

XXV.—*Notes on the Fish Remains from the Bone Bed at Abden, near Kinghorn, Fife.* By WILLIAM ANDERSON.

(Read 10th June 1886.)

THE bone bed to which I wish to call your attention to-night has long been known to geologists and local collectors for the abundant but fragmentary remains of fish which it contains. Although there has been much material obtained from it by different collectors (among whom I may mention Mr Stock, Mr Henderson, Mr Bennie, and Mr Gall), I believe that no systematic account has been written of the various species of fish whose remains occur in it; and I therefore hope that the following notes (though by no means exhaustive) may be of some use to local carboniferous palæontology.

The only mention of this bed, with which I am acquainted, occurs in a Paper by the Rev. Thomas Brown, "On the Mountain Limestone and Lower Carboniferous Rocks of the Fifeshire Coasts," read before the Royal Society of Edinburgh in 1861. That writer's description of his discovery of this bone bed is so admirable that I am tempted to give an extract from it. Speaking of the section at Abden, he says, "Beginning at the top, and resolved that nothing should escape, I had nearly gone over the whole, when, about three inches above the lowest trap, I caught the glitter of a ganoid scale, and laying open the spot, a very slight effort disclosed a whole array of fish remains, spines, plates, teeth, scales, &c., in singular abundance. I was reminded of the famous bone bed of Ludlow, described as resembling a mass of broken beetles. This was obviously a similar formation of the carboniferous system. About an inch in thickness, imbedded among shale with a few shells, and charged with its abundant fish remains, all disjointed but in beautiful preservation, I could trace it running at its own level for fifty yards till lost in its course seaward at low-water mark. All the fish I had found at Ardross were here, with additional species, but there was one new and noticeable feature—the abundance of cestraciant teeth, the crushing teeth of ancient sharks." The same writer mentions the occurrence of the "head plates and scales of *Rhizodus Hibberti*, the scales of *Amblypterus*, a spine of *Otenacanthus* which was identified by Sir Philip Egerton, and specimens of *Cochliodus*." I have met with none of these, and I think it probable that the scales named *Rhizodus Hibberti* were *Rhizodopsis* scales, and that the spine of *Otenacanthus* was a spine of *Tristychius arcuatus*.

In describing the section in which this bone bed occurs, I may be allowed to indicate roughly the series of rocks which lie so beautifully exposed from Burntisland eastwards, in order that you may get an idea as to the horizon on which this bed occurs. Beginning near Burntisland, where we meet with the upper portion of the Calciferous Sandstone series, and following the cliff sections on to Kinghorn, we see that they are composed of a series of lavas and tuffs, alternating with beds of sandstone and shales, the igneous rocks forming by far the larger part of the series. From Kinghorn eastwards the rocks are well exposed along the sea-shore between tide-marks; and as far as Abden, where the bone bed occurs, they consist largely of igneous rocks, with a few beds of interstratified sandstones and shales. From this point on past Kirkcaldy, we have the Carboniferous Limestone series well exposed, with a few intrusive and contemporaneous volcanic beds among them; and still further to the east we pass up through the Millstone Grit into the coal measures of Dysart and Leven.

The particular part of this section to which I wish to refer a little more fully, occurs at Abden, about a quarter of a mile to the east of Kinghorn, at a point where the volcanic rocks begin to be less frequent in their occurrence. Here the strata have an average dip of about 25° to the south-east. Beginning at the western and lower part of this small section, we have first a contemporaneous volcanic bed of some thickness. In its central part it consists of a compact, fine-grained basalt, the constituent minerals of which are much altered, which gives it a dirty greenish colour. Its upper surface contains amygdulæ of Calcite, Chalcedony, Quartz, &c., and small cavities filled with green earth. But down towards low-water mark, there occurs on the top of this bed of basalt a considerable thickness of a fine-grained greenish coloured mudstone, which graduates upwards into the black shales in which the fish remains are imbedded. This mudstone contains abundant traces of the remains of plants, most of which, however, are in an undeterminable condition; but I have noticed one or two impressions of *Stigmaria*. Passing upwards, we come to about four feet of black shale, at the base of which there is a layer which is literally crammed with the remains of fish scales, teeth, spines, bones,—a veritable bone bed. In this same set of shales, about a foot above the bone bed, occurs a layer containing the bivalve shell *Myalina gregaria*, Eth., in great abundance; and a little higher up still, another layer containing the shells *Sanguinolites Abdenensis*, Eth., and *Pteronites persulcatus*, M'Coy. Overlying these black shales is a bed of calcareous mudstone of a greenish colour, about five feet thick, showing indistinct traces of false bedding. This again is overlaid by a few thin layers of shale,

and here this section is repeated owing to the presence of a small fault. On again taking it up, however, we find that a little above the mudstone there is a limestone, nine or ten feet thick, which in its lower part is encrinital, while in its upper part occur many marine fossils—Corals and Brachiopods, &c. Overlying this limestone are a few thin beds of shale, among which Mr Bennie tells me there is another bone bed of a similar nature to the one which is the subject of these notes, but which I have never been able to work, because, just at this point the shore is covered with large boulders, which defy removal. Over these shales comes a bed of basalt, and then follows the Carboniferous Limestone series.

