws and jugular plates (*ju*) are exposed, and extending from beneath these are a pair of bones (*x*), one on

each side, which constitute a part of the pectoral arch and support the pectoral fins (*p*). The bones are nearly 2 inches in length: their anterior extremities extend towards the median portion of the branchiostegal apparatus, and are separated about an inch from each other; extending in a semicircle, the posterior extremities, somewhat flattened, are attached to the pectoral fins. A process on the outer margin of the bones gave attachment to other members of the pectoral arch, some elements of which are probably represented by the specimens on Pl. XLVII. figs. 4, 5, and 8. A separate example of the bone described above is represented by fig. 12 on the same Plate.

The vertebral column is in no instance preserved, but a decided impression remains in specimens showing its course through the body. The absence of bony vertebræ indicates that they were entirely cartilaginous, and in consequence have not been preserved. Neural spines extended from the vertebral column towards the dorsal aspect of the fish. They are strong and closely set; there are twelve in the space of one inch in that portion of the body surmounted by the anterior dorsal fin; they are 1 inch to $1\frac{1}{2}$ inch in length, being longest and most obliquely placed near the caudal extremity of the fish. The base of the spine attached to the vertebral column was divided, so as to afford a passage through which the spinal cord passed; the bifurcation extends $\cdot 3$ of an inch. The rays are hollow, the enclosed tube occupies about two fifths of the diameter of the spine, and the encircling bone is of a very fine close texture.

Prof. Huxley, in the Memoirs of the Geological Survey, decade xii. pp. 16 and 18, considers that the dorsal fins of *C. lepturus* are supported by large interspinous bones. Numerous specimens of the species now described have afforded no definite indication of such an interspinous bone; but rather seem to show a more close connexion between the spinous processes and the rays of the fin by smaller interspinous bones.

The whole of the ventral portion of the fish, from the insertion of the pectoral fins to midway between the ventral and anal fins, is occupied by an ossified air-bladder, and it is worthy of remark that the whole of this region appears devoid of ribs or hæmal spines: bones are occasionally found lying across this region, but they appear to have been displaced and fallen there accidentally. Posteriorly, hæmal processes, corresponding to those on the neural aspect of the vertebræ, extend to and support the anal fin and the inferior lobes of the caudal fins. The spinous processes are longer in this region than elsewhere, and appear to be directly connected with the rays of the tail without the intervention of interspinous bones (Pl. XLVIII. fig. 2). The connexion between the neural or hæmal spines and the fin-rays is not very clearly defined; but, so far as can be ascertained, there is no special arrangement such as was pointed out by the late Prof. Agassiz ('Poissons Foss.' vol. ii. p. 168). He describes the interspinous bones as ossicles which, instead of being attached by ligaments to the spinous bones on each side, are attached to the end of one of them, so as to form its direct continuation; and the ray, properly so called, is stated to be forked at its base, and embraces the interspinous ossicle in a manner similar to that of the spinous processes embracing the vertebræ. The specimen referred to above exhibits very clearly the attachment of the caudal rays to the spinous (?) bones. The basal extremities of the rays in this species are bent a little to one side, and thin out to a point. The distal extremity of each spinous bone, which is

also pointed, is in juxtaposition with the ray; but there is no appearance of bifurcation on the part of the latter. The terminal extremity of each ray of the caudal fin is divided into numerous little ossicles by transverse joints, as in the case of those of the other fins. The vertebral prolongation extends to a varied extent in different specimens beyond the first caudal fin: in the specimen now figured it terminates with a slightly rounded extremity, coequal with the length of the fin-rays; it is enclosed in enamelled scales quite to the end, from which a number of small rays expand to form the second caudal appendage. The number of rays is not easy to determine, but there are at least twelve of them. In a second specimen, not so large, and apparently pertaining to a younger fish, the vertebral continuation extends an inch beyond the termination of the major fin; its upper and lower surfaces are provided with short fin-rays, and the second caudal fin extends from its extremity, as in the previously described example.

A portion of the suspensory apparatus is represented by the hyomandibular bone on Pl. XLVII. fig. 3. There are also other bones whose position and function cannot be satisfactorily ascertained.

The *air-bladder* was large, and extended from a position immediately behind the pectoral arch a distance of 7 inches, to a point immediately under the second dorsal fin. Its depth is about 1 inch. It presents the appearance of a dull, semi-lustrous body, breaking with an irregular fracture, and capable of division into a large number of very thin layers. The latter are semi-transparent, something like thin layers of shellac. Under the microscope, no very decided characters can be detected; the layers do not present the appearance of osseous structure, but perhaps resemble as much as any thing the chitinous layers of the dermal covering of some insects. The outward appearance is well represented by the artist on Pl. XLVI., extending along the ventral portion of the specimen over two thirds its length, and on Pl. XLVIII. fig. 1 by an oval mass between the pectoral fins, where the scaly covering of the fish has been removed. The structural divisibility into a number of layers appears to indicate that the air-bladder consisted of an outer chamber or sac, divided into a considerable number of compartments by longitudinal septa, these also being, in all probability, subdivided by transverse partitions, which, however, have not been distinguished in the fossil state.

The species of *Cœlacanthus* now described is from the Cannel Coal in the Middle Coal Measures at Tingley, in the West Riding of Yorkshire, and with it have been found a number of other fish-remains. In a paper read before the Geological Society, and published in the Quarterly Journal of the Society for February 1880 *, a detailed description of the stratigraphical position of the Cannel Coal, as well as the manner of its occurrence, is given. In several respects this species possesses distinctive features, which exclude it from either of those described by Agassiz ('Poissons Fossiles,' vol. ii. p. 170), or from those which are described, or whose descriptions have been amplified, in the comprehensive treatise by Prof. Huxley in the Memoirs of the Geological Survey (decade xii.). The most important characters exhibited by the species now described, which I propose

* Quart. Journ. Geol. Soc. vol. xxxvi. p. 56.

shall be designated *Cœlacanthus Tingleyensis*, consist in the method of attachment of the rays of the dorsal and caudal fins to the spinous processes of the vertebræ, in the larger number of the fin-rays, and in their extremities being articulated; the ornamentation of the scales and exposed bones of the head consists partly of ridges and also of minute tubercles; and they also differ in the form of the scales.

DESCRIPTION OF THE PLATES.

PLATE XLVI.

Cœlacanthus Tingleyensis, Davis (nat. size).

PLATE XLVII.

Fig. 1. *Cœlacanthus Tingleyensis*, anterior portion of the body, exhibiting the under surface of the head (nat. size).

Figs. 2-13. Detached bones of the head.

PLATE XLVIII.

Fig. 1. *Cœlacanthus Tingleyensis*. Thoracic arch with attachment of the pectoral fins (nat. size).

Fig. 2. Caudal fin of same (nat. size).

PLATE XLIX.

Fig. 1. Restoration of *C. Tingleyensis* (half nat. size).

Fig. 2. Upper surface of head, restored.

Fig. 3. Scales, magnified.

Hy. Sykes del.

COELACANTHUS TINGLEYENSIS, Davis.

Hanhart imp.

Fig. 1.

CŒLACANTHUS TINGLEYENSIS, Davis.

Hy. Sykes del.

Hanhart rap.

Fig. 1.

By Sykes del.

Fig. 2.

CELACANTHUS TINGLEYENSIS. Davis.

Fig. 1.

Fig. 2.

Fig. 3.