ing strata overlying the pipes both in the chalk and magnesian limestone, for it assists in corroborating the views of Mr. Prestwich.

For a full exposition of the theory I have adopted, I would refer to Mr. Prestwich's most able paper "On the Origin of the Sand- and Gravel-pipes in the Chalk of the London Tertiary District," "Quart. Jour. Geol. Soc.," vol xi., p. 64.

ON THE OLD RED SANDSTONE AND ITS FOSSIL FISH IN FORFARSHIRE.

By W. POWRIE, Esq.

As anything calculated to throw light on the peculiar fauna of the Old Red Sandstone period must be interesting to geologists, I send you a short notice of some fossils lately found in the flagstones of Forfarshire, which may aid in adding to our knowledge of the peculiarities of the creatures found in these rocks.

Some six weeks ago, by far the finest specimen of *Pterygotus anglicus* yet found was discovered in the "pavement" quarries of Cannyllin: this superb specimen is now in the Arbroath Museum. This fossil, coming clean out from the matrix in which it was imbedded, consists of all the body-segments, a part of the caudal plate being also preserved and well seen in the cast from which the fossil had been lifted. It shows no features absolutely new or hitherto unknown, but it is nevertheless very interesting, as exhibiting the manner in which both the dorsal and ventral portions of this creature had been covered and protected by strong sculptured plates. It also proves that Mr. D. Page was quite correct in the place which he latterly assigned to the curious duck-bill like plate with its wing-like appendages, which, as noticed in Hugh Miller's "Old Red Sandstone," occasioned the name of "Seraphim" to be applied to this fossil. It is found *in situ*, covering the under portions of the segment next the head. In all probability, as suggested by Mr. Page, it formed part of the sexual organs of this creature, and also a covering for the vent or anal opening, there being no vestige of any such opening in either the sub-caudal segment, in the portion of the caudal plate, or telson, preserved, or on the junction of these segments. It gives some idea of the manner in which the different plates forming the body-segment joined into one another, the joinings being seemingly of such a nature as to allow the creature considerable powers of curvature. It also shows its comparative length and breadth, although in this respect it seems to differ from other specimens, showing a rather greater proportional length; but this might have been occasioned by these belonging to different sexes, the one being probably of a more slender form than the other. The head with all its appendages is wanting. The entire length of the fossil,

including the tail-segment, is three feet nine inches, and it measures very nearly twelve inches across at its greatest breadth. Making a fair allowance for the head, the creature must have been over four and a-half feet long, and had thus formed a rather formidable lobster-like animal when swimming in the waters of the primeval world. It had not, however equalled in size the *Pterygotus*, to which three tail-segments, very recently found in a quarry in this immediate neighbourhood, had belonged, and which are now in my possession.

I here give a rough sketch of this also very interesting fossil. The dotted line marks a portion which lifts clean out from the matrix, leaving a very fine cast of what I consider to have been the dorsal plates of these segments. The upper side of this fossil seems to have formed the upper portion of one of the layers or beds of the rock, and has the sculpturings a good deal obliterated; these are, however, beautifully preserved on the under side, as also on the cast. These markings are much smaller on the caudal than on the other plates, increasing in size, but still small, on the sub-caudal.

The sub-caudal plate, and that anterior to it, have ridges along both the ventral and dorsal surfaces, differing in this from some other specimens of these plates, which only show one ridge. The caudal segment is of some considerable thickness where it joins the one above it; this rapidly narrows, until, after extending to about one-fifth of its length, the upper and lower sides seem to join and become one plate. It would thus appear that the body of the creature had penetrated some little distance into this segment. No appearance of any vent or anal opening is found in these segments; and as, from the state of preservation of this fossil, had such an opening existed, it would have been in all probability readily distinguishable, it affords strong negative evidence against the existence of the vent in this part of the body of the animal. The caudal plate is seven and a-half inches long by five

Fig. 1.—Hinder Portion of *Pterygotus*.

and a-half inches broad, the sub-caudal about five and a-half inches long by seven and three-quarters inches broad. By comparing this with the Carmyllie specimen, it must have belonged to an animal about six feet in length.