It will be seen from what I have said, that the horizon of this bone bed is about the top of the Calciferous Sandstone series, or the base of the Carboniferous Limestone series. It is about an inch in thickness, and can be traced seawards along the strike of the beds by the peculiar green colour, which is present in the shale wherever these fish remains occur. In some places it rests immediately on the volcanic bed beneath, but in others there are a few layers of unfossiliferous shale between the two. Some parts of it are hard whilst others are very friable, and from this latter cause many specimens which, on being taken out seemed well preserved, in a day or two, when the shale had dried, became a mass of broken debris. One of the chief peculiarities of this bed consists in the comparative abundance of Cestraciont teeth, which, though in many cases exceedingly brittle, are, as a rule, very well preserved, and show great diversities in form and size. Another peculiar fact connected with this bed is, that in no case have I ever come across an entire specimen of a fossil fish, not even a portion of one—no two scales or bones are to be found in connection with each other. All the remains are detached fragments, jumbled up together.

Besides the remains of fish there occur in this bed a few species of mollusca. The most abundant among these are specimens of *Lingula squamiformis*, which are large and well preserved, and often occur mixed up with the fish remains. Of the others, none occurs so abundantly as *Lingula*. There are two or three species of *Aviculopecten*, a *Sanguinolites*, and one or two others, which are not identifiable. A few fragments of scorpions are to be met with, along with some traces of plants, such as fronds of *Sphenopteris affinis*, &c.

Judging from the remains of the mollusca alone, we should, I think, be justified in the conclusion that these shales had been laid down under marine conditions, and probably in rather deep water. But, both from the exceedingly fragmentary condition in which the fish remains occur, and also from the fact that they belong more to estuarine than marine forms of Carbonifer-

ous fishes, I think there can be little doubt, that the detached remains of these estuarine forms, had been carried into this marine deposit by currents, probably produced by some carboniferous river, whose mouth had not been very far distant.

At present the remains of sixteen species of fish have been identified from this bed, eight being Ganoids and eight Selachian, the remains of the former order being more numerous than those of the latter. The Ganoid remains occur as detached scales, plates, jaws, and teeth, and the forms most frequently met with are *Eurynotus* sp. (probably *E. crenatus*, Ag.), *Megalichthys* sp., *Elonichthys pectinatus*, Traq., and *Rhizodopsis* sp. The others are of rarer occurrence, and include *Cheirodus* sp., *Archichthys Portlockii*, Ag., sp., and *Strepsodus striatulus*, Traq.; while the genus *Acanthodes* is represented by spines alone, which, however, occur rather frequently.

The order *Selachii* is represented here by detached spines and crushing teeth, and the comparative abundance of these forms a marked feature of the bed. Of the spines the most common form is *Tristychius arcuatus*, Ag. The other two are new and undescribed. One of these Dr Traquair has provisionally referred to the genus *Pleurodus*, giving it the specific name *falcatus*. The second he has named *Oracanthus armigerus*, Traq. Both forms are met with frequently. The Selachian teeth occur very abundantly, and perhaps the most common of these belong to the genus *Pleurodus*. There is one as yet undescribed species, namely, *Poecilodus elongatus*, Traq. The other three forms occur sparingly, and are *Ctenoptychius pectinatus*, Ag., *Cladodus* sp., and *Deltoptychius* sp.; this last is the largest tooth of all, some specimens being over an inch across.

LIST OF FISHES FROM THE BONE-BED, ABDEN.

Ganoidei.

Eurynotus sp. (probably *E. crenatus* Ag.)
Megalichthys sp.
Elonichthys pectinatus, Traq.
Rhizodopsis sp.
Cheirodus sp.
Archichthys Portlockii, Ag. sp.
Strepsodus striatulus, Traq.
Acanthodes sp.

Selachii.

(Spines) *Tristychius arcuatus*, Ag.
Pleurodus falcatus nov. spec. Traq.
Oracanthus armigerus nov. spec. Traq.

(Teeth) *Pleurodus Woodii*, Davis.
Poecilodus elongatus nov. spec., Traq.
Ctenoptychius pectinatus, Ag.
Deltoptychius sp.
Cladodus sp.

I have to express my obligations to Dr R. H. Traquair, our highest authority on Carboniferous fossil fishes, for his kindness in examining and identifying the large number of specimens which I submitted to him from this bone bed, and also for the accompanying remarks on these fossils with which he was good enough to supply me.

Remarks on the Fossils of the Bone Bed at Abden. By
DR R. H. TRAQUAIR, F.R.S., &c.

The fish remains occurring in the estuarine and marine beds respectively of the Carboniferous formation are usually different in genera and species. While, for instance, the strata constituting the Coal Measures abound in Ganoids and Dipnoi, remains of these groups are rarely found in the purely marine limestones, which in England and Ireland constitute the greater part of the lower division of the Carboniferous system, whose imbedded fish remains, on the other hand, consist almost entirely of the teeth and spines of Selachii or Sharks. Selachian remains also occur in the Coal Measures, but of species and for the most part also of genera different from those of the Carboniferous Limestone below.

The Lower Carboniferous strata of Scotland consist, as we all know, largely of beds of estuarine origin, with which at certain horizons marine beds are interstratified; and here the same general differences occur. In the estuarine rocks, Ganoids, such as *Elonichthys*, *Rhadinichthys*, *Eurynotus*, *Rhizodus*, *Megalichthys* are the prevailing forms, while in the marine limestones the characteristic fish remains are the spines and teeth of sharks, such as *Ctenacanthus*, *Psammodus*, *Psephodus*, *Cochliodus*, *Petalodus*, &c. But Selachian remains occur also in the estuarine beds, and these though mostly of different species are more allied to those of the Coal Measures above, the most characteristic genera being *Gyracanthus*, *Tristychius*, *Otenacanthus* (type of *Otenacanthus hybodontoides*), *Pleuracanthus*, *Orthacanthus*, *Pleurodus*, &c.

It is thus clear that the muddy estuaries and the clear seas of the Carboniferous era were habitually frequented by different groups of fishes; the Ganoids being, as now, more partial to fresh and brackish waters, where they were also associated with a set of sharks different from those which preferred the clearer waters in which the Corals and Brachiopods of the period flourished.

It is interesting to find, however, that in some instances a mingling of these marine and estuarine faunæ took place, and under different circumstances. In the shale accompanying the well-known Cement Limestone of East Kilbride, Lanarkshire, specimens of Ganoids (*Rhizodus Hibberti*, Ag., *Rhadinichthys ornatissimus*, Ag., sp.) identical with forms characteristic of the estuarine Lower Carboniferous rocks occur along with such unmistakably marine Selachian types as *Psephodus magnus*, Ag. Here, from their state of preservation, some of the small fishes being quite entire, it is clear that this commingling is not due to these remains having been brought together by currents from distant localities.

In the Abden bone bed we have another case of commingling of estuarine and marine forms, but apparently under different circumstances, as in no case are two scales or two separable teeth in apposition.

The most abundant of all the remains are the scales and bones of *Eurynotus*, a characteristic estuarine Lower Carboniferous genus. *Elonichthys pectinatus*, Traq., *Strepsodus striatulus*, Traq., and *Archichthys Portlockii*, Ag., sp., may also be identified specifically with Lower Carboniferous estuarine forms. *Rhizodopsis*, *Megalichthys*, and *Cheirodus*, of which undetermined species occur, are also estuarine genera. *Cheirodus*, it may be mentioned, though a characteristic Middle Coal Measure genus, occurs also in the Carboniferous limestones of Derbyshire and Ayrshire.

Then as regards Selachii, the characteristic Lower Carboniferous estuarine species *Tristychius arcuatus*, Ag., is one of the most common forms, while *Ctenoptychius pectinatus*, Ag., so well known in estuarine beds, from the Calciferous Sandstone to the Middle Coal Measures, also occurs. *Pleurodus* is represented by teeth, and apparently by a spine, which, from its general resemblance to that associated with the teeth of *Pleurodus affinis* in the Coal Measures, I refer provisionally to that genus. The usually marine genera *Poecilodus* and *Deltoptychius* are represented by undescribed species. Most of the Selachian remains are, indeed, still undescribed, though they have come under my notice both from estuarine and marine beds in other parts of the country, and I hope very shortly to be able to figure and describe them fully.

On the whole, the fish remains occurring in this bed have a more decidedly estuarine than marine facies, and the commingling of marine forms, as well as the fragmentary state of the whole, render the bed of great interest to the geologist.