From the same quarry, and about the same time, I was also fortunate enough to procure five very nearly complete segments and part of a sixth of another *Pterygotus anglicus*, the segments of which lift quite out from the matrix, leaving a very thin cast. A seventh segment is also shown in this specimen, lying at nearly right angles to the others; this might, however, have belonged to another animal coming out entire and separate from the other segments. This specimen would seem to have formed part of an animal considerably broader in proportion to its length than the two before described: in this respect it agrees with another very fine specimen now in the museum of the Watt Institution of Dundee, found some two years ago in a quarry on Tealing, consisting of seven of the body segments of the *Pterygotus anglicus*.

These four are by far the most complete remains of this very curious crustacean yet found; besides those of this species, *P. anglicus*, only very fragmentary remains of another species of *Pterygotus*, *P. punctatus*, have yet been found in Forfarshire. In Caunterland Den, however, and the "fish-beds" near Farnell, several specimens of a *Pterygotus* very similar in appearance and form to the *P. anglicus* have been discovered, but of a comparatively very small size, being only six to ten inches in length. These have not as yet been examined and named by any competent authority. They are all preserved in the collections of the Rev. Henry Brewster, of Farnell, and the Rev. Hugh Mitchell, of Craig.

After the repeated notices of the Farnell "fish-bed" in the "GEOLOGIST," by Mr. Mitchell, it is unnecessary for me to give any lengthened description of this very curious deposit or its peculiar fossils. It was first noticed as affording evidences of being fossiliferous, and pointed out as such by Mr. Brewster. It is, however, to the indefatigable researches of Mr. Mitchell that we are indebted for a knowledge of the curious organisms it contains. It is at present being very fully explored. The Earl of Southesk, on whose estates it is situated, has not only allowed this to be done, but has, with the greatest liberality, furnished labourers for the heavy part of the work, placing the examination of its treasures in the hands of Mr. Brewster and myself; and it is only due to his lordship here to record our grateful thanks for the unexampled facilities it has afforded for having these treasures, so long locked up, made known to the geological world.

Besides a good many specimens of the genera *Acanthodes* and *Brachyacanthus*, discovered and noticed by Mr. Mitchell, several species, apparently new, of *Diplacanthus*, with the remains of other fishes of other genera have already been discovered, as also several curious and seemingly new species, if not genera, of *Eurypterida* and other crustaceans. These are in the course of being prepared for

laying before competent authorities for having their affinities determined, and their characteristic markings described.

Mr. Mitchell, in his notice in your July number, rightly places this deposit, as also that of Caunterland Den, amongst the very lowermost of our Forfarshire sandstones. The localities as well as the fossils clearly indicate this.

ON THE OUTLIER OF UPPER TERTIARY IRONSAND ON THE NORTH DOWNS OF KENT.

By T. RUPERT JONES, Esq., F.G.S., Assistant-Secretary of the
Geological Society of London.

Having at times been asked questions about the "Fossiliferous Ironsands" of the North Downs, which Mr. Prestwich described in the *Journal of the Geological Society* in 1858, vol. xiv., p. 322, &c., I find that some little diagram appears to be wanted by amateur geologists and general readers for the clearer demonstration of these strata and their relations to the Chalk and the Drift.

I beg, therefore, to offer you the accompanying diagram, illustrative of the relationship of the so-called "Kentish Crag," agreeable, I believe, to Mr. Prestwich's views of the subject, as given in his elaborate paper before mentioned. Having seen the ground at Lenham and Charing, to which Mr. Prestwich refers, and at the latter of which places my friend Mr. W. Harris, F.G.S., had some sections specially made, I feel the greater satisfaction in bearing testimony to Mr. Prestwich's careful working out of the whole question.

In the diagram you will see the whole known succession of these ironsand deposits at A, where such outlines as those of Paddlesworth and Vigo-Hill may be supposed to be represented; and partial remnants are seen at B, C, D, and E. At F and Fa may be discerned instances of sandpipes which have imbibed the ironsands before the changes at the surface led to the denudation of the ironsands off the chalk, and the wearing of the Chalk into furrows and cavities, leaving the clayish sands and gravel now known as "Drift," of which G represents the lower and H the upper portion.

The sandpipes at Lenham, where the ironsand is found to be richly fossiliferous, are such as are seen at F in the diagram, the broken ironstone having sunk gradually in with the sinking superincumbent beds as the cavity was slowly made in the Chalk, probably by the dissolution of the latter by means of percolating water.* At I the

* See Mr. Prestwich's account of the formation of Sandpipes in the Chalk, *Jour. Geol. Soc.*, vol. xi., p. 64.